Hazard Vulnerability Assessment: Sussex County, DE - 1998

prepared for

Delaware Emergency Management Agency

by

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Overview

Introduction

Hazard vulnerability assessment is the process of identifying and valuing critical assets that may be impacted by natural and man-made events. In this process, it may be possible to mitigate the potential damages in one or more ways. Mitigation is not without costs but those costs must be balanced against the costs avoided, should the hazard become real. One only has to remember the devastation following Hurricane Andrew and wonder whether better building codes and the associated increases in housing construction costs would have been far less to pay.

From 1953 to 1997 there have been seven presidential approved disaster declarations in Delaware. A total of $30 million has been provided in aid. The disasters included one coastal storm, one severe storm, two floods, two snow/ice storms, and two droughts. Sussex County was included in all seven declarations, Kent County followed with five, and New Castle County was included in two declarations.

Hazard vulnerability assessment is itself an uncertain process. It is easy to count up the costs after the event has occurred, e.g. Hurricane Andrew. Prior to the event, the probability of a Category III or greater hurricane striking in that vicinity was about 1 in 9 (11 in the last 96 years). The probability of a storm the size of Andrew was even smaller. The calculus for the politicians who must pass and enforce stricter building codes is between the certainty of increased building costs and some probability of massive destruction.

For emergency management agencies, hazard vulnerability assessment and mitigation is the proactive side of a function that is largely reactive. If they have fewer people living in flood plains, then the management of a flood becomes less difficult. If the bridges on evacuation routes are intact, then the evacuation of affected populations is more manageable. In other words, a proactive emergency agency will be more effective reacting when the emergency occurs. Hopefully, the damage avoided will far outweigh the costs of the mitigation.

This report is a reference to how hazards and vulnerabilities interact in Sussex County. It will cover five hazards and 14 potential vulnerabilities. The objective is first and foremost to identify which critical assets are likely to be affected. Second, the potential population, employment, and property affected will be ascertained. Third, the probability of each hazard

occurring will be addressed. Finally, where the information is sufficient, some measures of priority for mitigation will be addressed.

Following this overview, the report is structured in five sections, one for each hazard. Maps are provided in each section showing the affected vulnerabilities. Data describing the specific hazards and affected vulnerabilities are found in the Appendices and in machine-readable Excel spreadsheets organized by hazard and spatial location.

Sussex County

Sussex County has a population of approximately 136,700 as of July 1, 1998. That population is spread widely throughout the county with no one sub-area containing a disproportionate part of the population. It is important to note that this observation is directed at the year-round population of the county. During the summertime, the population of Sussex County will more than double. Most of that increase is concentrated in the coastal area. In contrast to Kent County with its large central city, most of the towns in Sussex County are small, under 6,000 in population. Those towns are important nodes on the transportation network. Sussex County's population is the oldest of the state's three counties.

Approximately 58,600 jobs are found in Sussex County with 500 people leaving the county each day for work elsewhere. There are substantially more people employed in the county during the peak summer season. The annual economy is estimated to be in excess of $4.9 billion and the market value of property is approximately $10.5 billion excluding government owned property.

The transportation network divides the county into three parts; DE 1 in the east, US113 in the center, and US13 in the west. Air service is available by charter, but there is no regular passenger service available to or from Sussex County. There is some public transportation operating on a limited basis to serve the state service centers in the county.

The health care system is supported by three hospitals; Beebe in the southeast, Nanticoke in the southwest, and Milford Memorial, which was recently acquired by Bay Health, in the northern part of the county. That group also operates the Kent General Hospital, which is located in Kent County. All are category 2 hospitals.

The eastern part of the county (east of DE 1) is principally wetlands and much of the activity in it is regulated under Delaware's Coastal Zone Management legislation. Much of the

coastline and the beach areas are state-owned and are part of the park system. The only port along this coast of any size, other than docks/marinas and ramps used for recreational fishing, is the Cape May-Lewes ferry terminal in Lewes.

Police services are split between the Delaware State Police, and a number of municipal police departments. Local volunteer fire companies and the State Paramedics provide ambulance services. Volunteer fire departments provide all fire-fighting services.

Hazards

This report covers five hazards that have some probability of occurring in Sussex County. They are floods, Category 3 hurricane slosh, dams, hazardous material sites, and nuclear power plants. All share the common characteristics that there is a reasonably designed spatial component that can be used to identify potential vulnerabilities.

Two other hazards were considered but were discarded. According to historical record the last known earthquake felt in Sussex County (Georgetown) was December 12, 1937 at 12:15pm. According to the Delaware Geological Survey, there is no basis for spatially differentiating earthquake risk in Sussex County. Similarly, there is one chance in 50 of sustained winds in excess of 100mph occurring in Sussex County in a given year. This too is not spatially differentiable. All parts of the county are at equal risk. Tornado activity over the past 50 years is presented in Figure 1.1, below. Since mobile homes are particularly vulnerable to high winds wherever they are located, the spatial distribution of mobile homes in Sussex County is provided in Figure 1.2 at the end of this section.

100-year Floods. This hazard is differentiated by the fact that it will broadly affect either large segments of the county's hydrography or at least particular basins. The primary problem with large-scale floods is fast moving water. This water can result in loss of life, destruction of property, pollution of the water supply, creation of health problems, and general environmental damage. Fires, loss of power, and loss of access to medical facilities can produce secondary impacts apart from water damage. Disruption of transportation systems can impact both employment and delivery of critical government services.

No 100-year floods have occurred in Sussex County drainage basins during this century. Several 50-year floods have occurred.

Category 3 Hurricane Slosh. This hazard primarily affects coastal areas but broadly so since accompanying winds can force significant waters onshore independent of any flooding produced by rain. The primary problem with hurricane slosh is also fast moving water. This water can produce loss of life, destruction of property, pollution of the water supply, creation of health problems, and general environmental damage. Fires, loss of power, and loss of access to medical facilities can produce secondary impacts apart from water damage. Disruption of transportation systems can impact both employment and delivery of critical government services.

No Category 3 hurricane has hit Delaware in the last 100 years.

Dams. The primary result of a dam failure is fast moving water. The main impact is usually property destruction, injury and loss of life. Depending on the nature of the vulnerabilities in its path, there will likely be damage to power and communications system, disruption of transportation and other government services, environmental damage, and health problems associated with water pollution, sewage and waste disposal, and secondary unplanned chemical releases. The impact of these secondary failures will extend both upstream and downstream depending on the type of failure and alternate sources of services available for those affected.

There are 27 dams at risk in Sussex County.

Hazardous Materials. The primary result of an accident at a hazardous material site is usually a toxic release. This may be accompanied by fire and explosion, which can aid or exacerbate the problem. There will be problems on the site and depending on the circumstance the toxic release may leave the boundaries of the property. In benign situations, the result may be nothing more than a bad odor in the air. In more serious situations, the site itself and even contiguous areas may have to be evacuated. Depending on the toxicity of the release, there may be health problems and even loss of life. If the site is next to a transportation facility, that facility may have to close until the situation is under control. There also may be water pollution if the release is of that type. Both the primary and secondary effects must be considered when assessing the hazard. The duration of the event is critical in determining its impact.

There have been 199 reported releases of toxic materials in Sussex County from 1990 through 1998. Thirteen of these releases were to the air, 126 were water related, 54 were onto land, and the other six were not classified. The end results were 500 people evacuated, three deaths, and two injuries for all 199 events.

Nuclear Power Plants. Essentially, any release from one of the two nuclear power plants in the region, Salem or Calvert Cliff, would have the same effect as a release at a hazardous material site with all the attendant problems. This may be accompanied by fire and explosion, which can aid and exacerbate the problem. There will be problems on the site and depending on the circumstance the toxic release will leave the boundaries of the property. The amount of radiation released and the prevailing winds will determine how much of Sussex County is affected. In a major accident at Salem Nuclear Power Plant, with radiation traveling 50 miles, the northern third of Sussex County would be impacted while a release from Calvert Cliff would impact the western third of Sussex County. This could require a mass evacuation and a total disruption of the local economy for an undetermined period of time depending on the levels of radiation.

No nuclear power plant toxic release has affected Sussex County since the plants were built. The only release of any kind in the region was during the worst accident in the nuclear power industry at Three Mile Island nuclear power plant in 1979. No deaths or serious injuries occurred. An event like Chernobyl in 1986 is several orders of magnitude more damaging.

Vulnerabilities

For convenience, the 14 potential vulnerabilities have been collapsed into eight functional groupings. Each of these groupings is examined in later chapters to determine which if any of its individual members will be impacted by a particular hazard.

Transportation. This category includes airports (3), bridges (325), and ports (17). The size of the airports and ports in Sussex County are such that they have limited impact on transportation or the economy in general. The Cape May-Lewes ferry facility is the only port with any economic importance. All of the other ports are docks, marinas, or ramps used by recreational boaters and the occasional emergency/regulatory service.

Bridges are another story. There are 325 bridges in Sussex County, 18 are rail-over-water, five are road-over-rail, 300 are road-over-water, and two are road-over-road. Ninety-nine of the bridges are classified as being on an evacuation route. To varying degrees these bridges can affect the economy, and public safety particularly if they interfere with evacuation. The roadways themselves can be impassable even if the bridge is intact, however the time and cost to restore

service when a roadway is lost may be considerably less than that for a bridge. However, the mere fact that a bridge or road fails, does not imply that there are no good alternatives.

Communications. This category includes sirens (0), dispatch centers (3), television and radio stations (7), newspapers/magazines (14), communication towers (6), and emergency operation centers (1). All of these facilities in some way impact the way information is disseminated during an emergency. Any loss reduces the warning time or information that could have a negative outcome for households and firms in Sussex County. To some degree however they are substitutes for each other and the failure of any one may not be critical.

