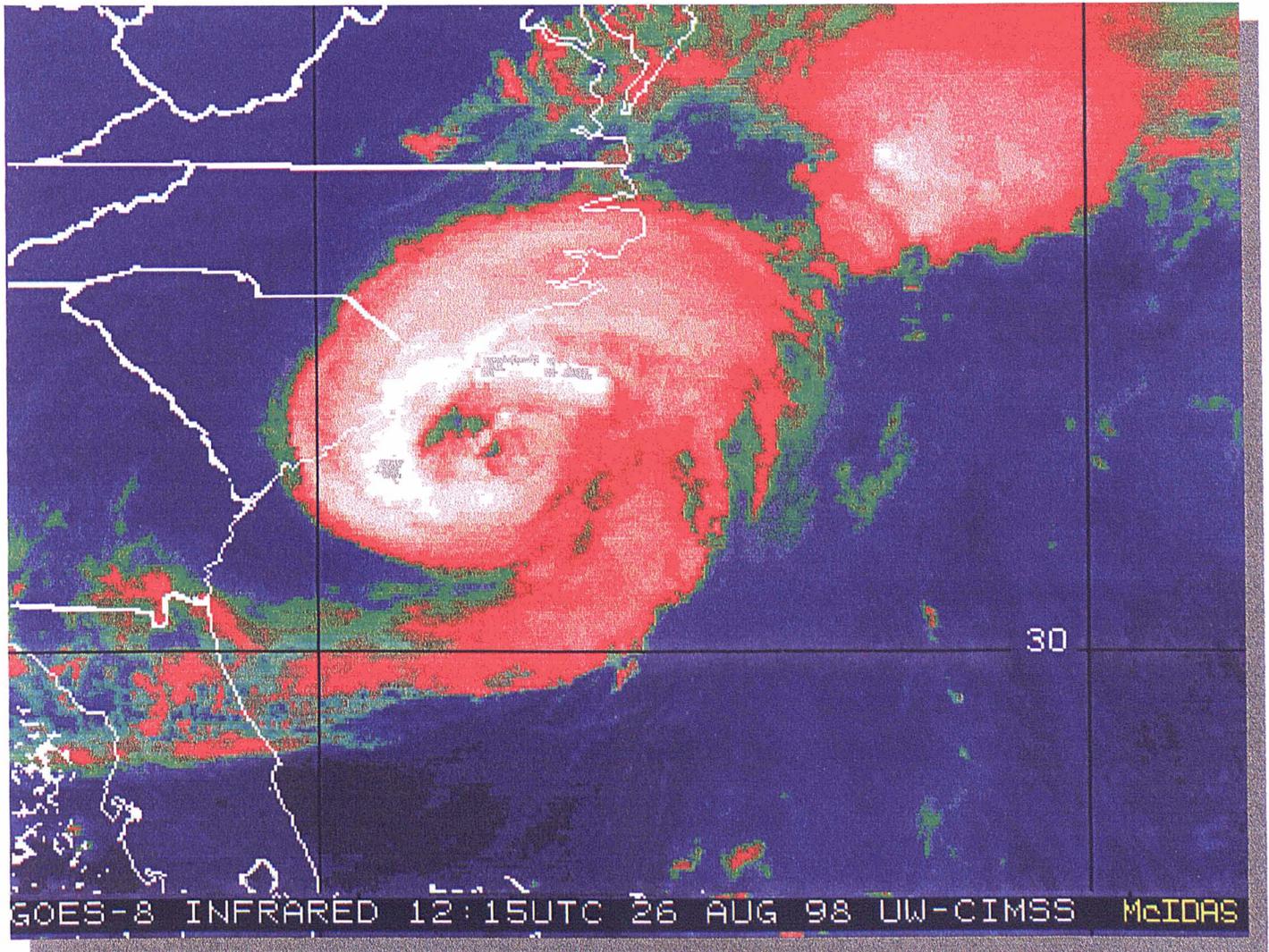


# *Hurricane Bonnie* *Assessment*

*Review of Hurricane Evacuation Studies  
Utilization and Information Dissemination*



*April 1999*



US Army  
Corps of Engineers



HURRICANE BONNIE ASSESSMENT  
Review of Hurricane Evacuation Studies Utilization  
And Information Dissemination

Prepared for

U.S. Army Corps of Engineers  
South Atlantic Division  
And  
Federal Emergency Management Agency  
Region IV

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# **National Oceanic and Atmospheric Administration Weather Bureau Hurricane Series**

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## Executive Summary

On Wednesday, the 26<sup>th</sup> of August 1998, Hurricane Bonnie passed just east of Cape Fear, North Carolina, making landfall near Wilmington, North Carolina early on the morning of the 27<sup>th</sup>. Although the storm was just a Category 2 hurricane at landfall, three deaths resulted and insured property damage totaled an estimated 360 million dollars nationwide.

Prior to Hurricane Bonnie, comprehensive hurricane evacuation restudies had been underway for both South Carolina and North Carolina. A restudy had not been initiated for Virginia. With completed early and mid 1980's studies in hand and with some draft restudy products on the table, Bonnie provided an opportunity to answer several key questions regarding these major FEMA/Corps planning efforts:

Did local and state officials use the products produced in these major studies?

Were study data regarding storm hazards, behavioral characteristics of the threatened population, shelter information, evacuation times, and decision-making accurate and reliable?

Which study products were most useful and which least useful – what improvements could be made to current methodologies and products?

To answer these questions, study teams comprised of representatives from FEMA; the US Army Corps of Engineers; and Post, Buckley, Schuh & Jernigan, Inc. visited with local and state officials throughout the directly impacted areas of South Carolina, North Carolina and Virginia.

Interviews and analysis conducted for the post Bonnie effort revealed modest evacuation participation rates on the part of the permanent population. Shelter usage was low except in Horry County, South Carolina, where many tourists went to public shelters. Few traffic problems were reported. The lack of traffic problems indicates that local and state officials started the evacuation in a timely manner, that traffic control was appropriate and effective, and that participation rates were much less than the 100% rates used in the study calculations.

State and local officials are anxious for restudy products to be finalized and delivered. Most were very pleased with the beta version of the new HURREVAC model. Attention needs to be given to evacuation zone delineations – those with newer studies evacuated in a manner consistent with the zone systems used in the transportation analysis. Those with older zone systems did not use the transportation analysis zones, saying they were too complicated to describe to the public.

Major recommendations from this post-Bonnie effort include:

1. Many of the areas interviewed for Bonnie are waiting for finalized surge mapping. There is still a wide variety of technology being used to produce the mapping around the country and within the interviewed areas. It is recommended that an ICCOH subcommittee be reorganized to address the mapping issue and determine what methods are the most cost effective and acceptable to state and local officials.
2. Update Virginia's hurricane evacuation study and provide a transportation analysis tool that will allow local jurisdictions the ability to update clearance times as housing unit growth/road construction dictates.
3. In the North Carolina restudy, make sure inland routing of traffic is taken to I-95 and inland bottlenecks noted.
4. Appoint an ICCOH subcommittee to address the evacuation zone delineation issues that face local and state EM officials as well as HES study managers.
5. Encourage NCDOT to implement some permanent traffic count stations that could strategically feed real time and post storm traffic count data to the EM community.
6. Finalize the South Carolina HES transportation analysis.
7. Update clearance time data and incorporate into the new HURREVAC model.
8. Conduct extensive training sessions with local EM's regarding the new HURREVAC model.

9. **Continue to discuss and refine shelter selection criteria with the American Red Cross.**
10. **Address backside flooding along the Albemarle Sound from an exiting storm.**
11. **Determine what public information products the HES process should produce for state and local officials**

## Chapter 1

### Introduction

On Wednesday, the 26<sup>th</sup> of August 1998, Hurricane Bonnie passed just east of Cape Fear, North Carolina, making landfall near Wilmington, North Carolina early on the morning of the 27<sup>th</sup>. Although the storm was just a Category 2 hurricane at landfall, three deaths resulted and insured property damage totaled an estimated 360 million dollars nationwide.

As reported over Lowes and FEMA's Storm 98 web site, Bonnie developed from a tropical wave over the Atlantic about 900 miles east of the Leeward Islands on Aug. 19 and became a tropical storm a day later. It moved on a west-northwestward track skirting the Leeward Islands. Late on the 21<sup>st</sup> the storm strengthened into a hurricane located about 200 miles north-northeast of eastern Hispaniola. Bonnie strengthened to its maximum winds of 115 mph late on the 23<sup>rd</sup> while located about 175 miles east of San Salvador in the Bahamas. The hurricane turned toward the northwest and stayed east of the Bahamas. Bonnie then headed toward the southeast U.S. coast in the general direction of the Carolinas gradually turning toward the north-northwest and then north. As the center neared the coast its forward speed slowed. Bonnie weakened to a tropical storm while moving slowly over eastern North Carolina. As the storm moved off the coast in the vicinity of the outer banks near Kitty Hawk, it re-strengthened into a hurricane. Bonnie soon weakened back to a tropical storm as it moved northeastward to eastward over the Atlantic into cooler waters.

Prior to Hurricane Bonnie, comprehensive hurricane evacuation restudies had been underway for both South Carolina and North Carolina. A restudy had not been initiated for Virginia. These studies and their associated work products are jointly funded by the Federal Emergency Management Agency (FEMA), the U.S. Army Corps of Engineers and the National Weather Service. The State of North Carolina also contributed study monies. The Wilmington District of the Corps of Engineers serves as study manager for the North Carolina Restudy effort and the Charleston District as study manager for the South Carolina Restudy effort.

With early and mid 1980's studies in hand and with some draft restudy products on the table, Bonnie provided an opportunity to answer several key questions regarding these major FEMA/Corps planning efforts:

Did local and state officials use the products produced in these major studies?

Were study data regarding storm hazards, behavioral characteristics of the threatened population, shelter information, evacuation times, and decision-making accurate and reliable?

Which study products were most useful and which least useful – what improvements could be made to current methodologies and products?

To answer these questions, study teams comprised of representatives from FEMA; the Corps of Engineers; and Post, Buckley, Schuh & Jernigan, Inc. visited with local and state officials throughout the directly impacted areas of South Carolina, North Carolina and Virginia. Post, Buckley, Schuh & Jernigan, Inc. was retained to accompany the study team and document all relevant findings. Many local and state officials provided their observations. Local emergency management directors, law enforcement officers, and Red Cross personnel were involved in meetings held in each area that responded to Hurricane Bonnie. Separate meetings were held to discuss study product usage with local media representatives. Appendix A lists those individuals who either attended meetings or provided input through telephone conversations.

Discussion with local emergency management officials focused on study products and their use relative to the evacuation decision process, evacuation and clearance time, sheltering, and public information. Discussions with state officials centered on the role the state played in the evacuation process, including the use of study products in communicating with local officials. Media representatives were asked to focus on study related materials that they possessed and that were broadcast to the general public. They also addressed the types of materials and public information they could have used that had not been developed or delivered to them to date.

In addition to the meetings held with state and local officials, Hazards Management Group conducted and analyzed a residential behavioral sample survey for selected communities in North Carolina. Telephone interviews were conducted to ascertain actual evacuation response in

Bonnie and to predict evacuation response parameters for the comprehensive hurricane evacuation restudy. The behavioral analysis focused on the actual percent of the affected population that evacuated during Bonnie, when the evacuees left their residence, what sort of refuge evacuees was used, where the refuge was located, and the number of vehicles used by evacuating households.

This report documents the findings of the study team and is organized by general category of hurricane evacuation study product. Those general categories that are addressed include:

- Hazards/Vulnerability Data
- Behavioral Characteristics of Evacuees
- Shelter Issues
- Transportation/Clearance Time Data
- Evacuation Decision-Making
- Public Information

Each chapter describes typical study components and products produced in comprehensive hurricane evacuation studies. The chapter then summarizes actual data related to Bonnie and where relevant, compares it with study produced data for a relevant storm scenario. Recommendations are then given for future study efforts concerning that study topic.

## Chapter 2

### Hazards/Vulnerability Data

In FEMA/Corps comprehensive hurricane evacuation studies, the primary objective of the hazards analysis is to determine the probable worst-case effects for the various intensities of hurricanes that could strike an area. Specifically, a hazards analysis quantifies the expected hurricane-caused inundation that would require emergency evacuation of the population. Historically, the hazards analysis also has assumed that mobile homes outside the surge inundation area must be evacuated due to their vulnerability to winds. The National Weather Services' SLOSH (Sea, Lake, and Overland Surge from Hurricanes) numerical storm surge prediction model was used as the basis of the hazards analysis for studies that have been completed or restudies that are ongoing in North Carolina, South Carolina and Virginia.

The vulnerability analysis uses the hazards analysis to identify the population potentially at risk to coastal flooding caused by the hurricane storm surge. Storm tide atlases are produced showing the inland extent of surge inundation for various hurricane intensities.