Employers and Government. This category includes major employers (47), those with more than 100 employees and government facilities (53). Government not only is the provider of essential public services but also is one of the major employers in Sussex County. Disruption of major businesses will have significant effects on many other firms with which they do business. The loss of key government services during an emergency can exacerbate situations and affect public safety, transportation, and health. Most firms of any size have disaster recovery plans and many including key state government agencies have alternate locations. Small business is probably the most vulnerable to hazards of the type discussed here.

Education and Corrections. This category includes schools (84), colleges and universities (5), as well as correction facilities (1). This is important either because the facilities may have to be evacuated or, in the case of schools, they may also be needed as shelter. However, the vulnerability of these facilities will depend largely on the number of people that would have to be evacuated and access to the transportation system.

Fragile Populations. This category includes hospitals (3), nursing homes (11), and daycare centers (47). All could require evacuation in the case of an emergency. There are good alternatives since there are three hospitals in the county and Kent General Hospital is less than an hour north. However, the transportation system must be intact to access them. Alternative housing for nursing home residents would be the most difficult to find.

Power Distribution. This category includes substations (17) and taps (12) by municipalities, industry, and REA into the power grid. It also includes the generating station at Indian River. These areas are sensitive since they would impact power delivery to significant areas of Sussex County if they were inoperative. The knowledge of how the power companies

would deal with this situation and what alternative connections were available would permit a more accurate assessment of the true vulnerability of these sites.

Emergency Services. This category includes police (22), fire (26), and ambulance services (2) in Sussex County. These agencies not only play a major role during emergencies, they have an ongoing daily role that could be hampered if they lost their primary facility. However, all three services are mobile and have on-board communications so they can relocate. If they are isolated and/or their equipment is destroyed, then they are clearly less effective.

Other Services. This last category is a catchall and includes landfills (4), weather stations (15), sewage treatment plants (30), and hotels/motels (56) some of which are in use only part of the year. Landfills and sewage treatment plants that are no longer operating can be a significant health hazard and also provide critical services to the Sussex County community. Hotels and motels are a concern both as potential sites requiring evacuation and also as potential shelters for evacuees.

Setting Priorities

One of the single most vexing problems in hazard mitigation is deciding where and how to mitigate the potential damage to the selected vulnerabilities and to the population and economy in general. The reason this process is so difficult is that it is both complex and layered with uncertainty. On top of that, the mitigation strategies that could be applied may differ by hazard and those hazards themselves have different frequencies and damage functions.

Selecting vulnerabilities for mitigation priority assumes that a lot of information is known. Consider a simple four step process for assigning priorities among competing vulnerabilities:

1. Identify the vulnerabilities that are affected by the hazard. In the hazards discussed in this report, that process is done spatially. While that is the most precise measurement possible, it is not without error.

2. Once vulnerabilities of the same type for a given hazard have been identified, each must be examined to determine if in fact it is vulnerable. For example, a bridge may well be subject to a 100-year flood, but its design characteristics may have taken that into account. In other words, it is not vulnerable to that hazard and should be removed from the list and the bridge database should be updated to reflect that. Also determine if there are changes that will affect the vulnerability's status. DELDOT's ongoing bridge inspection and maintenance process is a good example of that.

3. Once the vulnerabilities have "certified" in 2 above, the question is what priority should be assigned. Other things equal, one needs some idea of the value of the vulnerability. This might be a simple concept like the fact that a bridge is on or off an evacuation route. It also might depend on the number of vehicles that use the bridge in a given period. That will also be affected by alternatives to using that particular bridge if it was closed. The likely duration of the situation also comes into play here.

4. When all vulnerabilities have been assigned a computed value, these must be adjusted for the frequency of occurrence. Assume two bridges are of "equal value", but one is subject to a hazard that will occur once in 50 years and the other to a hazard that will occur once in 100-years. The expected value of the first vulnerability is twice that of the second.

The typical method used in hazard assessment for assigning priorities ignores most of these issues. Step one is essentially the same. Step 2 is ignored. Step 3 consists of determining if the vulnerability does or does not affect several broad categories, e.g. lifelines or the economy, without reference to "how much". Step 4 is to add up the number of hazards affecting the vulnerability (without reference to probability of occurrence or damage) and add that total to the count in Step 3.

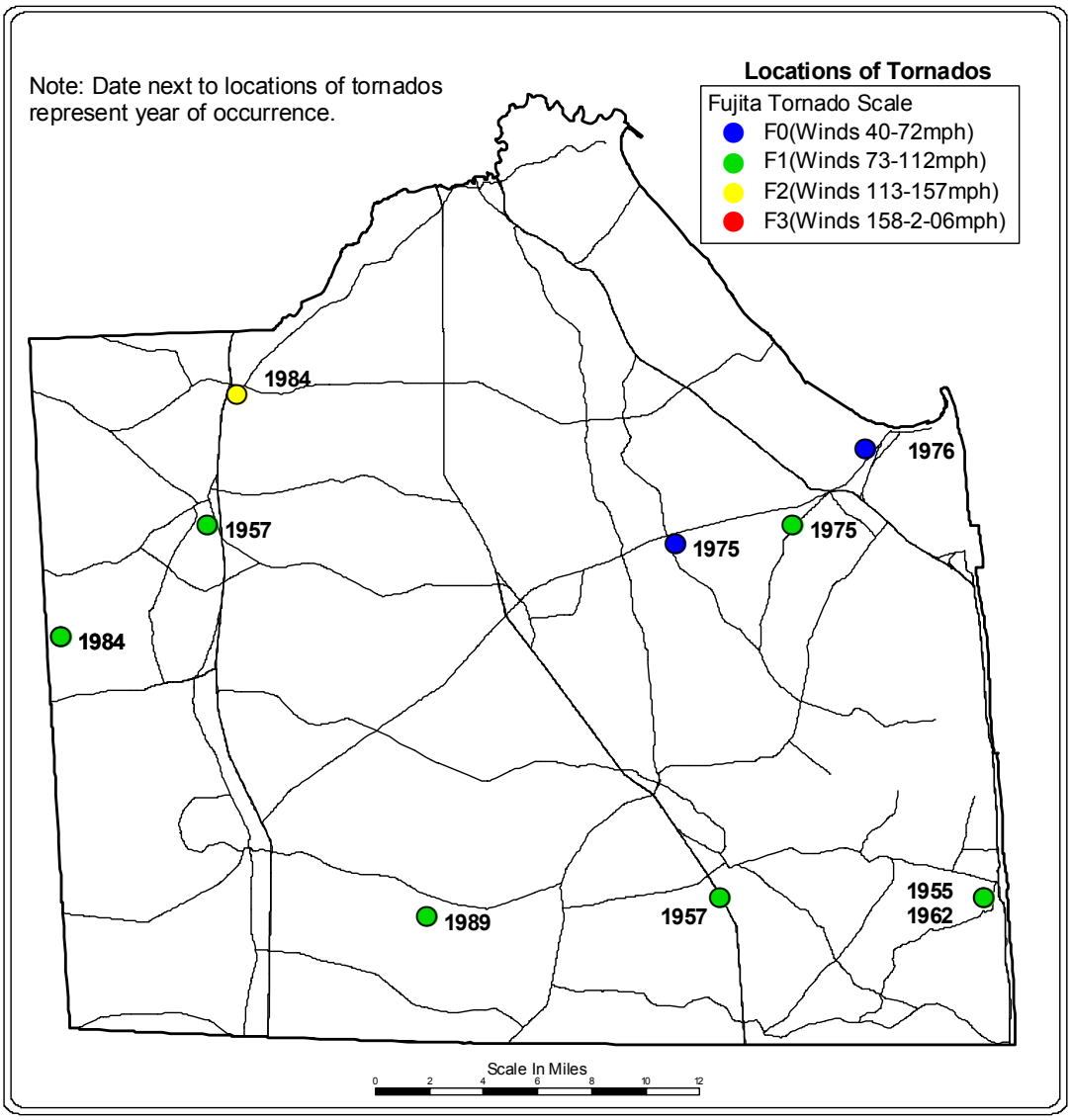
There are a couple of other issues that also further complicate this problem. In some cases, mitigation may operate best on the hazard and not on the vulnerability. This is particularly true for dams, hazardous material sites, and nuclear power plants. The best outcome is avoidance of the problem. This means regulation, inspection, working with responsible parties to understand the risk, and collecting/sharing as much information about the hazard as possible. In the case of floods, hurricanes, and other natural phenomenon it as yet is not possible to greatly influence their occurrence or to steer them away from vulnerable areas. There is no choice but to either prevent or reduce the value of the vulnerabilities by relocation and/or zoning and land-use restrictions; or to reduce the impact of the hazard on them and requirements for having flood insurance. In either case good evacuation plans, routes, and shelters become the fallback position and the only choice in some cases to reduce loss of life.

The other issue is the way a hazard affects the vulnerability. Floods, hurricanes, and dam failures all have the possibility of doing physical damage to the structure. This suggests that the duration of the failure is still another consideration. Release of toxic materials usually does not imply damages to the physical component of a vulnerability and in most cases those situations are of short duration. Of course, the other end of the spectrum is a major catastrophe at Salem that would render Sussex County uninhabitable though the facilities were still standing. Hopefully, the probability of that event is so small that the expected value of the damage is essentially zero.

All of these calculations require substantial information. Some of that information is available and is accurate. Other information is collected but it is not in a form that can be brought to bear on this problem. In the balance of this report, people, jobs, and property values will be used as replacements for the categories used in earlier analyses. In addition, some assessment of the frequency of these events will be presented whenever possible. In some respects, the identification of holes in the data sets may be as valuable an outcome as any in impacting hazard assessment in Delaware in the future.

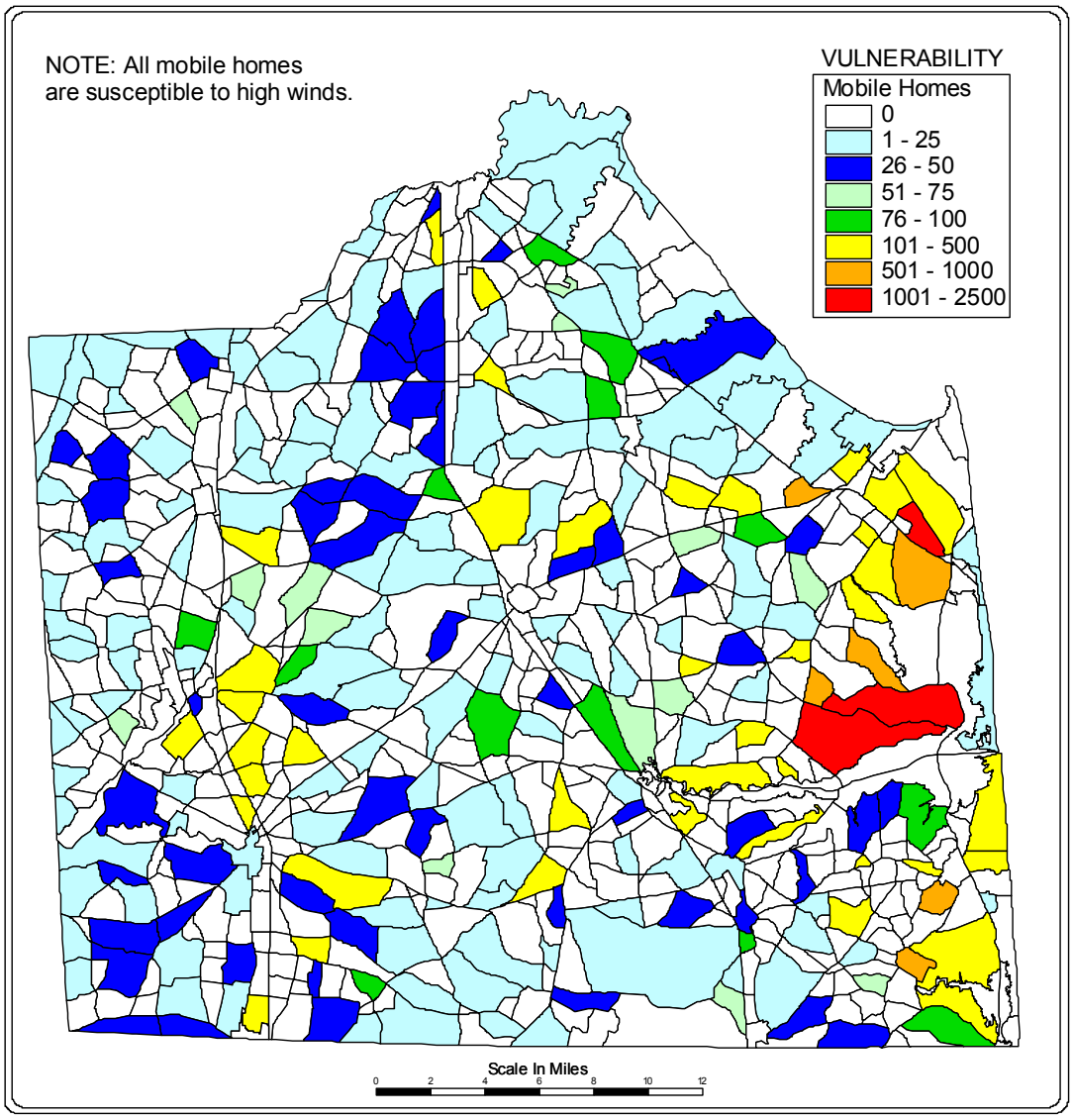
There is detailed information available that will help establish priorities for mitigation. It is found on the CDROM that was produced with this report. In addition a complete listing of the vulnerabilities for each hazard is found in a separate appendix at the conclusion of the report. This information is arranged spatially using the ADC map grid location.

Figure 1.1
Tornado Activity in Sussex County:
1950-1998



Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 1.2
Spatial Distribution of Mobile Homes in Sussex County: September, 1999



Source: Center for Applied Demography & Survey Research, University of Delaware.

100-year Floods

Background

Floods of this magnitude in Delaware are relatively infrequent as is indicated by the name. These floods are usually of relatively short duration and of low intensity at least in contrast with water flows that might result from a dam failure. Since floods of this magnitude build over time, they are not usually predictable in advance. They also can occur anytime of the year. Hence, it is not unusual to see people trapped by the rising water.

The damage caused by floods is largely a function of what is in the flood plain. Because of the risk and restrictions brought about by zoning, the level of damage is usually low to moderate. Beyond these restrictions there is probably a limited amount one can do to mitigate the effects of a flood.

The primary result of any flood is fast moving water. The main impact is usually property destruction, injury and loss of life. Depending on the nature of the vulnerabilities in the flood plain, there will likely be damage to power and communications system, disruption of transportation and other government services, environmental damage, and health problems associated with water pollution, sewage and waste disposal, and secondary unplanned chemical releases.

The source of the 100-year flood information for Delaware is the FEMA flood insurance database and associated overlays.

Sussex County Floods

There are three drainage basins in Sussex County for which stream gauge measurements are available for at least some period of time. These are the Broadkill-Smyrna, Nanticoke, and the Chincoteague. The last 50-year flood recorded in the Broadkill-Smyrna drainage basin was on 3/7/1979. In the Chincoteague drainage basin, a 50-year flood occurred on 3/3/1994. The largest flood recorded in the Nanticoke drainage basin was a 50-year flood on 2/26/1979.

Taken together the 100-year flood could impact 23,200 people and 18,400 jobs. The current market value of residential property in the flood plain is $2,600,000,000 and the total value of commercial, industrial, and utility property is approximately $336,000,000. These estimates do not include the value of state owned property that is not subject to the property tax and there are significant properties of that type in the impacted areas. An estimated $552,000,000 in annual wages and $788,000,000 in annual revenues is at risk. These are upper bound estimates since the exact area of the flood is approximate and the location of the employment is an estimate. Essentially, about 17% of the population, 31% of the employment and 28% of the property value in the county is at risk from this hazard. While these numbers are large, the data on floods show that the impact can be regional within the county.

Estimating potential economic losses due to flood is hazardous at best. For example, at least some of the employment affected is government. It is unlikely that those people would be terminated in the case of a disaster. In other situations, where there are significant labor contracts (the automobile industry for one), 95% of wages may be paid for as long as a year even though the workplace is closed. Finally, in most cases the duration of the impact would be less than a year and companies routinely have disaster recovery plans that would relocate employees to alternative sites.

Vulnerabilities

In the eight maps that follow, each of the 14 vulnerabilities identified as being within the 100-year flood plain are displayed. Any vulnerability that lies within the area of risk is coded yellow independent of its type. In some cases, the actual number of yellow symbols on the map may not agree with the list of affected vulnerabilities in the associated appendix table. This will happen when two vulnerabilities of the same type are co-located and thus have the same latitude and longitude and the same symbol.

The maps show three sub-areas of the 100-year flood plain. The dark blue area, coded as VE, represents the area affected by high velocity flooding. The second sub-area is coded AE and is colored in a lighter blue. It represents areas where flood elevations have been precisely measured. The third area is coded A and is colored the lightest blue. It is the most extensive but flood elevations have not as yet been precisely determined.

Transportation. None of the airports is located in the 100-year flood plain but 12 of the 17 ports are at risk. There are 197 bridges that fall in the 100-year flood plain. Of those, 60 are located on evacuation routes. Once again, some of those are currently designed to deal with a 100-year flood. However, those design characteristics are not available in DELDOT's database.

Communications. Of the various communications facilities, only six news/magazine operations and the Rehoboth Beach 911 Center lie within the 100-year flood plain.

Employers and Government. There are two major employers located in the flood plain, Dewey Beach Enterprises and CMF Paymaster Inc. Neither is a hazardous materials site.

No state agencies are located within the 100-year flood plain. There are however 15 government facilities that are in the 100-year flood plain area including the town halls of Henlopen Acres, Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany Beach, and Fenwick Island. The post offices in Greenwood, Milton, Dagsboro, and Bethany Beach are also at risk. Two US Coast Guard stations, the US Naval Reserve, and the Delaware National Guard facility are in the flood plain.

Education and Corrections. Only six of the 84 schools in Sussex County are in the 100-year flood plain. The Rehoboth Elementary School and the Selbyville Middle School and its Intensive Learning Center are the principal sites at risk. The University of Delaware's facility at Lewes is also within the flood plain. No correctional facility is at risk of flooding.

Fragile Populations. None of the nursing homes or any of the three hospitals was at risk of flooding. No daycare center was within the 100-year flood plain.

Power Distribution. Of the various power-related facilities in Sussex County only the Indian River generating station and four substations (Rehoboth, Cedar Neck, Laurel, and Bethany) are in the 100-year flood plain.

Emergency Services. Fire departments in Slaughter Beach, Milton, Rehoboth Beach, Indian River, Bethany Beach, and South Bethany Beach are inside the 100-year flood plain as are police stations in Greenwood, Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany Beach, and Fenwick Island. The Delaware River and Bay Authority police located in Lewes are also in the flood plain.

Other Services. Nineteen of the thirty sewage treatment facilities in Sussex County are located in the 100-year flood plain along with two landfills. These include both those operated by the towns (7) as well as those operated by the food processing industry (6). The state weather station located at Indian River, along with private stations in Greenwood, Dagsboro, and Seaford, are in the 100-year flood plain. Finally, forty-five hotels/motels are also at risk.