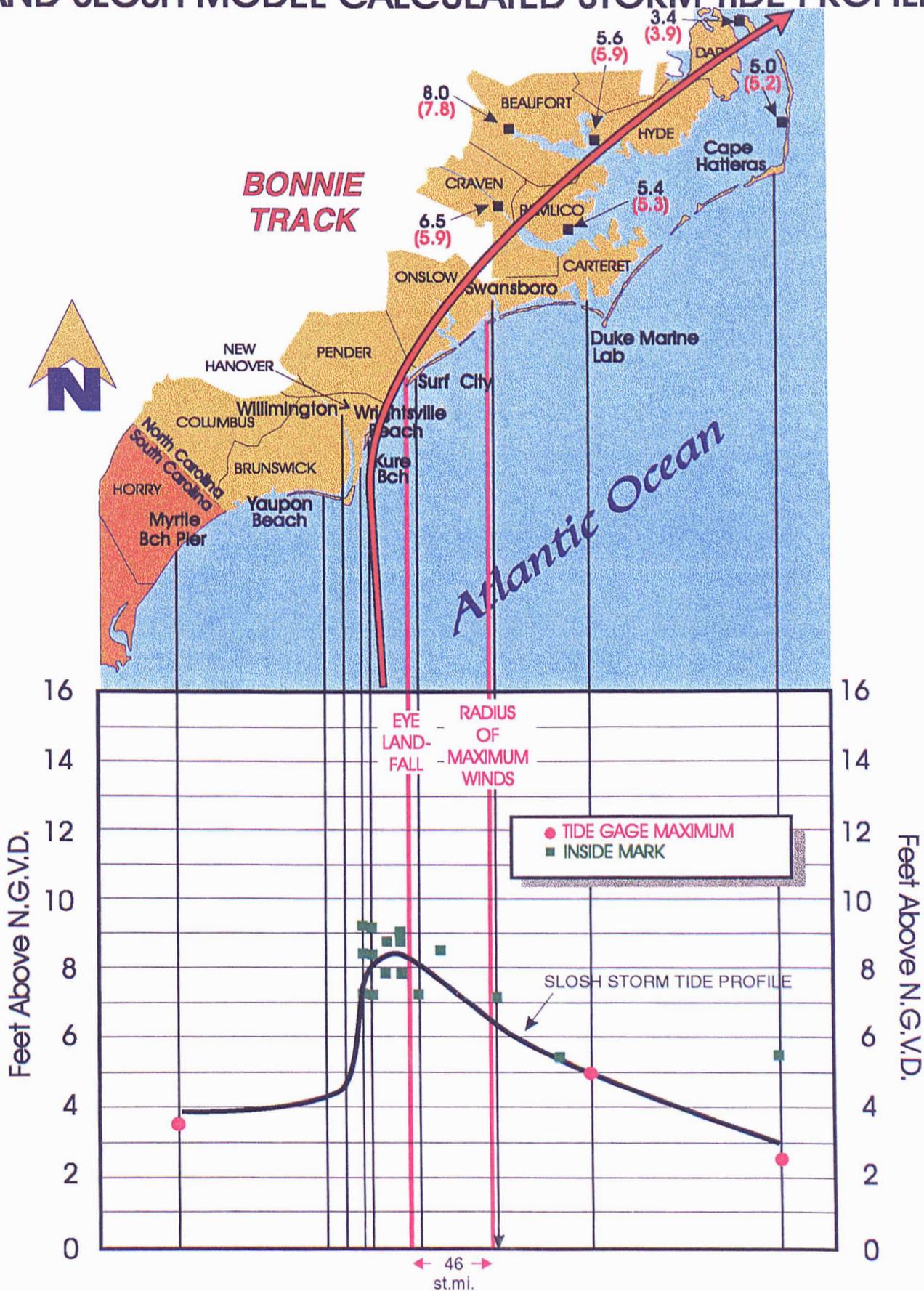
Hazards and vulnerability issues related to Bonnie that were discussed with local and state officials included the following:

What technical data/mapping was used to choose the areas to evacuate?

Did the technical data provide a good depiction of the hazard area?

Since North Carolina was the landfall state for Bonnie, it was the only area where SLOSH predictions could be compared with actual high water marks. The Wilmington District of the US Army Corps of Engineers prepared the high water mark data and then transmitted it to the National Hurricane Center for comparison with the SLOSH model. Figure 2-1 shows a comparison between the observed storm tide high water marks and the SLOSH model calculated storm tide profile along the North Carolina Atlantic Coastline for Hurricane Bonnie (1998). In addition, several individual comparisons between observed and SLOSH model calculated values are made inside of Pamlico Sound and on the Neuse and Pamlico rivers (i.e. Observed value given and calculated value below in parenthesis). All values

# OBSERVED STORM TIDE HIGH WATER MARKS FOR HURRICANE BONNIE (1998) AND SLOSH MODEL CALCULATED STORM TIDE PROFILE



are given in feet above NGVD. Also included in the figure is the radius of maximum wind at time of landfall. The results are similar to previous hurricane storm surge comparisons and generally show that the SLOSH model calculates the storm surge within plus or minus 20 percent of the observed values.

In addition to the SLOSH model comparison, the National Hurricane Center provided their preliminary forecast and warning critique for Hurricane Bonnie. Appendix B includes the “Best Track” positions for Hurricane Bonnie, including positions, barometric pressure, wind speed, and storm classification by date. The appendix also includes a table reporting selected surface observations at various localities throughout the impacted areas and a tropical cyclone watch and warning summary for Bonnie.

An excerpt from the NHC report regarding forecast error is provided as follows:

On the 22<sup>nd</sup>, most of the models suggested that Bonnie was going to remain out to sea. Thereafter, during the 23<sup>rd</sup> and 24<sup>th</sup>, there was a significant change in the model forecasts and some of them turned the hurricane toward the west while others kept it out to sea. At that point, the forecast became very difficult and highly uncertain. Consequently, watches and warnings were required for a large portion of the southeast U.S. coast. In spite of the model’s scatter, the official forecast tracks remained basically unchanged and in the middle of the model forecast ensemble. Apparently, during the earlier runs, the models weakened the ridge to the north of the hurricane too soon and forecast a premature recurvature. The official forecast errors for Bonnie were, in general, very close to the most recent 10 year average. There was only a small improvement in the 48 and 72 hour forecast if compared to the average. With the exception of a few 72 hour forecast errors at the beginning of Bonnie’s life, the NHC intensity forecasts for Bonnie were smaller than the past 10 year average errors.

#### Recommendations:

Many of the areas interviewed for Bonnie are waiting for finalized surge mapping. There is still a wide variety of technology being used to produce the mapping around the country and within the interviewed areas. It is recommended that an ICCOH subcommittee be reorganized to address the mapping issue and determine what methods are the most cost effective and acceptable to state and local officials.

Chapter 3  
Permanent Resident Public Response  
In Eastern North Carolina  
To Hurricane Bonnie  
(Prepared by Hazards Management Group)

The narrative below is provided by Hazards Management Group (HMG) for the post Bonnie evacuation assessment and focuses on describing the evacuation behavior of permanent residents in eastern North Carolina during the Bonnie event. It should be noted that FEMA and the US Army Corps of Engineers are working with HMG to ascertain the behavioral characteristics of the tourist population and their response to Bonnie. This work should be completed by summer 1999. In addition, HMG will publish a study document in February 1999 outlining behavioral parameters that should be used for the North Carolina restudy.

Method/Sample

Telephone interviews were conducted with residents of the following areas: approximately 200 on the Outer Banks (including Manteo), approximately 100 in areas subject to inundation in category 3 hurricanes along Pamlico and Albemarle Sounds, and approximately 100 in non-surge areas of counties bordering Pamlico and Albemarle Sounds. The Outer Banks/Manteo sample was broken into four sectors for reporting of results: Hatteras refers to the southern extent of the study area from Ocracoke through Rodanthe; Kill Devil Hills includes Nags Head and Wanchese; Southern Shores is the label used to refer to Kitty Hawk and point north on the Outer Banks; Manteo indicates the town of Manteo and Roanoke Island.

Statistical Reliability

Figures reported in surveys cited in this chapter are based upon samples taken from larger populations. The sample values provide estimates of the values of the larger populations from which they were selected, but are usually not precisely the same as the true population values. In general, the larger the number of people in the sample, the closer the sample value will be to the true population value. A sample of 200 will provide estimates which one can be 90% "confident" are within 4 to 6 percentage points of the true population values, compared to a sample of 100, which

will provide estimates which one can be 90% "confident" are within 5 to 8 percentage points of the true population values. With a sample of 50, one can be 90% "confident" of being within 7 to 11 percentage points of the actual population value. A sample of 25 is 90% "accurate" only within 10 to 17 percentage points. Estimates derived from samples smaller than 25 should be considered suspect.

This is particularly noteworthy in drawing conclusions about whether two survey results are "different" from one another. Differences of a few percentage points in sample results of 100 or less do not necessarily mean the populations from which the samples were drawn are different. When the aggregate samples are broken down into subgroups, the reliability of estimates for the subgroups suffers.

Questionnaire

Respondents were asked whether they evacuated their homes in Bonnie, and if so when they left, what sort of refuge they took, why they took it, and how they got there. All respondents were also asked why they responded as they did and they were asked a number of background questions to help explain their actions. The complete questionnaire is shown in Appendix C.

Evacuation Participation

The evacuation in Bonnie was not substantial in eastern North Carolina. Even on the Outer Banks only 27% said they left their homes to go someplace safer, and only 19% did so along the surge-prone areas on Albemarle and Pamlico Sounds. The Outer Banks response varied by location on the Outer Banks, however, with a high of 38% in the Southern Shores and Kill Devil Hills areas. If Manteo and Roanoke Island are excluded (not actually parts of the Outer Banks), the overall figure increases slightly.

Percent evacuating by risk area

Outer Banks/Manteo (N=202)	Coastal Sound (N=101)	Non-surge (N=99)
27	19	4

Percent evacuating by Outer Banks sectors

Hatteras (N=48)	Kill Devil Hills (N=53)	Southern Shores (N=32)	Manteo (N=60)
25	38	38	15

People who evacuated in Bonnie were asked what convinced them to leave. Respondents could give more than one reason, and some did. The answers are best interpreted as factors which influenced the decisions to leave. No single explanation dominates. The three sets of reasons given most frequently were 1) someone urged evacuation, 2) concern about the effects of the storm if it hit, and 3) concern that the storm would in fact hit.

Reasons given for evacuating (N=78) (percent giving reason; multiple reasons possible)

Officials said evacuate	21
NWS said evacuate	19
Police/Fire said evacuate	5
Media said evacuate	13
Friend/Relative said evacuate	15
Concern about severity of storm	24
Concern about increase in storm severity	4
Concern about flooding	13
Concern about wind	13
Concern about road flooding	3
Concern storm would strike	12
High strike probabilities	4
Other	17

Reasons given for not evacuating (percent giving reason; multiple reasons possible)

	Outer Banks (N=147)	Coastal Sound (N=82)	Non-Surge (N=95)
Storm not severe/house safe	49	68	80
Officials said stay	<1	5	6
Media said stay	2	9	6
Friends/relatives said stay	3	6	4
Officials didn't say to evacuate	3	5	8
Low probability of hit	20	12	32
Would miss	13	10	11
No transportation	<1	0	0
No place to go	1	2	2
Protect against looters	5	1	0
Prevent damage	11	4	6
False alarms	7	2	4
Job	10	2	4
Waited too long	2	0	1
Traffic bad	2	0	0
Too dangerous	3	0	1
No pets allowed in shelters	<1	0	0
Other	12	16	4

Similarly, those who did not evacuate were asked why they did not. By far the most common response was that the storm would not be strong enough to be a threat to the respondent's safety, either because the storm was not expected to be strong or because one's house was built adequately. The second most frequent reason given was that the storm was not expected to strike the respondent's location. Finally, some said they stayed because their job required it, some thought they could prevent damage from the storm if they were present when it struck, and some wanted to protect the property from looters.

The previous questions about reasons for leaving and staying were "open-ended." That is, respondents were simply asked the question, and their answers were placed into categories. Actual evacuation participation is often explained successfully if one knows whether the respondent believes he or she was told by authorities to evacuate. Such information would only come out in the previous questions if the respondent volunteered it. To ensure that the information was available from everyone in the sample, people were asked whether they heard during the threat from officials that

they should evacuate. Those answering yes were then asked whether the notice indicated that their evacuation was mandatory or whether it was just recommended. The results are shown below.

Type of evacuation notice heard by risk area (percent of respondents)

	Outer Banks/ Manteo (N=201)	Coastal Sound (N=98)	Non-Surge (N=99)
Mandatory Order	35	14	0
Recommendation	30	13	5
None	35	72	94

On the Outer Banks 65% said they heard from evacuation notices from officials, but only 35% believed the notices was compulsory. Although there appears to be some variation among locations on the Outer Banks, the differences are not statistically significant, given the relatively small samples in each location. Only 27% of the coastal sound sample said they heard from officials that they should evacuate.

Type of evacuation notice heard, by Outer Banks sector (percent of respondents)

	Hatteras (N=48)	Kill Devil Hills (N=53)	Southern Shores (N=31)	Manteo (N=56)
Mandatory Order	35	40	45	30
Recommendation	31	23	26	30
None	33	38	29	39

Residents who said they heard from officials that they should leave were more likely to do so, compared to people who said they did not hear evacuation notices from officials. The evacuation participation rates were not high even for those saying they had been ordered to leave from the Outer Banks, however, and the differences between those saying that the notice was mandatory versus voluntary are small. Sample sizes vary from cell to cell within and evacuation rates given for people receiving evacuation notices are reasonably reliable only in the Outer Banks/Manteo area. Sample sizes did not allow the Outer Banks/Manteo sample to be broken down further for this analysis.

Percent evacuating by type of official evacuation notice heard by risk area

	Outer Banks/ Manteo	Coastal Sound	Non-Surge
Mandatory Order	34	50	*
Recommendation	33	13	*
None	14	14	4

\*Figures based on fewer than 10 respondents.

Previous studies have shown that evacuation behavior is also strongly related to one's perception of personal vulnerability, and eastern North Carolina residents were asked two questions to assess this variable. First, they were asked whether their own home would experience dangerous flooding in a 115 MPH hurricane, which Bonnie had been at one time prior to landfall. People who believe their homes would flood dangerously should be more likely to evacuate than other people. Fewer than half the respondents said their homes would flood, even on the Outer Banks and in the coastal sound area subject to flooding in a category 3 hurricane. Because of the scale of available SLOSH inundation maps, we cannot say with certainty that everyone in the sample would be subject to flooding in at least some 115 MPH hurricanes, but in generating the sample it was our intention to include respondents in the Outer Banks and coastal sound samples who would be told to evacuate in category 3 hurricanes. This belief by residents of these locations will make it less likely that the residents will evacuate when advised or even ordered to do so. In none of the four subgroups of the Outer Banks used in our sample did a majority believe they would be at risk to dangerous flooding in a 115 MPH hurricane.

Belief that home would experience dangerous flooding in 115 MPH hurricane, by risk area (percent of respondents)

	Outer Banks/ Manteo (N=201)	Coastal Sound (N=101)	Non-Surge (N=99)
Would Flood	40	43	21
Would Not Flood	53	51	74
Don't Know	7	7	5

**Belief that home would experience dangerous flooding in 115 MPH hurricane, by Outer Banks sector (percent of respondents)**

	Hatteras (N=48)	Kill Devil Hills (N=53)	Southern Shores (N=31)	Manteo (N=60)
Would Flood	48	40	36	40
Would Not Flood	50	51	55	52
Don't Know	2	9	10	8

On the Outer Banks, people believing they would be at risk to flooding were more likely than others to evacuate in Bonnie, 40% vs. 18%. There was no statistically significant difference among residents living in the coastal sound risk area. Although people on the Outer Banks who perceived themselves to be at risk to flooding were twice as likely as others to leave in Bonnie, still fewer than half actually evacuated. Reasons would include the fact that Bonnie was not anticipated to have 115 MPH winds when she struck the Outer Banks, and respondents might not have expected the storm to strike their area at all.

**Percent evacuating by belief home would flood in 115 MPH hurricane, by risk area**

	Outer Banks/ Manteo	Coastal Sound	Non-Surge
Would Flood	40	19	5
Would Not Flood	18	16	3
Don't Know	*	*	*

Tables below extend the flood perception analysis to include wind. Respondents were asked whether it would be safe to stay in their homes in a 115 MPH hurricane, considering both wind and water. Note that the response pattern is reversed – this time they were asked whether their home would be safe, while in the previous question they were asked whether it would be at risk. Fewer than 50% said their home would not be safe, with another 12% saying they weren't sure. This was also true on the Outer Banks.

**Belief that home would be safe in 115 MPH hurricane, by risk area (percent of respondents)**

	Outer Banks/ Manteo (N=201)	Coastal Sound (N=101)	Non-Surge (N=99)
Would Be Safe	43	45	54
Would Not Be Safe	46	44	34
Don't Know	11	12	12

**Belief home would be safe in 115 MPH hurricane, by Outer Banks sector (percent of respondents)**

	Hatteras (N=47)	Kill Devil Hills (N=53)	Southern Shores (N=31)	Manteo (N=60)
Would Be Safe	49	45	45	37
Would Not Be Safe	40	47	45	47
Don't Know	11	8	10	17

People saying their homes would not be safe were about twice as likely as others to evacuate in Bonnie, although most did not. In this case, however, there was also a difference among residents along the sound.

**Percent evacuating by belief home would be safe in 115 MPH hurricane, by risk area**

	Outer Banks/ Manteo	Coastal Sound	Non-Surge
Would Be Safe	20	9	2
Would Not Be Safe	36	30	6
Don't Know	*	*	*

Finally, an analysis was performed to assess the effect of several of the above factors simultaneously. Among respondents on the Outer Banks who said they heard from officials that they should evacuate in Bonnie and who believe their homes would be unsafe in a 115 MPH hurricane, 48% left. Excluding Manteo from the Outer Banks sample raises the evacuation participation for the above residents to 50%.

### Other Predictors

People who evacuated in Fran, also tended to evacuate in Bonnie, and those who stayed in Fran tended to stay in Bonnie. This was true in all three risk zones.

Percent evacuating in Bonnie, by response in Fran, by risk area

	Outer Banks/ Manteo	Coastal Sound	Non-Surge
Left in Fran	64	67	13
Stayed in Fran	18	10	2

There were not many mobile home residents in the sample, but those who were included were more likely than others to evacuate in Bonnie. This was true on the Outer Banks and also in the coastal sound area.

Percent evacuating in Bonnie, by housing type, by risk area

	Outer Banks/ Manteo	Coastal Sound	Non-Surge
Mobile Homes	46	30	*
Other Housing	26	18	4

Length of residence in one's present home and length of residence on the Carolina coast were good predictors of evacuation. People living in their homes or the region fewer than 10 years were substantially more likely than others to evacuate in Bonnie. This could have something to do with hurricane experience, but it might also be that another explanatory variable is correlated with length of residence. More recently developed areas on the Outer Banks might be more vulnerable, for example.

Percent evacuating in Bonnie, by years lived in present home, by risk area

	Outer Banks/ Manteo	Coastal Sound	Non-Surge
Less Than 10 Years	35	31	11
10 to 20 Years	23	6	0
At Least 20 Years	17	11	0

Percent evacuating in Bonnie, by years lived in present region, by risk area

	Outer Banks/ Manteo	Coastal Sound	Non-Surge
Less Than 10 Years	42	50	25
10 to 20 Years	28	14	0
20 to 40 Years	23	14	3
At Least 40 Years	13	18	0

Finally, people who said they relied on the Weather Channel a fair amount or a great deal for information about Bonnie were more likely than others to evacuate (23% vs. 6%). In the coastal sound and non-surge areas renters were more likely to evacuate and home owners. People with lower incomes tended to be more likely than others to evacuate, although the exact relationship varied among risk areas.

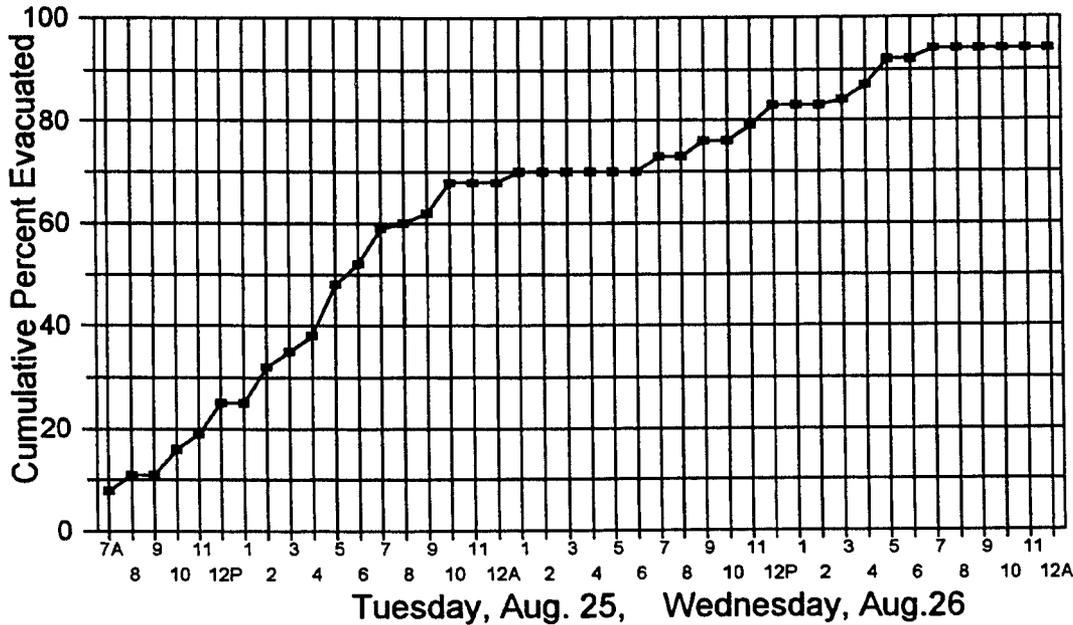
These variables were not found to be associated with evacuation in Bonnie:

- Receiving storm information from local government.
- Receiving storm information from state government.
- Living in the area when Fran threatened.
- Hearing evacuation notices in Fran.
- Number of people living in the home.
- Presence of children in the home.
- Presence of pets in the home.
- Race (except in non-surge areas, where non-whites were more likely to evacuate)

### Evacuation Timing

Evacuees were asked the day and time when they evacuated, and to refresh their memories they were reminded of the times when a hurricane watch and then a warning was first issued. Figure 3-1 displays the cumulative evacuation rate in Bonnie. That is, the line shows, of those who eventually evacuate, the cumulative percentage who had left by various times.

**Figure 3-1  
Cumulative Evacuation in Bonnie**



The hurricane watch was issued at 5 PM on Monday, August 24<sup>th</sup>, and the warning, which included all of the North Carolina coast, was issued at 5 AM on Tuesday, August 25<sup>th</sup>, just before the time when the graph in Figure 1 commences. Evacuation continued steadily throughout the 25<sup>th</sup>, and paused around 10 PM that night. It then resumed around 6 AM on the following morning. When the evacuation paused Tuesday night, 70% of the eventual evacuees had left. When it resumed Wednesday morning it did so at a slower rate.

Type of Refuge

Evacuees were asked whether they went to a public shelter, the home of a friend or relative, a hotel or motel, or someplace else. The surprising response was that no one said they went to a public shelter. Because so few evacuated, the number of evacuees answering the question was less than 100, but still this was surprising. Most people went to the homes of friends and relatives, which is common in most evacuations.

Type of Refuge in Bonnie, by risk area

	Outer Banks/ Manteo (N=54)	Coastal Sound (N=19)	Non-Surge (N=5)
Public Shelter	0	0	*
Friend/Relative	59	63	*
Hotel/Motel	33	16	*
Other	7	21	*

Tests were performed to assess whether refuge choice was related to type of structure lived in, age, years in present home, years in the region, number of people in the household, owning vs. renting, pets, race, and income. All were unrelated to the sort of refuge used by evacuees. People with children were more likely than others to go to motels, and less likely to go to friends and relatives.

Location of Refuge

Regardless of the type of refuge used in Bonnie, respondents were asked its location. From the Outer Banks 80 percent of the evacuees left their own county. Almost half (47%) went someplace else in North Carolina, and 26% went north to Virginia. A few scattered elsewhere. From the coastal sound area, more evacuees went to destinations in their own neighborhoods, and fewer went great distances.

Evacuation destinations in Bonnie, by risk area (percent of respondents)

	Outer Banks/ Manteo (N=53)	Coastal Sound (N=19)	Non- Surge (N=5)
Own Neighborhood	11	32	*
Elsewhere in Own County	9	10	*
Elsewhere in North Carolina	47	42	*
Virginia	26	16	*
Kentucky	2	0	*
Maryland	2	0	*
Pennsylvania	2	0	*

The number of evacuees from each location on the Outer Banks is too few to be statistically reliable. However, the breakdown is presented below so that readers can combine sectors as they wish in order to create data sets with geographically meaningful and statistically reliable groupings.

Evacuation destinations in Bonnie, by Outer Banks sector (percent of respondents)

	Hatteras (N=11)	Kill Devil Hills (N=20)	Southern Shores (N=12)	Manteo (N=13)
Own Neighborhood	0	25	0	8
Elsewhere in Own County	9	5	17	8
Elsewhere in North Carolina	64	30	58	62
Virginia	27	30	25	15
Kentucky	0	5	0	0
Maryland	0	0	0	8
Pennsylvania	0	5	0	0

### Vehicle Use

Not all vehicles available to evacuating households are always taken. This is often because the family doesn't wish to become separated more than necessary. Respondents who evacuated in Bonnie were asked the number of vehicles that were available to be used in the evacuation and the number actually taken. Based on those responses, only 53% of the available vehicles were used. This figure is low but not completely unheard of, compared to results elsewhere in other hurricanes. The low figure could result from residents evacuating with friends and neighbors, for example. The 53% figure corresponds to an average of 1.18 vehicles being used by each evacuating household. Only three households said they took motorhomes or pulled trailers. All were on the Outer Banks, which accounts for 4% of the evacuating households.

Six percent of the households surveyed said someone in the household needed assistance in evacuating. Two-and-a-half percent indicated a special need, whereas 3.5% needed transportation only. Four percent said they had no vehicles of their own available. All of the assistance was provided either from within the household or by friends and relatives. No one said the assistance was provided by an agency.

## Information Sources

Respondents were asked how much they relied on a variety of sources of information about Bonnie. The Weather Channel and local television stations were the most heavily used sources. On the Outer Banks the Weather Channel was number one, and in the other two areas, local stations prevailed. It was mentioned earlier that people who said they relied on the Weather Channel were more likely than others to evacuate.

Percent of respondents saying they relied a fair amount or a great deal on sources of information about Bonnie, by risk area

	Outer Banks/ Manteo (N=53)	Coastal Sound (N=19)	Non- Surge (N=5)
Local Radio	29	27	22
Local TV	42	70	71
CNN	25	34	23
Weather Channel	73	56	52
Other Cable	14	10	11
Internet	7	6	7
On-line Services	3	4	4
Word of Mouth	16	21	5

## Chapter 4

### Shelter Issues

The primary objectives of shelter analyses prepared for FEMA/Corps comprehensive hurricane evacuation studies are to list public shelter locations, assess their vulnerability relative to storm surge flooding, and to estimate the number of people who would seek local public shelter for a particular hurricane intensity or threat. Shelter location/capacity data are obtained from state and local emergency management staff working in conjunction with the American Red Cross, school board or other local agencies. Comparisons are then made with SLOSH data to assess flooding potential. Public shelter capacity is usually compared to public shelter demand figures generated in the transportation analysis to determine potential deficits or surpluses in sheltering. The behavioral analysis is important to this process as assumptions for the transportation analysis (regarding the percent of evacuees going to public shelter) come from the behavioral analysis or behavioral parameters recommended by the local directors.