Next Steps

Several issues are suggested by these data:

1. Both the latitude and longitude of all government buildings need to be accurately measured.

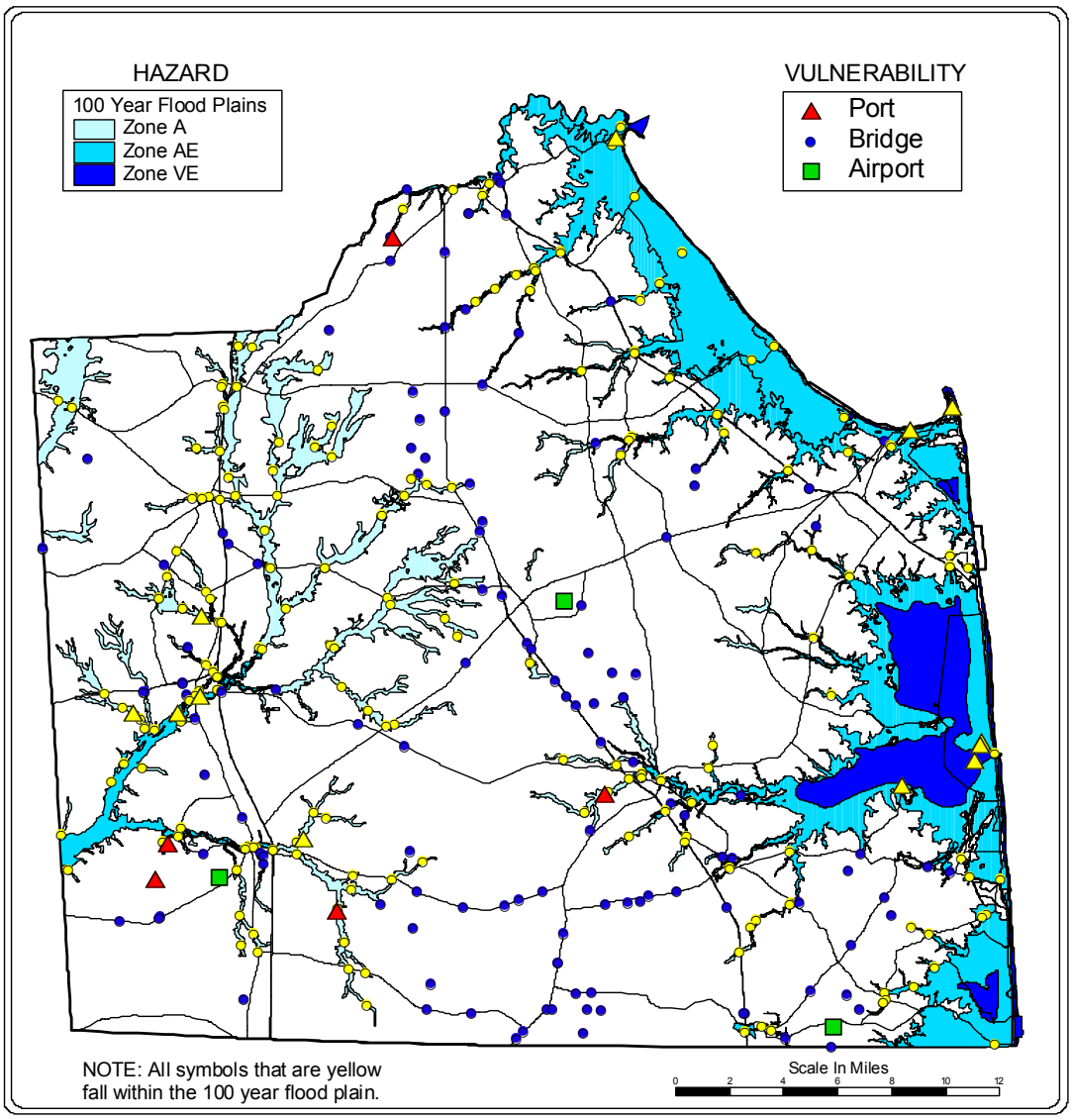
2. Actual employment of both the government sites and the private sector employers should be added to the database and updated periodically.

3. There needs to be an analysis of hazard-to-hazard intersections to determine if one hazard could increase the risk of another.

4. Capacity of each of the schools needs to be added to the database along with the employment at each school. This will further help in evaluating the risk.

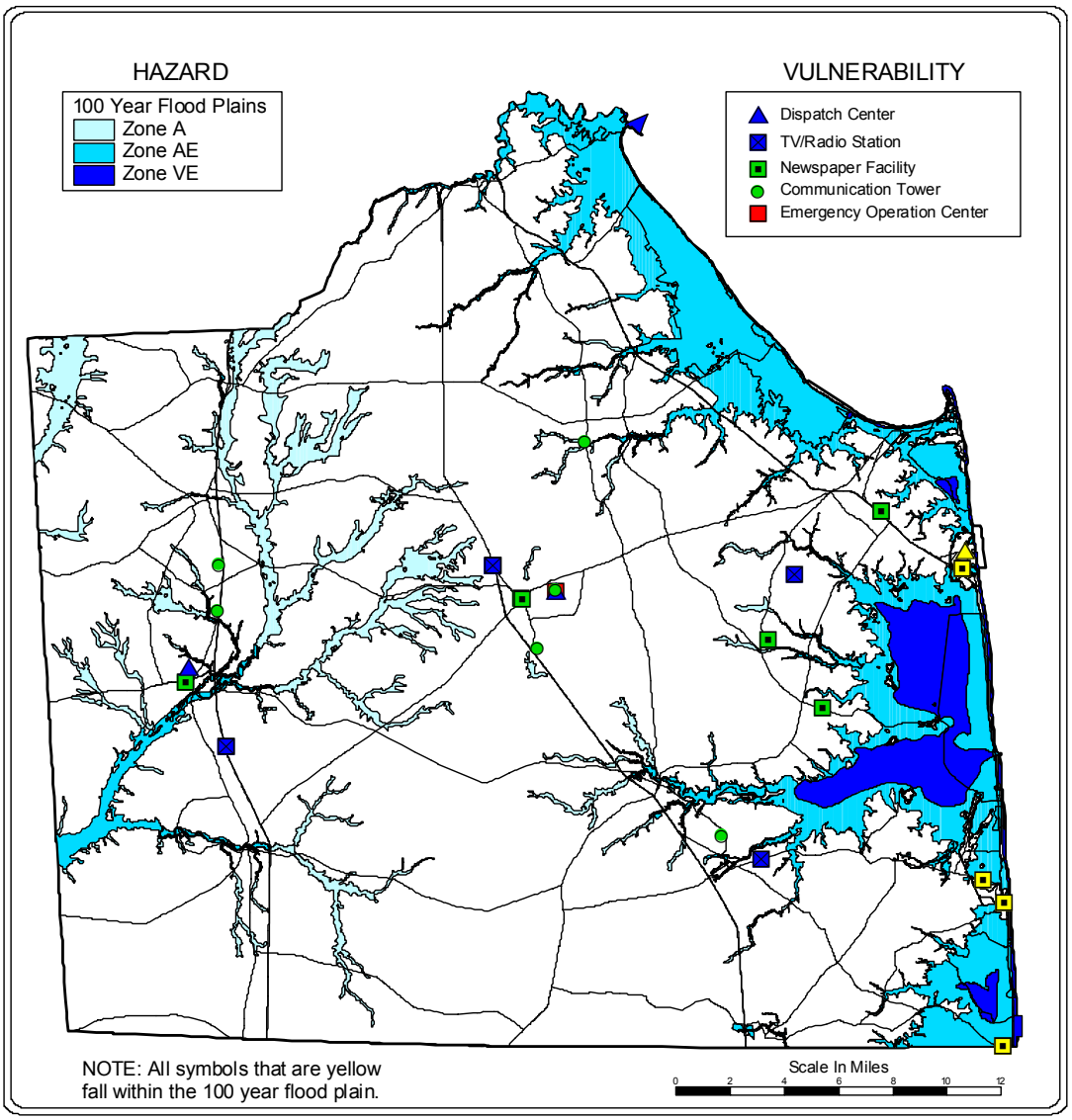
5. Design characteristics relative to bridges needs to be in the database; in particular, height above the water and the roadway.

Figure 2.1
Selected Vulnerabilities within the 100-year Flood Plain:
Transportation



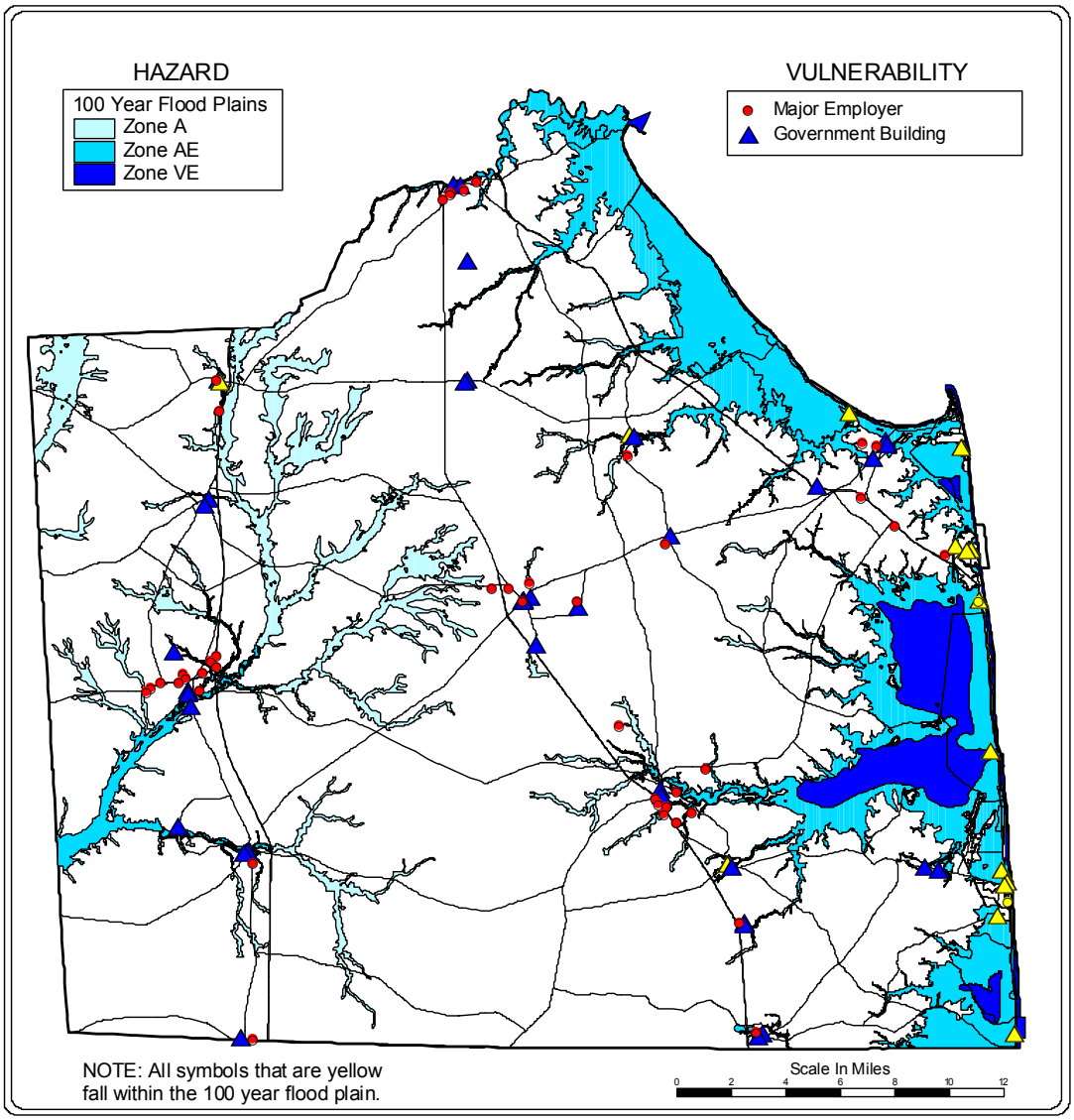
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 2.2
Selected Vulnerabilities within the 100-year Flood Plain:
Communications



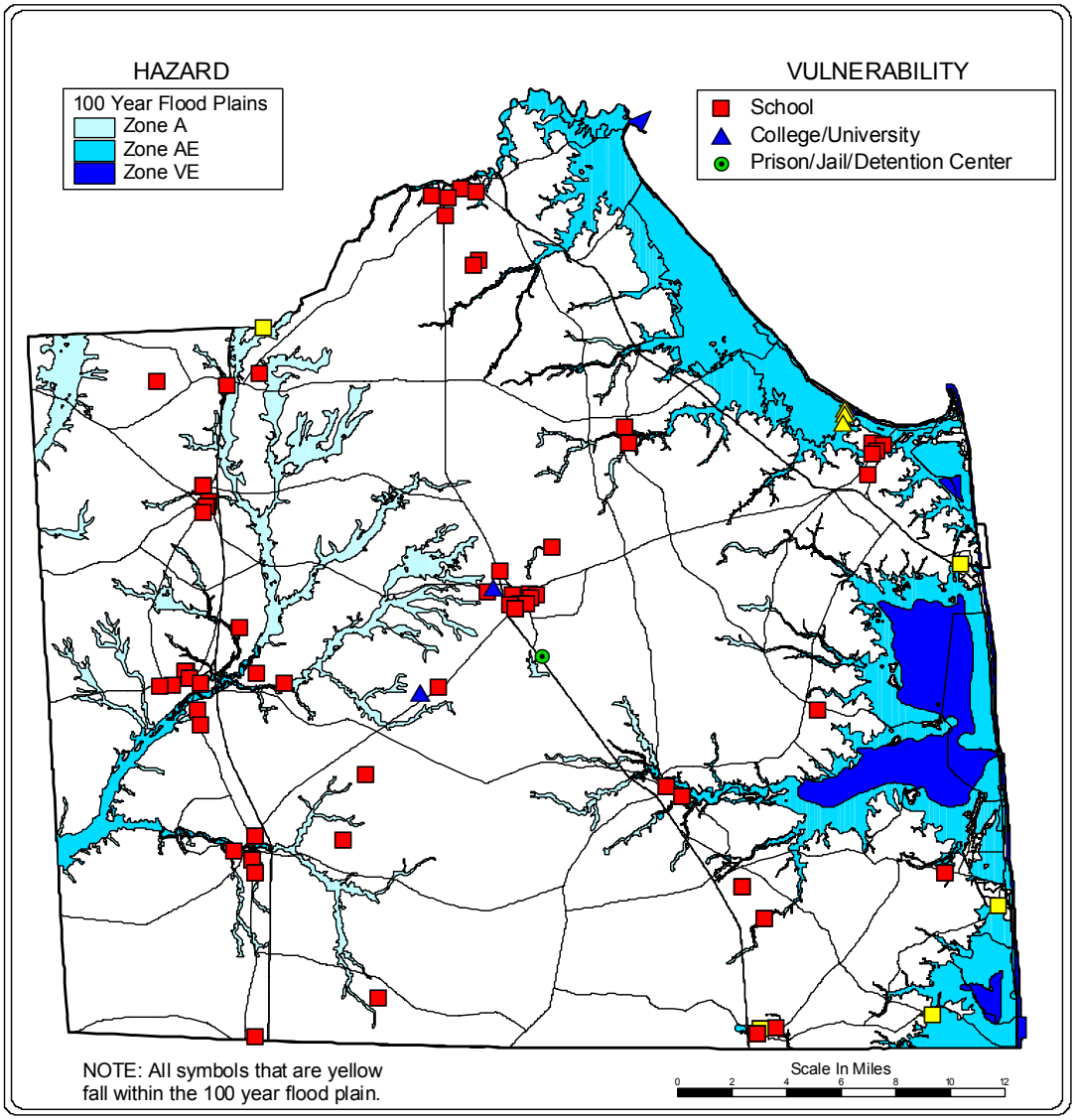
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 2.3
Selected Vulnerabilities within the 100-year Flood Plain:
Employers and Government



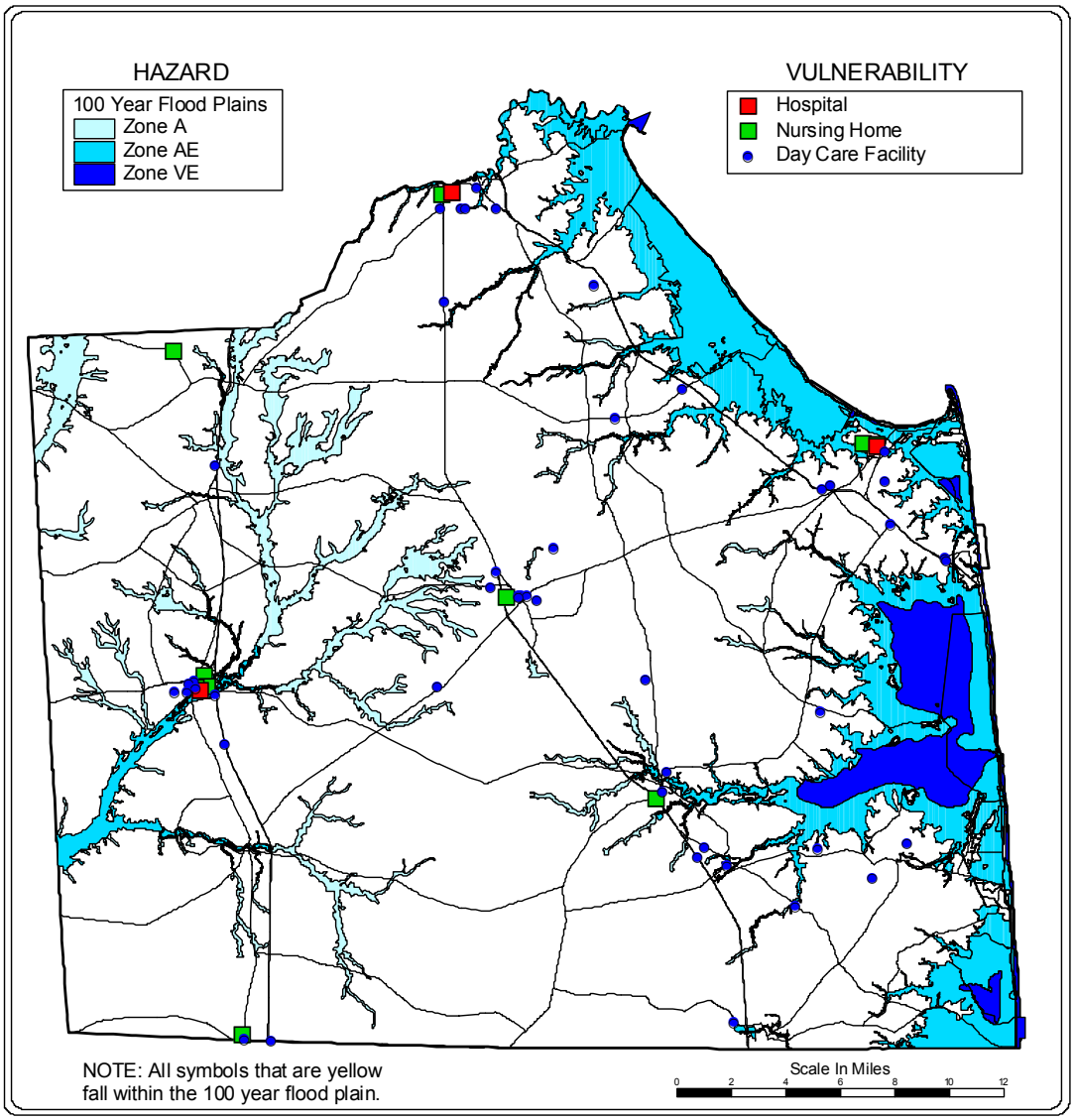
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 2.4
Selected Vulnerabilities within the 100-year Flood Plain:
Education and Corrections