Shelter issues related to Bonnie were discussed with local and state officials. Discussions focused on the following topics:

When were shelters opened and when did evacuees arrive/stop arriving?

How many shelters were opened and how many people were sheltered?

Were any flooding, wind, or loss of power problems encountered with shelters during the storm?

Table 4-1 summarizes the responses to each of these topics gathered for the counties interviewed in South Carolina, North Carolina and Virginia.

In general, the number of evacuees going to public shelters was less than what was anticipated even in the old hurricane evacuation studies for each area. Horry County, South Carolina was somewhat of an exception due to the significant number of tourists who traveled to local public shelters. For all other jurisdictions, public shelter evacuees were primarily permanent residents. Since evacuation

**Table 4-1  
Public Shelter Data Summary  
Hurricane Bonnie Evacuation Assessment**

<b>Location</b>	<b>Number of Shelters Opened</b>	<b>Number of People Sheltered</b>	<b>Tech. Data Report Shelters/Expected Shelter Demand</b>	<b>Time Opened/Duration</b>	<b>Problems Encountered</b>
<b>North Carolina</b>					
Dare	Not Applicable	-	-	-	-
Hyde (Oracoke)	Not Applicable	-	-	-	-
Carteret	5	750	N/A	6 PM on 8/25/98; 48 hrs	Loss of power; over capacity at Beaufort; locals waited for shelters to open
Albemarle Sound Counties	1 shelter in each	Washington Cnty 104 Perquimans Cnty 250 Chowan Cnty 125	N/A	Washington Cnty 4 PM Perquimans Cnty 6 PM Chowan Cnty 6 PM Pasquotank Cnty 6 PM Camden Cnty 6 PM	All counties want a statewide shelter plan
Currituck	None local	-	-	-	Public needs better information about inland public shelters
Pender	2	893	2500	4 PM on 8/25/98 3 days	Power loss
Onslow	7	1600	7600	-	Need better generators; would like to know how many people churches are sheltering
New Hanover	4	800 (Mostly permanent residents)	3800	2 opened on 8/25/98 at 5 PM; other 2 opened on 8/26/98	Loss of power; sewer lift stations down; minor structural problems; shelter staffing
Brunswick	4	3000	4450	10 AM on 8/25/98	Shalote Middle School handled overflow of evacuees from other 3 shelters

**Table 4-1 (Continued)  
Public Shelter Data Summary  
Hurricane Bonnie Evacuation Assessment**

<b>Location</b>	<b>Number of Shelters Opened</b>	<b>Number of People Sheltered</b>	<b>Tech. Data Report Shelters/Expected Shelter Demand</b>	<b>Time Opened/Duration</b>	<b>Problems Encountered</b>
Pamlico Sound Counties	Martin 4 Craven 4 Beaufort 3	Martin 800 Pamlico 225 Beaufort 800	N/A	Beaufort 8/25/98 2:00 PM 3 Days	-
<b>Virginia</b>					
Norfolk	1	28	N/A	8/26/98	Roof damage
Virginia Beach	2	300	N/A	8/25/98 3 1/2 days	Power loss
Chesapeake	3	35	N/A	08/25/98	-
Suffolk	2	20	N/A	8/26/98 1 day	-
Portsmouth	1	35	N/A	8/26/1998 5:00AM	-
<b>South Carolina</b>					
Georgetown	2	543	2000	Pleasant Hill 20 hours Andrews 48 hours	Evacuees arrived before shelter staff; loss of power; loss of water
Horry	10	6510	6100	48 hours	Power outages; lots of tourists in shelters; once full, permanent residents seeking shelter were sent inland.
Inland Counties	35	3269	-	8/25/98 through 8/27/98	-

participation rates of permanent residents from potential storm surge areas were much less than 100%, lower actual public shelter demand figures are to be expected.

In the Virginia jurisdictions very little evacuation took place making any comparison to study figures meaningless. Only isolated problems regarding shelter staffing and loss of power were reported. Several instances occurred where the public showed up at shelters before they were staffed and officially opened. Communications to evacuees traveling to inland county public shelters is a concern to some local directors particularly in eastern North Carolina.

## Chapter 5 Transportation/Clearance Time Data

In FEMA/Corps of Engineers comprehensive hurricane evacuation studies, the primary objective of the transportation analysis is to determine the clearance times needed to conduct a safe and timely evacuation for a range of hurricane threats. Information from the vulnerability, shelter, and behavioral analyses are directly input as well as various sources of permanent and seasonal population data.

For North Carolina, clearance times had been updated for Brunswick, New Hanover, Onslow and Pender Counties prior to Bonnie. The remainder of the state had to rely on older clearance times developed in the mid 1980's. Horry and Georgetown Counties in South Carolina had received draft updated clearance time data in the spring of 1998. For Virginia, clearances time data was somewhat dated as their base hurricane evacuation study had been accomplished in 1990. Each of these studies provided clearance times for a range of scenarios reflecting differing storm intensities, seasonal occupancy levels, and differing mobilization rates. Hurricane Bonnie provided a limited opportunity to analyze the validity of these study products.

Transportation and clearance time issues related to Bonnie and discussed by the study teams with local and state officials included the following:

- Was the evacuation roadway network accurate – did evacuees use projected routes?
- Were any traffic control actions taken to speed up flow?
- When was the evacuation essentially completed – how long did the evacuation take?
- Were any major problems encountered in this evacuation?

Table 5-1 provides a summary of the responses received regarding transportation and clearance time data. Very little data is available for Virginia as little evacuation took place in each local jurisdiction. The most significant evacuations took place along the Outer Banks area (where tourists moved inland) and lower southeast coastal counties of North Carolina. Evacuations also took place in

**Table 5-1  
Transportation/Clearance Time Data Summary  
Hurricane Bonnie Evacuation Assessment**

<b>Location</b>	<b>Evacuation Roadway Network Accurate</b>	<b>Traffic Control Actions</b>	<b>Clearance Time Experienced</b>	<b>Study Calculated Time</b>	<b>Problems Encountered</b>
<b>North Carolina</b>					
Dare	Yes	Highway patrol stationed at critical points	14 Hours	N/A	2 lane highway section from Corolla congestion; bottleneck in Elizabeth City late in the evening; permanent population didn't participate to the degree the tourists did; inland NCDOT road construction
Hyde (Oracoke)	Yes	-	Need 36 hours	N/A	Would like to relocate Swan Quarter Ferry
Carteret	Yes	Coordination of traffic signals	5 hours reported but shelter arrivals would imply 8-10 hours	N/A	Minor traffic problems at NC24/NC58 in Cape Carteret and in Morehead City at bridge terminus with US70
Albemarle Sound Counties	Yes	-	Not applicable	N/A	Traffic study needs to go all the way to I-95; signing needed directing traffic to I-95; bottlenecks at 64/32 and 343/158
Currituck	Yes	Manned traffic control points	Dare/Currituck traffic ended after midnight	N/A	Major accident on 168; bottlenecks at 158/12, 158/168, 158/34, 168 at Virginia State Line
Pender	Yes	None needed	8 Hours	9 1/4	None
Onslow	Yes	Manned traffic control points; evacuation routes already signed	6-8 Hours	9 1/4	None
New Hanover	Yes	Manned traffic control points; some rerouting; variable message sign used	10-12 Hours	9 1/2	Clearance times okay but close; 88-90% participation of beach communities; Brunswick traffic to I-40 was initially a problem
Brunswick	Yes	Highway patrol pre-staged and manned intersections	8-10 Hours	11 1/2	Traffic flow was smooth; concerned about participation rates on some barrier islands

**Table 5-1 (Continued)  
Transportation/Clearance Time Data Summary  
Hurricane Bonnie Evacuation Assessment**

<b>Location</b>	<b>Evacuation Roadway Network Accurate</b>	<b>Traffic Control Actions</b>	<b>Clearance Time Experienced</b>	<b>Study Calculated Time</b>	<b>Problems Encountered</b>
Pamlico Sound Counties	Yes	None reported	Hyde - 24 hours	N/A	Some traffic stopping where evacuation signs ended; US 264 Business floods early in Washington
<b>Virginia</b>					
Norfolk	Not applicable (NA)	NA	NA	NA	Truck congestion on Chesapeake Bay Bridge
Virginia Beach	NA	NA	NA	NA	Hotels filled with NC evacuees
Chesapeake	NA	NA	NA	NA	NC evacuees created congestion along 17, 168 and I-64
Suffolk	NA	NA	NA	NA	NC evacuees traffic congestion
Portsmouth	NA	NA	NA	NA	
<b>South Carolina</b>					
Georgetown	Yes	Police officers manned bottlenecks	8-10 Hours	13 (northern conglomerates)	Manner in which traffic was routed through Georgetown caused problems; rerouted during evacuation; traffic moved well
Horry	Yes	Signal modification and police at key intersections/traffic control points	12-13 Hours	13 (northern conglomerates)	Bottlenecks at 21st Avenue and 17 ByPass and at 501 in Conway; good participation from tourists, not as good from permanent residents; traffic moved well

Georgetown and Horry Counties in South Carolina. However, in both North Carolina and South Carolina, local emergency management directors felt that participation in the evacuation by tourists was much better than that of the permanent residents who were asked to relocate.

In those counties where evacuations were carried out, traffic was reported to move smoothly. The lack of traffic problems indicates that local and state officials started the evacuations in a timely manner, that traffic control was appropriate and effective and that evacuation participation rates were modest out of those areas that potentially could have been impacted. Those local bottlenecks and congestion areas that were reported for Bonnie had been anticipated in the studies.

One of the most important sources of post-Bonnie traffic data was the traffic count summaries provided by the South Carolina Department of Transportation through the South Carolina Emergency Preparedness Division. Just as for hurricanes Bertha and Fran, SCDOT did an excellent job collecting and reporting the traffic associated with Bonnie for several key evacuation routes. Figures 5-2 through 5-5 show the evacuation traffic versus normal daily traffic for SC 9, US 501, US 17, and I-20. Benchmarks along the timeline show when the voluntary relocation recommendation and mandatory evacuation orders were issued relative to traffic peaking. The duration of evacuation in the graphics helps verify the clearance times reported in Table 5-1. The peak traffic flow rate on I-20 westbound of about 1100 vehicles per hour falls well short of the theoretical maximum flow rate of 3000 vehicles per hour, indicating modest levels of evacuation taking place in the coastal counties.

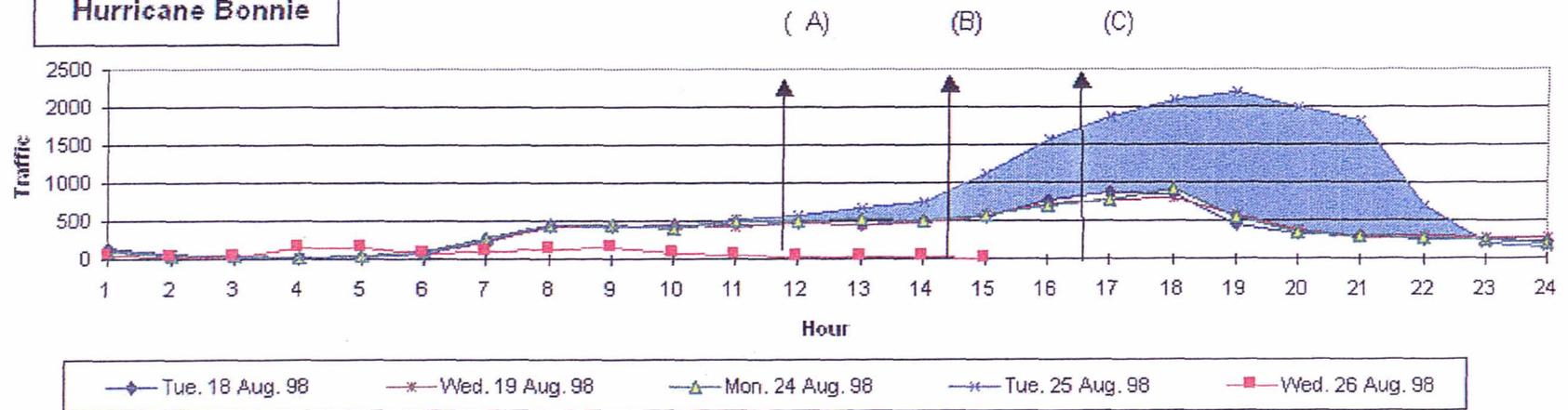
#### Recommendations:

1. Update Virginia's hurricane evacuation study and provide a transportation analysis tool that will allow local jurisdictions the ability to update clearance times as housing unit growth/road construction dictates.
2. In the North Carolina restudy, make sure inland routing of traffic is taken to I-95 and inland bottlenecks noted.
3. Appoint an ICCOH subcommittee to address the evacuation zone delineation issues that face local and state EM officials as well as HES study managers.

4. Encourage NCDOT to implement some permanent traffic count stations that could strategically feed real time and post storm traffic count data to the EM community.
5. Finalize the South Carolina HES transportation analysis.