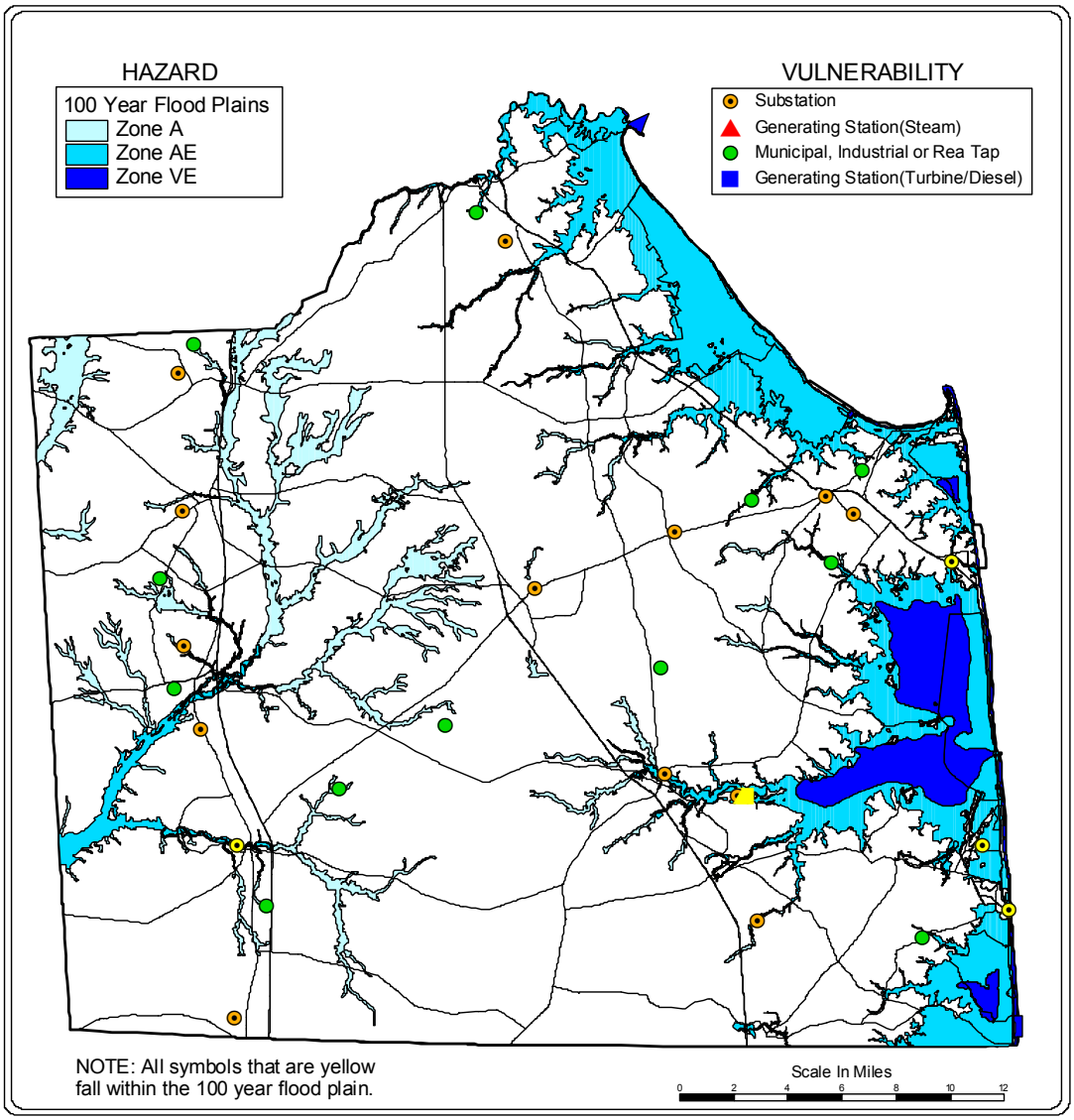
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 2.5
Selected Vulnerabilities within the 100-year Flood Plain:
Fragile Populations



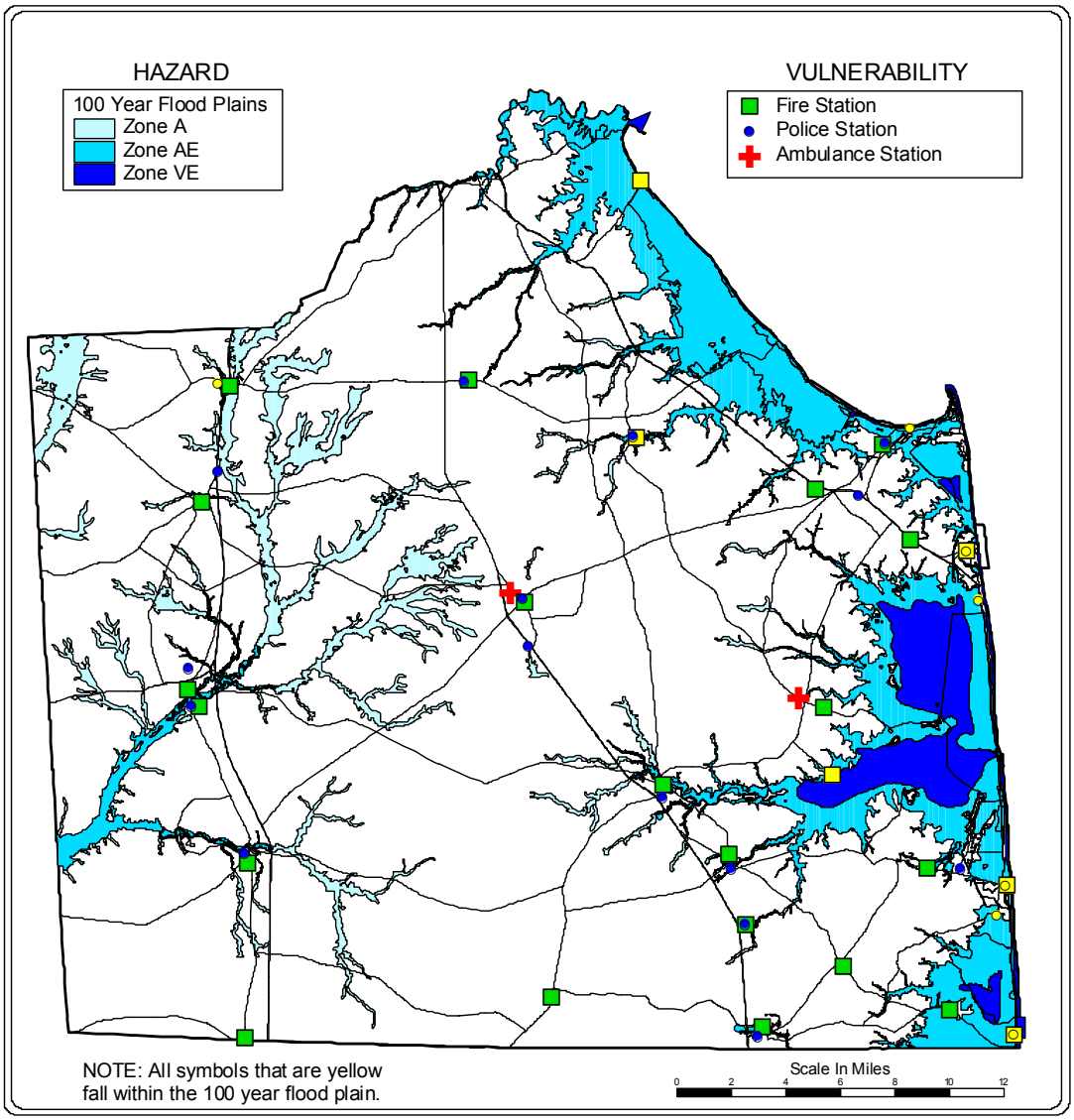
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 2.6
Selected Vulnerabilities within the 100-year Flood Plain:
Power Distribution



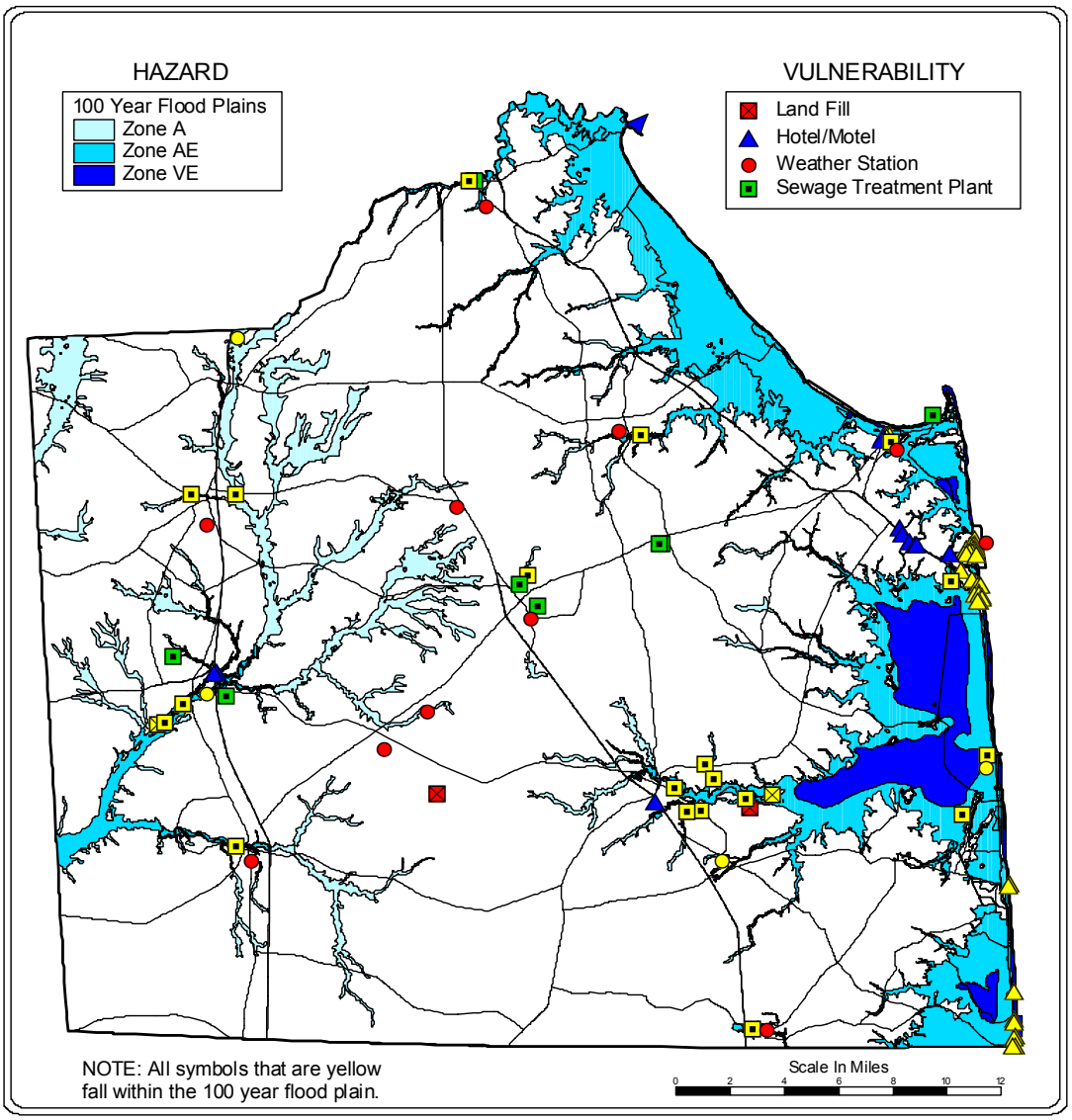
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 2.7
Selected Vulnerabilities within the 100-year Flood Plain:
Emergency Services



Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 2.8
Selected Vulnerabilities within the 100-year Flood Plain:
Other



Source: Center for Applied Demography & Survey Research, University of Delaware.

Category 3 Hurricane Inundation Area

Background

A Category 3 hurricane has not entered Delaware during this century. Thus, they are clearly of very low frequency. If such an event were to occur, the intensity would be high and the recovery times would be extensive. The flooding caused by a Category 3 hurricane would be extensive but would be largely confined to the coastal area as opposed to more generally across the county. That is in direct contrast to the 100-year flood. Hurricanes occur for the most part during the summer and fall, which means the period of risk is shorter than that for floods in general.

The damage caused by a Category 3 hurricane inundation is largely a function of the strength of the storm surge (putting aside the direct effect of wind). Because of the velocity of this surge, the damage can be extensive. In contrast with mitigation used for more general flooding and flood plain management, the effectiveness of mitigation strategies such as restrictive zoning is even more limited. The beach communities are always going to be at risk, and the people who live there will continue to take those risks.

The primary result of flooding associated with a hurricane is fast moving water. The main impact is usually property destruction, injury and loss of life. Depending on the nature of the vulnerabilities in the flood plain, there will likely be damage to power and communications system, disruption of transportation and other government services, environmental damage, and health problems associated with water pollution, sewage and waste disposal, and secondary unplanned chemical releases.

The source of hurricane inundation information for Delaware is the US Corps of Engineers database and associated overlays.

Sussex County Hurricanes

In contrast to the 100-year flood, the primary inundation area that could be affected is along the Sussex County coastline. However, the penetration of the storm surge from the coastline is much deeper than would be expected by the 100-year flood. Since there has never

been a Category 3 hurricane impact Sussex County, these results are somewhat tenuous. Further, just as 100-year floods are usually regional within the county, it would be reasonable to expect differential depths of penetration along the coastline.

Taken together, the Category 3 hurricane inundation could impact 28,800 people and 17,500 jobs. The current market value of residential property in the inundation area is $3,200,000,000 and the total value of commercial, industrial, and utility property is approximately $385,000,000. These estimates do not include the value of state owned property that is not subject to the property tax, and there are significant properties of that type in the impacted areas. An estimated $525,000,000 in annual wages and $750,000,000 in annual revenues is at risk. These are upper bound estimates since the exact area of the inundation is approximate and the location of the employment is an estimate. Essentially, about 21% of the population, 30% of the employment and 34% of the property value in the county is at risk from this hazard.

Estimating potential economic losses due to hurricane slosh is hazardous at best. For example, at least some of the employment affected is government. It is unlikely that those people would be terminated in the case of a disaster. In other situations, where there are significant labor contracts (the automobile industry for one), 95% of wages may be paid for as long as a year even though the workplace is closed. Finally, in most cases the duration of the impact would be less than a year and companies routinely have disaster recovery plans that would relocate employees to alternative sites.

Vulnerabilities

In the eight maps that follow, each of the 14 vulnerabilities identified as being within the hurricane inundation area are displayed. Any vulnerability that lies within the area of risk is coded yellow independent of its type. In some cases, the actual number of yellow symbols on the map may not agree with the list of affected vulnerabilities in the associated appendix table. This will happen when two vulnerabilities of the same type are co-located and thus have the same latitude and longitude and the same symbol.

The map provides information for three categories of hurricane that could conceivably affect Sussex County. The Category 1 hurricane would affect the least area but presumably would be the most likely. It is coded in dark blue. The Category 2 hurricane inundation area includes

both the dark-blue area and the area coded in a middle-blue. Finally, the Category 3 inundation area includes the entire area colored in any of the shades of blue.

Transportation. None of the three airports is in the inundation area. Six of the 17 ports/ramps are within it. There are 73 bridges that fall in the inundation area. Of those 24 are located on evacuation routes. Once again, some of those are currently designed to deal with a Category 3 hurricane. However, those design characteristics are not available in DELDOT's database.

Communications. Of the various communications facilities, only six news/magazine operations and the Rehoboth Beach 911 Center lie within the inundation area.

Employers and Government. There are six major employers located in the inundation area. These include Sea Watch International, Harbor Health Care, Beebe Medical Center, Dewey Beach Enterprises, Roses, and CMF Paymaster Inc. None is a hazardous material site.

No state agencies are located within the Category 3 hurricane inundation area. There are however 21 government facilities that are in the Category 3 hurricane inundation area including the town halls of Lewes, Henlopen Acres, Rehoboth Beach, Dewey Beach, Millville, Milton, Dagsboro, Bethany Beach, South Bethany Beach, and Fenwick Island. The post offices in Milford, Milton, Lewes, Rehoboth Beach, Millville, and Bethany Beach are also at risk. Two US Coast Guard stations, the US Naval Reserve, the Army Reserve Center, and the Delaware National Guard facility are in the inundation area.

Education and Corrections. Nine of the 84 schools in Sussex County are in the inundation area. These include three elementary schools and one middle school. The University of Delaware facility at Lewes is also in the inundation area. No correctional facility is within the inundation area.

Fragile Populations. Two nursing homes and the Beebe Medical Center are at risk of inundation. In addition, five daycare centers with a capacity of 258 children are inside the inundation area.

Power Distribution. The Indian River generating station along with three REA sites and five substations located at Rehoboth, Millsboro, Indian River, Cedar Neck, and Bethany are in the Category 3 hurricane inundation area.

Emergency Services. Fire departments in Slaughter Beach, Milton, Lewes, Rehoboth Beach, Indian River, Millville, Roxana, and Bethany Beach are inside the inundation area as are police stations in Milton, Lewes, Rehoboth Beach, Dewey Beach, Dagsboro, Ocean View, Bethany Beach, South Bethany Beach, and Fenwick Island. The Delaware River and Bay Authority police located in Lewes is also in the inundation area along with the Mid-Sussex Rescue Service near Long Neck.

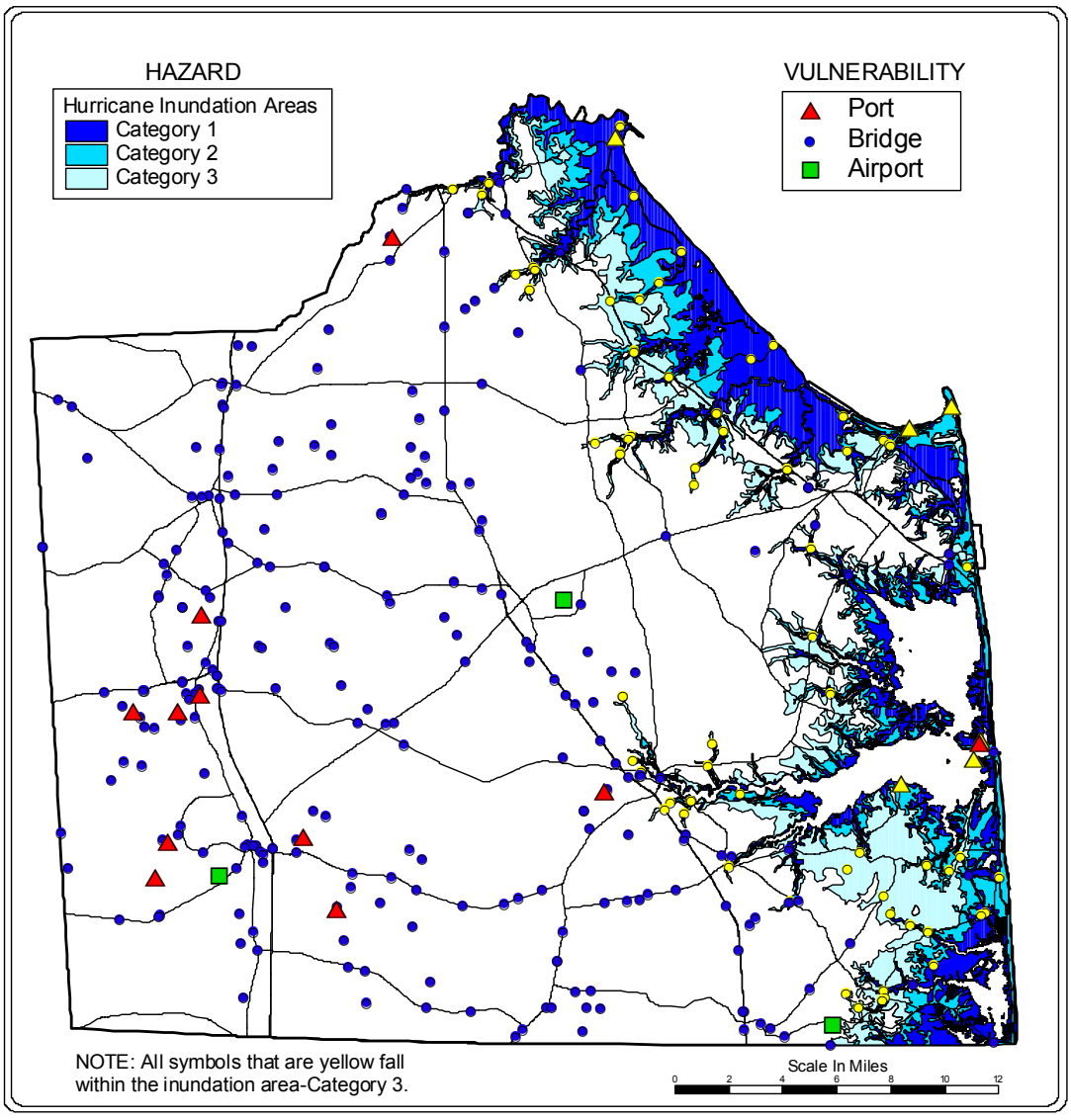
Other Services. Ten sewage treatment facilities including four operated by municipalities and six by private firms are at risk along with two landfills. Forty-seven hotels/motels are located in the inundation area. Finally, two state weather stations, one at Indian River Inlet and another at Lewes are at risk.