Station 36- SC 9 Horry County  
(North Bound)

Hurricane Bonnie



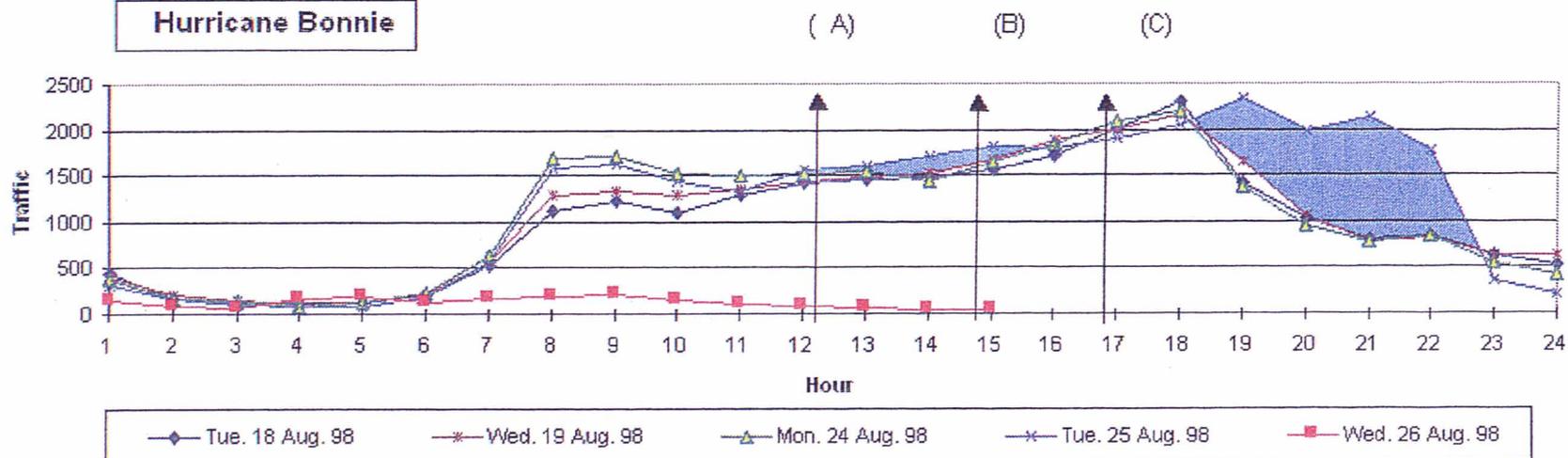
(A) Governors Voluntary  
Evacuation

(B) Notification of 5PM  
Mandatory evacuation

(C) Mandatory Evacuation

Station 18- US 501 MYRTLE BEACH  
(North Bound)

Hurricane Bonnie

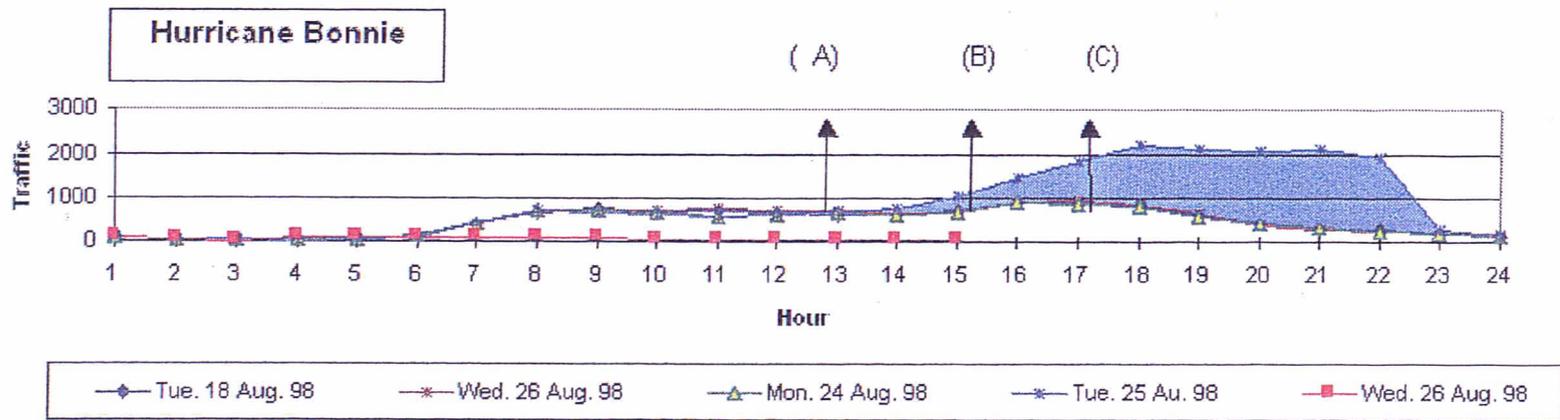


(A) Governors Voluntary  
Evacuation

(B) Notification of 5PM  
Mandatory evacuation

(C) Mandatory Evacuation

Station 11- US 17 GEORGETOWN  
(South Bound)



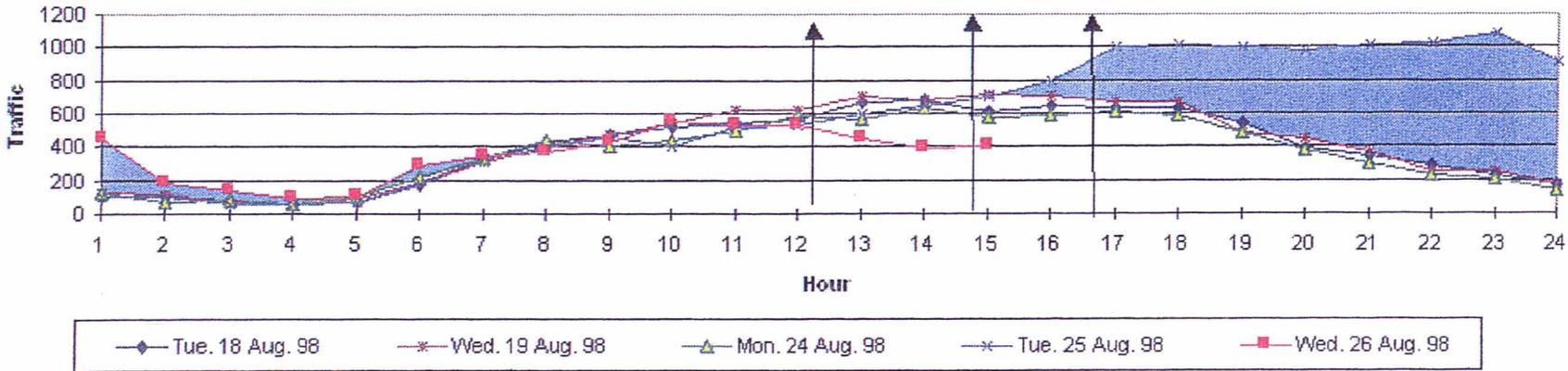
(A) Governors Voluntary  
Evacuation

(B) Notification of 5PM  
Mandatory evacuation

(C) Mandatory Evacuation

Station 42-1-20 @ SC 403 Lee County Line  
(West Bound)

Hurricane Bonnie



(A) Governors Voluntary Evacuation

(B) Notification of 5PM Mandatory evacuation

(C) Mandatory Evacuation

## Chapter 6

### Decision Making

Some of the most important products developed as a part of the FEMA/Corps of Engineers hurricane evacuation studies and delivered to local and state officials have been evacuation decision making tools. These tools are decision arc maps and tables as well as computer software such as HURREVAC. These products graphically tie together real-time storm characteristics with HES produced hazards, shelter and clearance time data. Their purpose is to give emergency management directors a means of retrieving Technical Data Report information without having to dig through a report during an emergency. Evacuation decision tools provide guidance and assistance to decision makers as to when an evacuation should begin relative to a specific hurricane, its associated wind field, forward speed, probabilities, forecast track, and intensity.

Discussions initiated by the FEMA/Corps study teams with local and state officials regarding the evacuation decision process focused on the following questions:

- When was the Emergency Operating Center fully activated and what prompted this decision?
- What study products/decision aides were used to decide when to evacuate and who should evacuate? Was the new HURREVAC product used?
- When was the evacuation order or request made?

Table 6-1 provides a summary of the responses and information gathered from each county. In general, most jurisdictions were impressed with the new HURREVAC beta version that was available for the Bonnie event. Those counties that didn't access it, used HURRTRAC and/or the old version of HURREVAC. Some North Carolina counties as well as Norfolk, Virginia still use the decision arc systems developed in the old HES studies. Many of the Virginia and North Carolina counties did not use the evacuation zone concepts developed in the older studies. However, Horry and Georgetown Counties in South Carolina did successfully use their recently delineated evacuation area concepts from draft restudy products. Most local jurisdictions desire evacuation zone systems that can be easily described over radio and TV.

**Table 6-1  
Evacuation Decision Process Summary  
Hurricane Bonnie Evacuation Assessment**

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/ Decision Aids were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
<b>North Carolina</b>					
Dare	8/23/98	Newport, Wakefield NWS offices - Miami NHC information, HURREVAC, HURRTRAC	New HURREVAC; surge inundation mapping	8/25/98 6:00 AM; 200,000+	Good information; zones don't work - best to evacuate whole county; need better graphics for flood predictions
Hyde (Oracoke)	-	NHC information, communication with Billy Wagner of liaison team	Decision arcs	2,000+	-
Carteret	8/25/98	State information, Newport NWS	SLOSH mapping; new HURREVAC	8/25/98 2:00 PM (Tourists 11:00 AM) 30,000+	Good
Albemarle Sound Counties	8/25/98 AM in most counties	Local NWS office information	Didn't use 87 Study but did use old HURREVAC information that state was providing	8/25/98 Washington Cnty 2:00 PM Perquimans Cnty 7:00 PM Pasquotank Cnty 4:00 PM Camden Cnty 4:00 PM	SLOSH didn't model back-side storm effect; inland wind model not user friendly
Currituck	8/24/98	Decision arcs, weather channel, Dare Cnty actions, NWS information	Decision arcs	8/25/98 8:00 AM 40,000+	Okay, would like broader zones; would like SLOSH flooding depths
Pender	8/25/98 7:00 AM	Wakefield NWS, storm track DTN information	-	8/25/98 Noon 15000±	Didn't use study decision aids
Onslow	8/24/98	HURREVAC (old version), inland winds model, NHC information/downloads	HURREVAC (old version)	8/25/98 1:00 PM	Did not use zones or decision arcs; clearance times okay
New Hanover	8/25/98 Noon	Increase in strike probability, HURREVAC, DTN information, decision arcs	HURREVAC (manual input) decision arcs	8/25/98 11:00 AM voluntary; 5:00 PM mandatory evacuation 6,000 from beaches	Well; zones not used because too difficult to describe
Brunswick	8/25/98	Bald Head Is. evacuation time requirements	Decision arcs; old version of HURREVAC	8/29/98 11:00 AM 12,000±	Good

**Table 6-1 (Continued)**  
**Evacuation Decision Process Summary**  
**Hurricane Bonnie Evacuation Assessment**

<b>Location</b>	<b>Time EOC was Activated</b>	<b>What Prompted Decision to Activate</b>	<b>What Study Products/ Decision Aids were Used in Decision Making</b>	<b>Time of Evacuation Order/Number Evacuated</b>	<b>How Well Study Products Worked</b>
Pamlico Sound Counties	-	Newport NWS information, conference call with state	Did not use 87 Study; Beaufort Cnty used old version of HURREVAC and decision arcs	Except for Hyde mainland and Beaufort, no ordered evacuation Beaufort 8/25/98 2:00 PM	Did not use zones; need study updated
<b>Virginia</b>					
Norfolk	8/26/98	HURREVAC, HURRTRAC, DTN information, decision arcs, probabilities, coordination with military	HURREVAC, decision arcs	Minimal evacuation	Would like to see category 5 added to SLOSH runs
Virginia Beach	8/26/98	HURRTRAC, HURREVAC, HURWIN 95, tides, SLOSH programs	HURREVAC, study mapping	Minimal evacuation for wind concerns	Would like study updated and zones looked at again; need easier to use format
Chesapeake	8/26/98	HURREVAC (old version), tides, SLOSH	HURREVAC (old version)	Minimal evacuation for wind concerns	Need study updated; zones re-examined
Suffolk	8/26/98 5:00 PM	HURREVAC (old version), DTN data, conference calls	HURREVAC (old version)	Voluntary evacuation of campgrounds only	-
Portsmouth	8/26/98 partial activation	HURWIN 95, HURRTRAC	HURWIN 95	No evacuations carried out	Relook at zones; new HURREVAC looks good; need re-study
<b>South Carolina</b>					
Georgetown	Partial 8/24/98 8:30 AM Full 8/25/98	Old HURREVAC model, governor/state actions, DTN information, governor's video conference	HURREVAC (old version)	8/25/1998 12:30 PM Voluntary evacuation mandatory in late afternoon 12,000±	Used new evacuation areas from restudy
Horry	8/24/1998 1:00 PM	Storm movement, National Guard mobilization, DTN information, new HURREVAC, governor's directives	New HURREVAC	8/25/1998 12:00 PM Voluntary relocation; 3:30 PM mandatory; unknown number of total evacuees	Well; used evacuation area concept from restudy

In South Carolina and North Carolina, EOC's were activated on Monday, August 24<sup>th</sup> with evacuations taking place on Tuesday, the 25<sup>th</sup>. Virginia jurisdictions activated on Wednesday, the 26<sup>th</sup> and due to the storm's exiting characteristics, evacuated very little of their resident population.

**Recommendations:**

1. Update clearance time data and incorporate into the new HURREVAC model.
2. Conduct extensive training sessions with local EM's regarding the new HURREVAC model.
3. Deliver new SLOSH storm tide atlases to North Carolina and South Carolina Counties as soon as possible.
4. Work with state and locals to refine evacuation zone concepts.

## Chapter 7

### Public Information

Although not a major part of previous FEMA/Corps of Engineers hurricane evacuation study efforts, public information is recognized as an important final element that must be addressed. Study products and data must ultimately be tailored to a format that the media and general public can understand so that correct evacuation decisions and preparations can be made at the household level. Bonnie provided a glimpse of the current means of getting hurricane evacuation information into the hands of the general public. Bonnie also provided local and state officials with an opportunity to assess additional needs regarding public information.

Methods used and suggestions offered in the study areas to inform the public in Bonnie and future events included the following:

1. Public information brochures were developed and widely distributed early in the season showing vulnerable areas, evacuation levels, and tips on hurricane preparedness.
2. Press briefings with national and local media to insure that they (radio, TV, newspapers) disseminate consistent information to the public – Media were given packets of hurricane materials early in the season by some emergency officials.
3. Law enforcement officials drove through neighborhoods with sirens and P.A. systems to encourage people to evacuate – this technique was used in some beach communities – some officials went door-to-door.
4. Some communities were able to provide evacuation information to the public through printed information in the local phone book.
5. An important means was through radio and television – some communities used cable TV overrides to alert the public of evacuation advisories and provide PSAs.
6. The Weather Channel was used extensively by local emergency management staff and citizens for public education and information.
7. Some emergency management officials faxed advisory and teleconference information to media every six hours.
8. Some counties used their web sites to display storm information and advisories.

9. Brunswick County, North Carolina used portable “drive-by” FM broadcasters at intersections to advise the public of evacuation orders.
10. The North Carolina state hurricane brochures are popular in some areas. Motels that ran out of them called local EM directors for more.
11. Decision arc systems are good for public and school education as they are easy to understand.
12. County public information officers are important resources during the event to interface with the media and public.
13. There is a mixture of ideas from the media regarding “canned” HES media products. Many would rather develop their own graphics.
14. Some selected areas would like hurricane information in Spanish.

## Appendix A

### Meeting Participants

## Meeting Participants

### NAME

### ORGANIZATION

Stanley Kite	EMC – Craven County
Doug Haas	NCEM – Area 3
Robbie J. York	Pamlico
Timothy P. Harvey	EMC – Pamlico County
George Sullivan	NCEM – Area 2 Coordinator
Jeff M. Credle	EMC/Hyde County Manager
Dale Lilley	EMC/Martin County
Lesley Williams	NCEM/DROC
Daden H. Wolfe, Jr.	EMC/Beaufort County
Roger Lambertson	PIO – Currituck County
Kathlyn S. Flora	Director, DSS – Currituck County
Stanley D. Griggs	EM – Currituck County
Bill Richardson	Currituck County Manager
Dan Scanlon	Currituck County
Donald C. Lewis	PBS&J
Lisa Goddard	WBTB 13
Rusty Glusing	WPDE-TV 15
Robert Smith	FEMA
Brent Campbell	WPDE-TV 15
Cheryl Henry	PIO/Horry County
Paul Whitten	EPD/Horry County
Allan McDuffie	U.S. Army Engineers, Wilmington
Tom Collins	NCDEM
Leslie Williams	NCDEM
Cecil Logan	EM/Brunswick County
Patricia Byrd	EM/Georgetown
Charmel Menzel	EPD/South Carolina
Dan Summers	EM/New Hanover
Karen Wagley	EM/Onslow County
Paula Brown	NC DEM
Al Bjorkquist	Corps of Engineers – Wilmington
James Smith	NCDEM
Chris Coudriet	NCDEM
Frank McGovern	US Army Corps of Engineers – SA
Jerry Canupp	USCOE – SAD

## Meeting Participants (Continued)

<u>NAME</u>	<u>ORGANIZATION</u>
Bill Massey	FEMA
Don Needham	NCDEM
Patricia Chappell	EMO
Paul Moye	US Army Corps of Engineers, Norfolk
Lisa Moon	PBS&J
Tom Cooke	Fire Dept & Emergency Services
Mark Marchbank	EM-Virginia Beach
Pat Gilbert	OEM
Jim Talbot	Emergency Services-Norfolk
Bruce Sterling	Emergency Services
Jeff Messinger	Emergency Services
NH Sanderson	FEMA
Eddie King	EM/Pender
Carson Smith	EM/Pender
Cathy Henry	NC EM
Susan Dwyer	USACE
Ron Fascher	USCOE-Wilmington
Dianne Hood	USACE-
Ann Keyes	EM-Washington County
Jan Stzins	Albemarle Pamlico Red Cross
Kenneth Ray Cullepha	EM/Perquimans County
Christy Saunders	EM
Douglas L. Belch	Emergency Services/Chowan County
James Smith	NCEM
Bobby Joyner	Pitt County
Phillip Williams	WNCT – TV 9
Lesley Williams	NCEM
Al Hadley	Carteret County EM
Geneva Perry	Dare County Commission

## Appendix B

### Best Track Data and Watch/Warning Summary

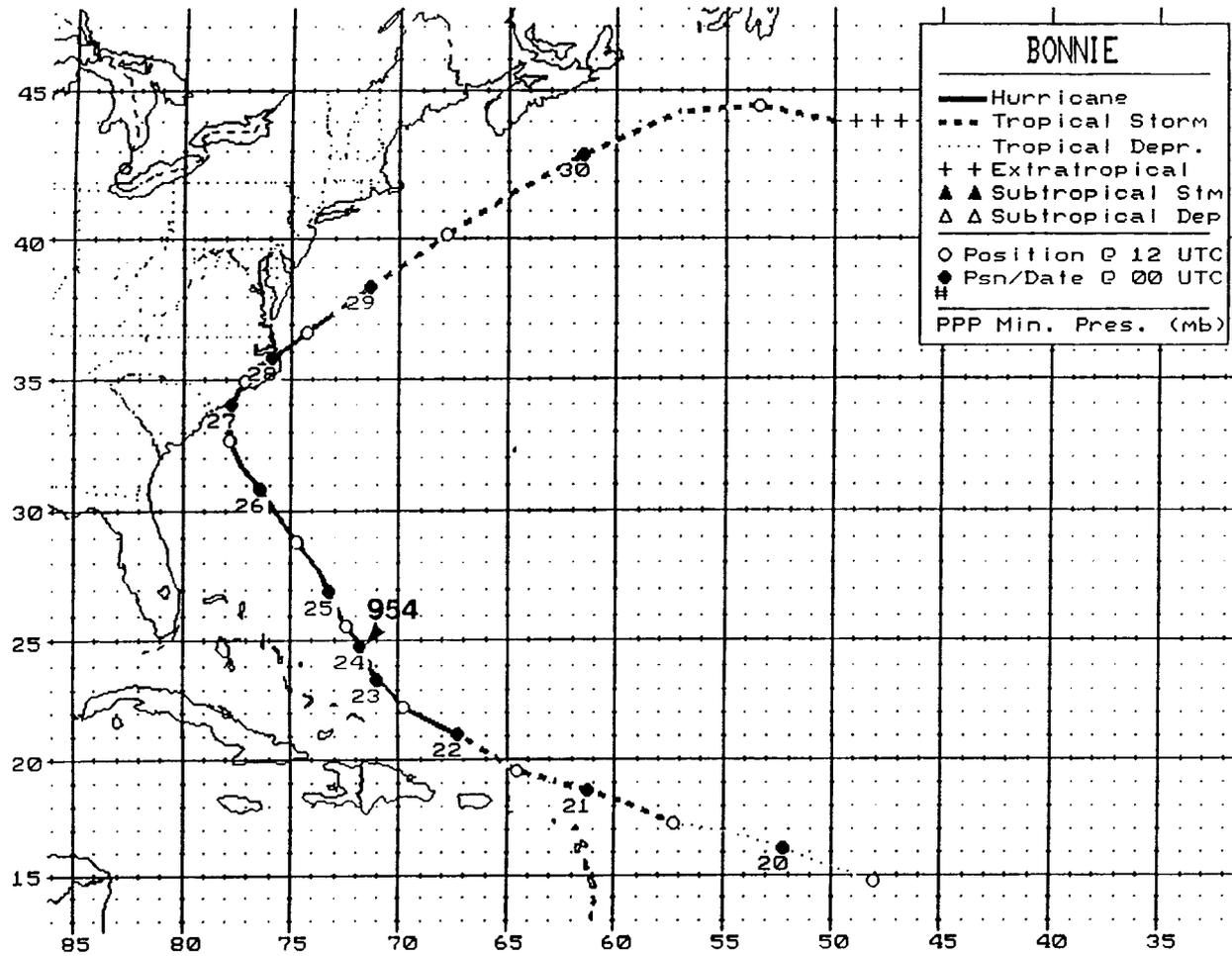


Fig. 1. Best track positions for Hurricane Bonnie, 19-30 August 1998.

Table 1. Best track, Hurricane Bonnie, 19- 30 August, 1998

Date/Time (UTC)	Position		Pressure (mb)	Wind Speed (kt)	Stage
	Lat. (°N)	Lon. (°W)			
19/1200	14.7	48.1	1009	25	tropical depression
1800	15.4	50.1	1009	30	"
20/0000	16.2	52.2	1009	30	"
0600	16.9	54.7	1008	30	"
1200	17.3	57.3	1007	35	tropical storm
1800	18.2	59.6	1006	35	"
21/0000	18.7	61.3	1005	40	"
0600	19.1	62.9	1002	45	"
1200	19.5	64.5	1000	50	"
1800	20.3	65.9	999	55	"
22/0000	21.1	67.3	991	65	hurricane
0600	21.8	68.7	989	70	"
1200	22.3	69.8	980	75	"
1800	23.0	70.5	970	85	"
23/0000	23.4	71.0	962	90	"
0600	23.8	71.3	960	95	"
1200	24.1	71.5	958	100	"
1800	24.4	71.7	955	100	"
24/0000	24.8	71.8	954	100	"
0600	25.2	72.1	960	100	"
1200	25.6	72.4	962	100	"
1800	26.1	72.8	963	100	"
25/0000	26.9	73.2	963	100	"
0600	27.8	73.8	962	100	"
1200	28.8	74.7	963	100	"
1800	29.8	75.6	963	100	"
26/0000	30.8	76.4	958	100	"
0600	31.7	77.3	964	100	"
1200	32.7	77.8	965	100	"
1800	33.4	77.8	962	100	"
27/0000	34.0	77.7	963	95	"
0600	34.5	77.5	965	85	"
1200	34.9	77.1	974	75	"
1800	35.4	76.6	980	60	tropical storm
28/0000	35.8	75.9	983	65	hurricane
0600	36.2	75.1	985	75	"
1200	36.7	74.3	990	65	"
1800	37.3	73.2	991	60	tropical storm
29/0000	38.3	71.4	993	45	"
0600	39.2	69.6	999	45	"
1200	40.2	67.8	999	45	"
1800	41.6	64.8	1000	45	"
30/0000	42.9	61.5	1000	45	"
0600	44.3	57.0	1000	45	"
1200	44.5	53.5	1000	45	"
1800	44.0	50.0	998	45	extratropical
31/0000	44.0	45.0	996	45	"
0600	43.0	41.0			absorbed by a front
24/0000	24.8	71.8	954	100	minimum pressure
27/0400	34.4	77.7	964	95	Landfall near Wilmington NC

Table 2. Hurricane Bonnie selected surface observations, August 1998.

Location	Press. (mb)	Date/ time (UTC)	Sustained wind (kts) <sup>a</sup>	Peak gust (kts)	Date/ time (UTC) <sup>b</sup>	Storm surge (ft) <sup>c</sup>	Storm tide (ft) <sup>d</sup>	total rain (in)
<b>U.S. Virgin Islands</b>								
St. Thomas Airport	1006.1	21/1128	23	33	21/0851			0.29
<b>Puerto Rico</b>								
Ceiba	1006.8	21/1121	24	33	21/0156			0.51
Carolina								1.10
Grand Turk								3.50
<b>South Carolina</b>								
Charleston International Airport	1007.0	26/1856	25	33	26/2034			
Charleston City Office			25	39	26/1230			
Myrtle Beach (MYR)			38	52	26/1715			
<b>North Carolina</b>								
Wilmington	969.9	27/0053	49	64	26/1827			9.04
Kure Beach				77	26/1630			
Florence Air.			34	44	26/2150			
Elizabeth City	995.7	28/0030	51	63	28/0333			1.42
Ocracoke	990.5	27/1815		66	27/1457			6.60
Oregon inlet	989.1			54	27/2015			
Emerald isle	976.9			62				
Newport	985.1	27/1030		52	27/0553			9.51
Greenville				63	27/0915			8.20
Morhead City								10.70
Cherry Point			41	61	27/0114			10.93
Jacksonville				62	27/1133			11.00
Frisco			49	69	27/1109			
New Hanover							7-9	
Tide Gage on Masonboro Isl.							9.1	
Wrightsville Beach							7-7.3	
<b>Virginia</b>								
Cape Henry			70	90	28/0300			
Chesapeake Light Stn. Brookley Field			68	81	28/0350			
Currituck County EOC				81	28/0400			
Oceana NAS	999.0		38	54	28/0357			
Langley AFB	1005.0		46	58	27/2355			
Norfolk Airport (ORF)	1000.4	28/0024	40	56	28/0141			6.77
Porthmouth	1000.0	28/0105		55	28/0222			2.44
Norfolk NAS	1002.0		36	48	27/2315			4.91
Sewells Point							6.0	
Coastal Pasquotank						6.0		
Chowan County						5-6		
<b>New Jersey/Delaware</b>								
Delaware Light BouCrestviewy	1005.2	28/1800	32	40	28/1700			
Reedy Point							6.28	
Cape May							6.05	
Atlantic City							4.97	
Sandy Hook							5.64	
Georges Bank bouy	990.2	29/1600	35	45	29/1700			

<b>C-MAN Stations</b>					
Frying Pan Shoals (FPSN7)	964.0	26/1630	76 <sup>f</sup>	90	26/2130
Cape Lookout (CLKN7)	994.2	27/1300	48	75	27/1211
Diamond Shoals (DSLN7)	996.8	27/2200	68	79	27/2034
Duck NC (DUCN7)	993.5	28/0100	45	55	27/2000
Cheasepeake Lt. (CHLV7)	995.7	28/0600	72 <sup>f</sup>	86	28/0532

<b>Buoys</b>					
41002	998.7	26/0300	42 <sup>f</sup>	57	26/0426
41004	990.5	26/1300	38	49	26/1600
44004	994.3	29/0600	36 <sup>f</sup>	46	29/0131
44014	989.8	28/1000	37	47	28/0200
44137	998.2	30/0000	50		30/0300
44144	990.8	30/0300	47		30/0300

<sup>a</sup> Standard NWS ASOS and C-MAN maveraging period is 2 min; buoys are 8 min unless otherwise indicated.

<sup>b</sup> Date/time is for sustained wind when both sustained and gust are listed.

<sup>c</sup> Storm surge is water height above normal astronomical tide level.

<sup>d</sup> Storm tide is water height above NGVD.

<sup>e</sup> Estimated.

<sup>f</sup> 10 min average wind.

Table 3. Tropical Cyclone watch and warning summary for Hurricane Bonnie.

Date/Time (UTC)	Action	Location
20/0300	Tropical Storm Watch issued	Antigua, Barbuda, Anguilla, St. Maarten, Saba and St. Eustatius
20/1500	Tropical Storm Watch issued	U.S. and British Virgin Islands
20/2100	Tropical Storm Warning issued	U.S. and British Virgin Islands
20/2100	Tropical Storm Watch issued	Puerto Rico
21/0900	Tropical Storm Watch issued	Turk and Caicos and the southeastern Bahamas
21/1200	Tropical Storm Watch discontinued	Antigua, Barbuda, Anguilla, St. Maarten, Saba and St. Eustatius
21/1500	Tropical Storm Warnings and a Hurricane Watch	Turk and Caicos and southeastern Bahamas
21/1500	Hurricane watch issued	Central Bahamas
21/1500	Tropical Storm Warning discontinued	U.S. and British Virgin Islands
21/1500	Tropical Storm Watch discontinued	Puerto Rico
22/0900	Hurricane Warning issued	Central Bahamas
22/1500	Hurricane Watch issued	Northwestern Bahamas
23/0000	Hurricane Warning discontinued	Turks and Caicos
23/0000	Hurricane Warning replaced by Tropical Storm Warning	Southeastern Bahamas
24/0900	Tropical Storm Warning discontinued	Southeastern Bahamas
24/2100	Hurricane Watch issued	Savannah, Georgia to the North Carolina/Virginia border including the Pamlico and Albemarle Sounds
25/0900	Hurricane Warning issued	from Murrells Inlet, S.C. To the north Carolina Virginia border, including the Palmico and Albemarle Sounds
25/1200	Hurricane Watch issued	from North Carolina/Virginia border to Cape Henlopen, Delaware including the Chesapeake Bay southward from Windmill point.
25/1500	Tropical Storm Warning issued	from Murrells inlet to Cape Romain, S.C.
25/1800	Hurricane Warning extended northward	to Chincoteague, VA
25/2100	Hurricane Warning extended southward	to Cape Romain, S.C.
26/0600	Hurricane Warning extended southward	to Edisto Beach, S.C.
26/1500	Hurricane Warning and Watches discontinued	south of Cape Romain

26/2100	Hurricane Warnings and Watches revised. Tropical Storm Warning and Hurricane Watch issued	from North Carolina/ Virginia border to Chincoteague, Virginia and for the Chesapeake Bay from Smith Point southward
26/2100	Tropical Storm Warning issued	from Chincoteague, Virginia to Cape Henlopen, Delaware
27/0100	Hurricane warning replaced by Tropical Storm Warning	south of Murrels Inlet to Cape Romain
27/0900	Hurricane Warning replaced by Tropical Storm Warnings	south of Little River Inlet, NC to Murrels Inlet, SC
27/0900	Tropical Storm Watch issued	from north of Cape Henlopen to Sandy Hook, NJ including Delaware Bay
27/0900	Tropical Storm Warning discontinued	from south of Murrels Inlet
27/1500	Tropical Storm Warning issued	from new River Inlet, NC to Cape Henlopen, DE including Pamlico and Albemarle Sounds and Chesapeake Bay southward from Smith Point
27/1500	Tropical Storm Watch issued	Chesapeake bay from Smith Point to Drum Point and for the Potomac River from Cobb Point to Smith Point
27/2100	Tropical Storm Warnings extended northward	from New River Inlet NC to watch Hill, RI including Pamlico and Albemarle Sounds, Chesapeake Bay southward from Smith Point and Delaware Bay
27/2100	Tropical Storm Watch issued	from east of Watch Hill, RI to Plymouth, MA
28/0300	Tropical Storm Warning discontinued	south of Cape Lookout, NC
28/0900	Tropical Storm Warning issued	from Watch Hill to Plymouth
28/0900	Tropical Storm Warning discontinued	south of Ocracoke, NC and for the Chesapeake Bay and Potomac River north of Smith Point
28/1500	Tropical Storm Warning discontinued	south of NC/VA border including Pamlico and Albemarle Sounds and for Chesapeake and Delaware Bays
28/2100	Tropical Storm Warning discontinued	south of Watch Hill including Delaware Bay and Long Island Sound
29/0300	Tropical Storm Warning discontinued	remainder of the U.S. East coast

\* Tropical Cyclone watches and warnings are issued by respectively countries in coordination with the National Hurricane Center.

## Appendix C

### Hurricane Bonnie Evacuation Response Questionnaire

## Hurricane Bonnie Response Questionnaire (11-16-98)

Hello, my name is \_\_\_\_\_ and I'm calling on behalf of the Army Corps of Engineers and the North Carolina Division of Emergency Management. I'm conducting a telephone survey of residents in North Carolina concerning experiences in hurricane Bonnie last summer. May I speak with the (ROTATE):

1. Youngest male over 18
2. Oldest male
3. Youngest female over 18
4. Oldest female in your household?

My questions will only take a few minutes. Your responses are important to us so that we may have accurate information about hurricane preparedness. Before we begin, let me assure you everything you say will remain strictly confidential.

1. Do you live at this residence year-round?  
  1   Yes (**GO TO Q3**)  
  2   No (**GO TO Q2**)  
  3   Other (**GO TO Q2**)
  
2. Do you live here at least part of the time during the summer or fall?  
  1   Yes (**GO TO Q3**)  
  2   No (**THANK & TERMINATE**)  
  3   Other (**THANK & TERMINATE**)

**IF "NO," TERMINATE THE INTERVIEW BY RESPONDING "THANK YOU FOR YOUR TIME, BUT WE ARE LOOKING FOR PEOPLE WHO ARE IN THIS REGION DURING THAT TIME FRAME. THANK YOU AGAIN. GOODBYE.**

3. As you may recall hurricane Bonnie affected North Carolina in late August this last summer. Were you in the area, i.e., not out of town, when **HURRICANE BONNIE** began to threaten your area last August?  
  1   Yes (**GO TO Q4**)  
  2   No (**THANK AND TERMINATE**)  
  3   Other (**THANK AND TERMINATE**)

**IF "NO," TERMINATE THE INTERVIEW BY RESPONDING "THANK YOU FOR YOUR TIME, BUT WE ARE LOOKING FOR PEOPLE WHO**

**WERE IN THIS AREA AT THAT TIME. THANK YOU AGAIN.  
GOODBYE."**

4. As you may recall, the center of Hurricane Bonnie made landfall near Wilmington, North Carolina on the Wednesday, August 26. Did you leave your home to go someplace safer **before** the hurricane?

- 1 Yes (**GO TO Q6**)  
2 No (**GO TO Q5**)  
3 Other, \_\_\_\_\_ (**GO TO Q19**)  
9 Don't know (**GO TO Q19**)

5. What made you decide *not* to go anyplace else? (**CATEGORIZE - PROBE UP TO 3**) (**THEN GO TO Q19**)

- a. 0/1 Storm not severe/house adequate  
b. 0/1 Officials said evacuation unnecessary  
c. 0/1 Media said evacuation unnecessary  
d. 0/1 Friend/relative said evacuation unnecessary  
e. 0/1 Officials didn't say to evacuate  
f. 0/1 Probabilities indicated low chance of a hit  
g. 0/1 Other information indicated storm wouldn't hit  
h. 0/1 Had no transportation  
i. 0/1 Had no place to go  
j. 0/1 Wanted to protect property from looters  
k. 0/1 Wanted to protect property from storm  
l. 0/1 Left unnecessarily in past storms  
m. 0/1 Job required staying  
n. 0/1 Waited too long to leave  
o. 0/1 Traffic too bad  
p. 0/1 Tried to leave, but returned home because of traffic  
q. 0/1 Too dangerous to evacuate  
r. 0/1 Other, specify:  
s. 0/1 Don't know

**(IF ANSWERING Q5, GO TO Q19)**

6. Did you go to a public shelter, a friend or relative's house, a hotel, or somewhere else? (**DO NOT READ**)

- 1 Public shelter (Red Cross)  
2 Church  
3 Friend/relative  
4 Hotel  
5 Second home  
6 Workplace  
7 Mobile home park clubhouse  
8 Other, specify:  
9 Don't know

7. Is that (**ANSWER FROM #6**) located in your neighborhood or someplace else?

- 1 Neighborhood (**SKIP TO Q11**)  
2 Somewhere else  
9 Don't know

8. In which city is that located?

9. Is that (**ANSWER FROM #8**) located in your county?

- 1   Yes (**SKIP TO Q11**)
- 2   No
- 9   Don't know

10. In which state is that located?

- 1   North Carolina
- 2   Virginia
- 3   Other,
- 9   Don't know

11. What convinced you to go someplace else? (**CATEGORIZE - PROBE UP TO**

**3**)

- a.   0/1   Advice or order by elected officials
- b.   0/1   Advice from Weather service
- c.   0/1   Advice/order from police officer or fire fighter
- d.   0/1   Advice from media
- e.   0/1   Advice from friend or relative
- f.   0/1   Concerned about severity of storm
- g.   0/1   Storm increased in strength
- h.   0/1   Concerned storm would cause home to flood
- i.   0/1   Concerned strong winds would make house unsafe
- j.   0/1   Concerned flooding would cut off roads
- k.   0/1   Concern that storm might hit
- l.   0/1   Heard probability (odds) of hit
- m.   0/1   Other, specify:
- n.   0/1   Don't know

12a. The National Hurricane Center issued a hurricane watch for Bonnie at 5 PM on Monday, August 24<sup>th</sup>, and they issued a hurricane warning at 5AM on Tuesday, August 25<sup>th</sup>. Bonnie hit the Wilmington area of North Carolina on the afternoon of Wednesday, August 26<sup>th</sup>. On which day did you leave your home to go someplace safer? (**WAS IT BEFORE OR AFTER THE NATIONAL HURRICANE CENTER ISSUED A HURRICANE WARNING AT 5 AM ON WEDNESDAY MORNING?**)

- 1   Monday, August 24<sup>th</sup> →**READ**: The hurricane warning didn't come until 5 AM on Tuesday the 25<sup>th</sup>. Are you sure you left on Monday?  
(**REVISE ANSWER IF NECESSARY**)
- 2   Tuesday, August 25<sup>th</sup>
- 3   Wednesday, August 26<sup>th</sup>
- 4   Thursday, August 27<sup>th</sup>
- 5   Other
- 9   Don't know

12b. About what time on the (REPEAT DATE) did you leave? (WAS IT BEFORE OR AFTER THE HURRICANE WARNING AT 5 AM on the 25th?) (USE 1 HOUR INCREMENTS) (TAKE MIDPOINT) (99=DK)

\_\_\_\_\_ Hour (IF 99, SKIP TO Q13)

12c. Was that AM or PM? (NOTE: 12 O'CLOCK NOON = 12 PM)  
(NOTE: 12 O'CLOCK MIDNIGHT = 12 AM  
ON THE "NEW" DAY)

  1   AM  
  2   PM

13. Did you or anyone in your household require assistance in evacuating?

  1   Yes  
  2   No (SKIP TO Q15)  
  3   Not sure (SKIP TO Q15)

13a. Did the person just need transportation, or did they have a disability or medical problem that required special assistance?

  1   Transportation only  
  2   Special need ( disability or medical problem)  
  3   Both  
  4   Other, specify:  
  5   Don't know

14. Was that assistance provided by someone within your household, or by an outside agency, or by a friend or relative outside your household?

  1   Within household  
  2   Friend/relative (outside)  
  3   Outside agency  
  4   Other,  
  9   Don't know

15. How many vehicles were available in your household that you could have used to evacuate?

\_\_\_\_\_ Number of vehicles (IF 0, GO TO Q16; OTHERWISE GO TO Q17)  
(9 = DK) (IF 1 OR MORE IN Q15, SKIP TO Q17) (8 =NA)  
(RECORD "0" IF NO VEHICLES ARE AVAILABLE)

16. Did your household members leave in someone else's vehicle, did they use public transportation, or did you evacuate another way?

  1   Other's vehicles (GO TO Q19)  
  2   Public transportation (GO TO Q19)  
  3   Other, specify: \_\_\_\_\_ (GO TO Q19)  
  9   Don't know (GO TO Q19)

17. How many vehicles did your household take in evacuating? (9 = DK) (8 =NA)  
**(RECORD "0" IF NO VEHICLES ARE AVAILABLE)**  
 \_\_\_\_\_ Number of vehicles
18. When you evacuated, did you take a motor home or pull a trailer, boat, or camper?  
  1   Yes  
  2   No  
  3   Other, specify:  
  9   Don't know
19. During the threat, did you hear anyone in an official position - such as emergency management, police, etc. - say that you **should** evacuate from your location to a safer place?  
  1   Yes (**GO TO Q20**)  
  2   No (**GO TO Q22**)  
  9   Don't know (**GO TO Q22**)
20. Did officials recommend that you **should** evacuate or did they say it was mandatory that you **must** evacuate?  
  1   Should  
  2   Must  
  9   Don't know
21. Did police or other authorities come into your neighborhood going door-to-door or with loudspeakers, telling people to evacuate?  
  1   Yes  
  2   No  
  9   Don't know
22. Would you do anything differently in the same situation again? (**CATEGORIZE**)  
**(PROBE UP TO 3)**  
 a   0/1   Would evacuate  
 b   0/1   Wouldn't evacuate  
 c   0/1   Would leave earlier  
 d   0/1   Would wait later to leave  
 e   0/1   Would go further away  
 f   0/1   Wouldn't go as far away  
 g   0/1   Would go to public shelter  
 h   0/1   Wouldn't go to public shelter  
 i   0/1   Would use different route  
 j   0/1   No  
 k   0/1   Other, specify:  
 l   0/1   Don't know
23. We're interested in how you got most of your information about Bonnie - where the storm was; when it was going to hit; how severe it was. I'm going to list a number of different ways you might have gotten information, and I'd like you to

tell me whether you relied upon that source none at all (0), a little (1), a fair amount (2), or a great deal (3). **(READ & ROTATE)**

	None	Little	Fair Amount	Great Deal	
a	0	1	2	3	Local radio stations
b	0	1	2	3	Local television stations
c	0	1	2	3	CNN on cable
d	0	1	2	3	The Weather Channel on cable
e	0	1	2	3	Other cable television stations
f	0	1	2	3	The Internet * <b>(DO YOU HAVE A COMPUTER WITH A MODEM)</b>
g	0	1	2	3	Services like American Online or CompuServe * <b>(DO YOU HAVE A COMPUTER WITH A MODEM)</b>
h	0	1	2	3	Word of mouth

**IF "0" TO ALL, SKIP TO Q 27a**

24. Of those sources of information, did you find any one of them to be have more accurate information than the others?

- 1   Yes
- 2   No **(SKIP TO Q26a)**
- 3   Don't Know/Not Sure **(SKIP TO Q26a)**

25. Which one was that?

- 1   Local radio stations
- 2   Local television stations
- 3   Out of town television stations you could only get on cable
- 4   CNN on cable
- 5   The Weather Channel on cable
- 6   The Internet, if you have a computer
- 7   Computer services like American Online or CompuServe, if you have a computer
- 8   All equally accurate
- 9   Don't know

26a. Of those sources of information, did you find any one of them to have **less** accurate information than the others?

- 1   Yes
- 2   No **(SKIP TO Q27a)**
- 9   Don't Know/Not Sure **(SKIP TO Q27a)**

26b. Which one was that?

- 1   Local radio stations
- 2   Local television stations
- 3   Out of town television stations you could only get on cable
- 4   CNN on cable
- 5   The Weather Channel on cable
- 6   The Internet, if you have a computer

7 Computer services like American Online or CompuServe, if you have a  
computer  
8 All equally inaccurate  
9 Don't know

27a. Did you receive any information from local government officials about whether Bonnie was going to be a danger to your safety or how to protect your home and property?

- 1 Yes  
2 No (**SKIP TO Q28a**)  
9 Don't Know/Not Sure (**SKIP TO Q28a**)

27b. How would you rate the information you received from **local government officials**? Would you say it was generally accurate or generally not accurate?

- 1 Generally accurate  
2 Generally not accurate  
3 Some accurate, some not  
9 Don't Know/No Opinion

27c. Would you say it was generally useful or generally not useful?

- 1 Generally useful  
2 Generally not useful  
3 Some useful, some not  
9 Don't Know/No Opinion

28a. Did you receive any information from **state officials** about whether Bonnie was going to be a danger to your safety or how to protect your home and property?

- 1 Yes  
2 No (**SKIP TO Q29**)  
9 Don't Know/Not Sure (**SKIP TO Q29**)

28b. How would you rate the information you received from state government officials? Would you say it was generally accurate or generally not accurate?

- 1 Generally accurate  
2 Generally not accurate  
3 Some accurate, some not  
9 Don't Know/No Opinion

28c. Would you say it was generally useful or generally not useful?

- 1 Generally useful  
2 Generally not useful  
3 Some useful, some not  
9 Don't Know/No Opinion

29. What information did you need that you were unable to find any place as Bonnie approached? **(RECORD VERBATIM)**

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30. At one point Bonnie's maximum sustained winds were almost 115 MPH. If Bonnie had made landfall near your location with winds of 115 MPH, do you believe your home would have been at risk to dangerous flooding from storm surge or waves?

- 1 Yes  
2 No  
9 Don't Know/Depends

31. Considering both wind and water, do you think it would have been safe for you to have stayed in your home if Bonnie had hit near your location with winds of 115 MPH?

- 1 Yes  
2 No  
9 Don't Know/Depends

32. In Bonnie, what kinds of steps, if any, did you take before the storm arrived to protect your property? **(CATEGORIZE) (PROBE UP TO 3)**

- a  
b  
c  
d  
e  
f  
g  
h  
i  
j  
k  
l  
m  
n  
o
- 0/1 Apply window protection  
0/1 Apply door/garage door protection  
0/1 Secure or remove loose objects from yard  
0/1 Move boat, camper, etc.  
0/1 Prepare pool  
0/1 Elevate furniture, appliance, rugs, etc.  
0/1 Protect documents, photos, etc.  
0/1 Sandbag property  
0/1 Purchase items for repair after/during storm (plastic film, plywood)  
0/1 Buy/rent generator  
0/1 Secure plants  
0/1 Cut limbs  
0/1 Other (Specify)  
0/1 None  
0/1 Don't Know/Not Sure

33. Now let's talk about Hurricane Fran back in 1996. Were you in the area, i.e., living here and not out of town, when Hurricane Fran threatened? Fran was the storm that struck between Wrightsville Beach and Topsail Beach North Carolina on the afternoon of Friday, July 12<sup>th</sup>, 1996. It was the second storm to hit North Carolina that year, after Bertha.

- 1 Yes **(GO TO Q34)**  
2 No **(GO TO Q43)**  
3 Other \_\_\_\_\_ **(GO TO Q43)**  
9 Don't Know **(GO TO Q43)**

34. In Fran did you leave your home to go someplace safer before the hurricane?  
1 Yes (**GO TO Q35**)  
2 No (**GO TO Q40**)  
3 Other \_\_\_\_\_ (**GO TO Q40**)  
9 Don't Know (**GO TO Q40**)
35. Did you go to a public shelter, a friend or relative's house, a hotel, or somewhere else? (**DO NOT READ**)  
1 Public Shelter (Red Cross)  
2 Church  
3 Friend/Relative  
4 Hotel/Motel  
5 Home  
6 Workplace  
7 Mobile home park clubhouse  
8 Other  
9 Don't Know
36. Is that (**ANSWER TO Q35**) in your neighborhood or somewhere else?  
1 Neighborhood (**SKIP TO Q40**)  
2 Somewhere else  
9 Don't Know (**SKIP TO Q40**)
37. In what city is that located?
38. Is that (**ANSWER TO Q37**) located in your county?  
1 Yes (**SKIP TO Q40**)  
2 No  
9 Not Sure (**SKIP TO Q40**)
39. In which state is that located?  
1 North Carolina  
2 Virginia  
3 Other  
9 Don't Know
40. Did you hear anyone in an official position -- emergency management, police, etc. -- say that you **should** evacuate to a safer place?  
1 Yes  
2 No (**GO TO Q43**)  
9 Don't Know (**GO TO Q43**)

41. Did they say that you **should** evacuate or that it was mandatory that you **must** evacuate?
- 1   Should  
  2   Must  
  9   Don't Know
42. Did police or other authorities come into your neighborhood going door-to-door or with loudspeakers, telling people to evacuate?
- 1   Yes  
  2   No  
  9   Don't Know
43. Have you identified the safest location in your home to ride out a strong hurricane if you had to?
- 1   Yes  
  2   No  
  9   Don't Know/Not Sure
44. Do you have any kind of window protection such as storm shutters, security film, or plywood sheets designed to protect the windows during a strong hurricane?
- 1   Yes (**SKIP TO Q46**)  
  2   Would Attach Them Before Storm (**SKIP TO Q46**)  
  3   No (**ASK Q45**)  
  9   Don't Know/Not Sure (**SKIP TO Q46**)
- 44b. What kind of protection is it?
- 1   Permanent roll-down metal panels  
  2   Removable metal panels  
  3   Plywood sheets  
  4   Security Film  
  5   Impact-resistant glass  
  6   Other  
  9   Don't Know/Not Sure (**SKIP TO Q46**)
45. If not, why not? (**CATEGORIZE**)
- 1   Don't need it  
  2   Too expensive  
  3   Don't think it works  
  4   Don't have enough time to do it  
  5   Other (specify) \_\_\_\_\_  
  9   Don't know
46. About how much do you think window protection such as storm shutters would cost per window? (**PAUSE - READ IF NECESSARY**)
- 1   Under \$10  
  2   \$10 to \$50  
  3   \$50 to \$100  
  4   \$100 to \$200  
  5   \$200 to \$500  
  6   Over \$500  
  9   Don't Know/Not Sure

47. Do you believe window protection like that would mainly just prevent the windows from breaking and reduce the danger of flying glass, or do you believe they would also significantly reduce the total damage your house would suffer in other ways?

- 1 Mainly Windows
- 2 Total Damage Also
- 9 Don't Know/Not Sure

48. Other than window protection, what permanent improvements have you added or built into your home reduce the damage to your property in a hurricane?  
**(CATEGORIZE) (PROBE UP TO 2)**

- a 0/1 Roof/truss Strengthening
- b 0/1 Door/Garage Door Protection
- c 0/1 Flood proofing
- d 0/1 Other (Specify)
- e 0/1 None
- f 0/1 Don't Know/Not Sure

49. Is your home or building elevated on pilings or fill material to raise it above flood water?

- 1 Yes
- 2 No
- 9 Don't Know/Not Sure

49a. In addition to elevating the entire structure, have you ever elevated any of the following above their normal height to raise them above flood water?

- 0/1 Water heater
- 0/1 Electrical panel (i.e., circuit breaker box)
- 0/1 Furnace
- 0/1 Electrical wall outlets

49b. Have you installed backflow valves to prevent sewer backup in case of flooding?

- 1 Yes
- 2 No
- 9 Don't Know/Not Sure

50. How much money do you plan to spend **this year** on changes to your home to make it stronger, if any? **(999=DK)**  
\$ \_\_\_\_\_

51. If your homeowners insurance company offered to reduce the price of your insurance premium if you were to make your home stronger, would you consider doing it?

- 1 Yes
- 2 No
- 3 Depends on Cost/Savings
- 9 Don't Know

52. How much damage to your property did you experience in Bonnie? **(999=DK)**  
\$ \_\_\_\_\_

53. Do you feel that local building officials are making sure that repairs after Fran and Bonnie meet the parts of the building code that deal with hurricane protection?
- 1 Yes  
2 No  
9 Don't Know
54. Do you believe that you are receiving as much information as you need on how to reduce damage to your home and property from hurricanes and flooding?
- 1 Yes (Skip to Q.55)  
2 No (Go to Q. 54a)  
9 Don't Know (Skip to Q.55)
- 54a. What additional information do you need?
- 

**WE HAVE JUST A FEW MORE QUESTIONS FOR BACKGROUND PURPOSES ONLY.**

55. Which of the following types of structures do you live in? Do you live in a:  
**(READ)**
- 1 Detached single family home?  
2 Duplex, triplex, quadruple home?  
3 Multi-family building -- 4 stories or less? (Apartment/condo)  
4 Multi-family building -- more than 4 stories (Apartment/condo)  
5 Mobile home  
6 Some other type of structure  
9 Don't Know  
10 Refused
56. How old were you on your last birthday?  
 \_\_\_ Number of years (99 = DK) (88=REFUSED)
57. How long have you lived in your present home? **(ROUND UP) (99 = DK)**  
**(88=REFUSED)**  
 \_\_\_ Number of years
58. How long have you lived on the North Carolina Coast? **(ROUND UP) (99 = DK)**  
**(88=REFUSED)**  
 \_\_\_ Number of years
59. How many people live in your household, including yourself? **(99 = DK)**  
**(88=REFUSED)**  
 \_\_\_ Number of people **(IF 1, SKIP TO Q61)**
60. How many of these are children, 17 or younger? **(99 = DK) (88=REFUSED)**  
 \_\_\_ Number of children

61. Do you own your home or rent?  
1 Own  
2 Rent  
3 Other
62. Do you have any pets?  
1 Yes  
2 No  
9 Refused
63. Which race or ethnic background best describes you? **(READ)**  
1 African American or Black  
2 Asian  
3 Caucasian or White  
4 Hispanic  
5 American Indian  
6 Other  
9 Refused
64. Which of the following ranges best describes your total household income for 1997? **(READ)**  
1 Less than \$12,000  
2 \$12,000 to \$24,999  
3 \$25,000 to \$39,999  
4 \$40,000 to \$79,999  
5 Over \$80,000  
9 Refused

**Thank you so much. Sometimes my supervisor will call people to check on my work. May I get your first name in case she wants to check?**

65.

**RECORD INTERVIEW INFORMATION ON RESPONDENT DISPOSITION SHEET**

66. Sex of respondent 1 Male 2 Female
67. Interviewer ID
68. Date of survey
69. Phone number
70. Risk Zone \_\_\_\_\_ (1= Out Banks) (2= Coastal Sound) (3= Non-surge)
71. County
72. Zip code