Next Steps

Several issues are suggested by these data:

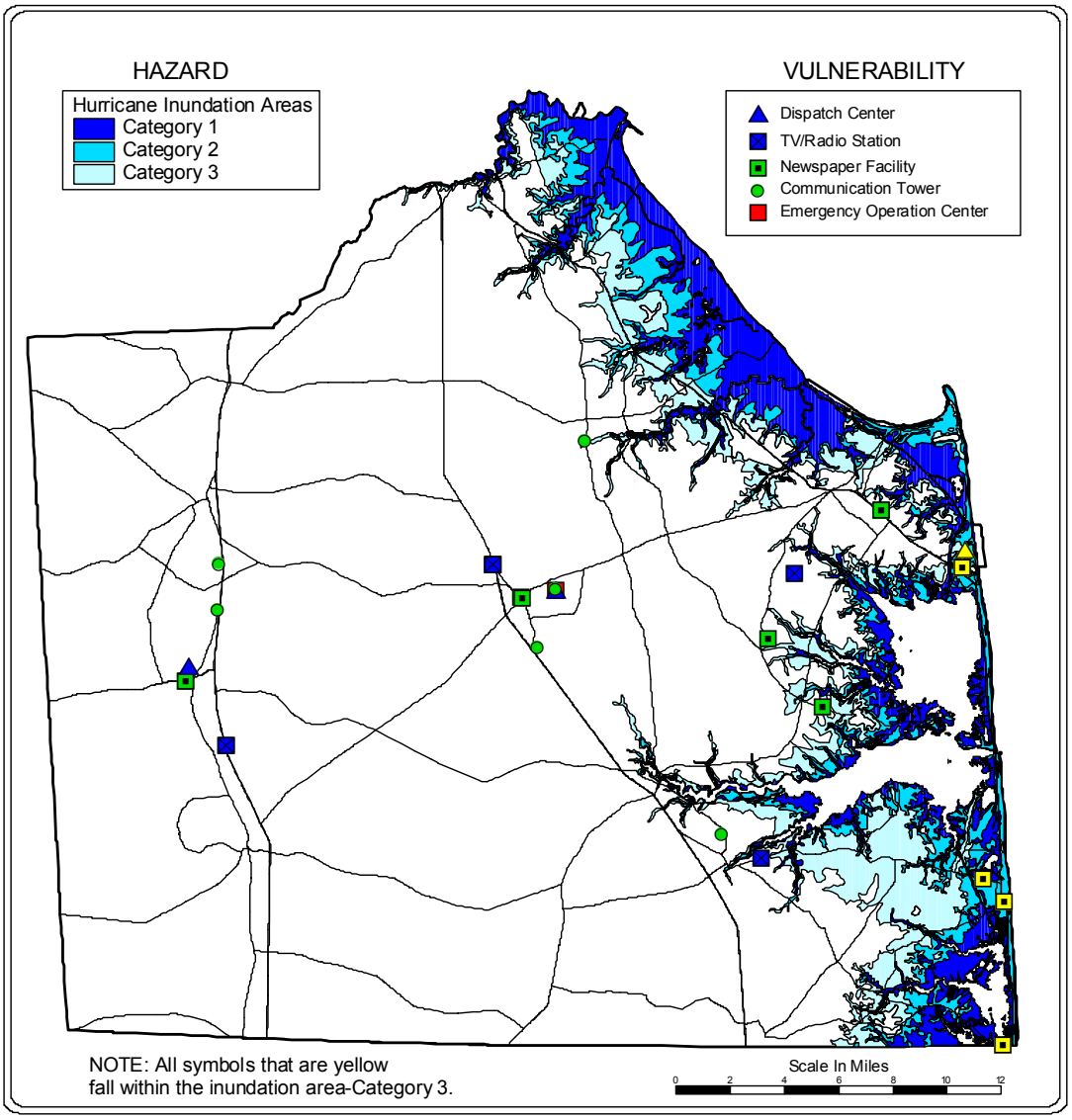
1. Both the latitude and longitude of all government buildings need to be accurately measured.
2. Actual employment of both the government sites and the private sector employers should be added to the database and updated periodically.
3. There needs to be an analysis of hazard-to-hazard intersections to determine if one hazard could increase the risk of another.
4. Capacity of each of the schools needs to be added to the database along with the employment at each school. This will further help in evaluating the risk.
5. Design characteristics relative to bridges need to be in the database; in particular, height above the water and the roadway.

Figure 3.1
Selected Vulnerabilities within the Category 3-Hurricane Inundation Area: Transportation



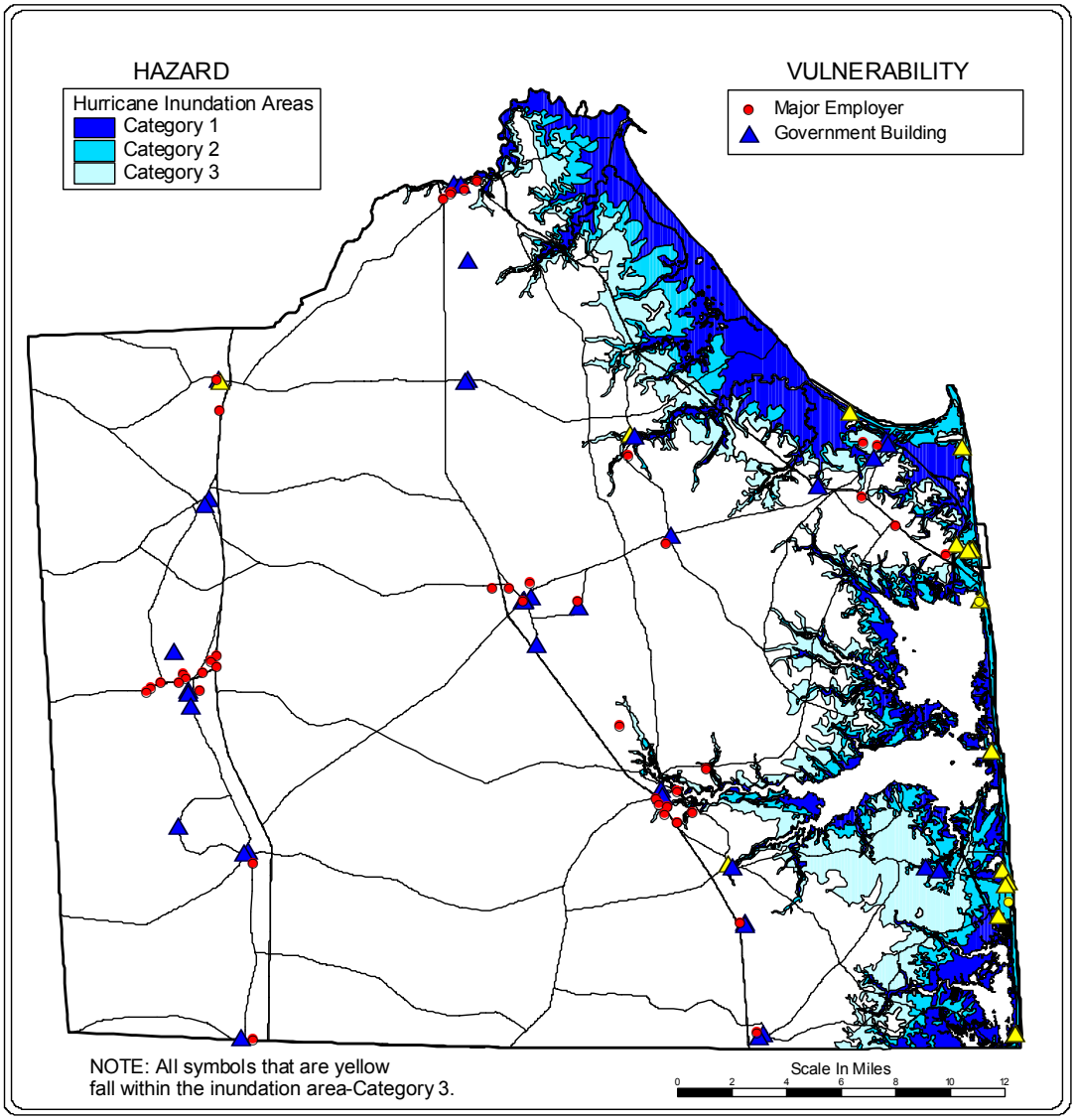
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 3.2
Selected Vulnerabilities within the Category 3-Hurricane Inundation Area: Communications



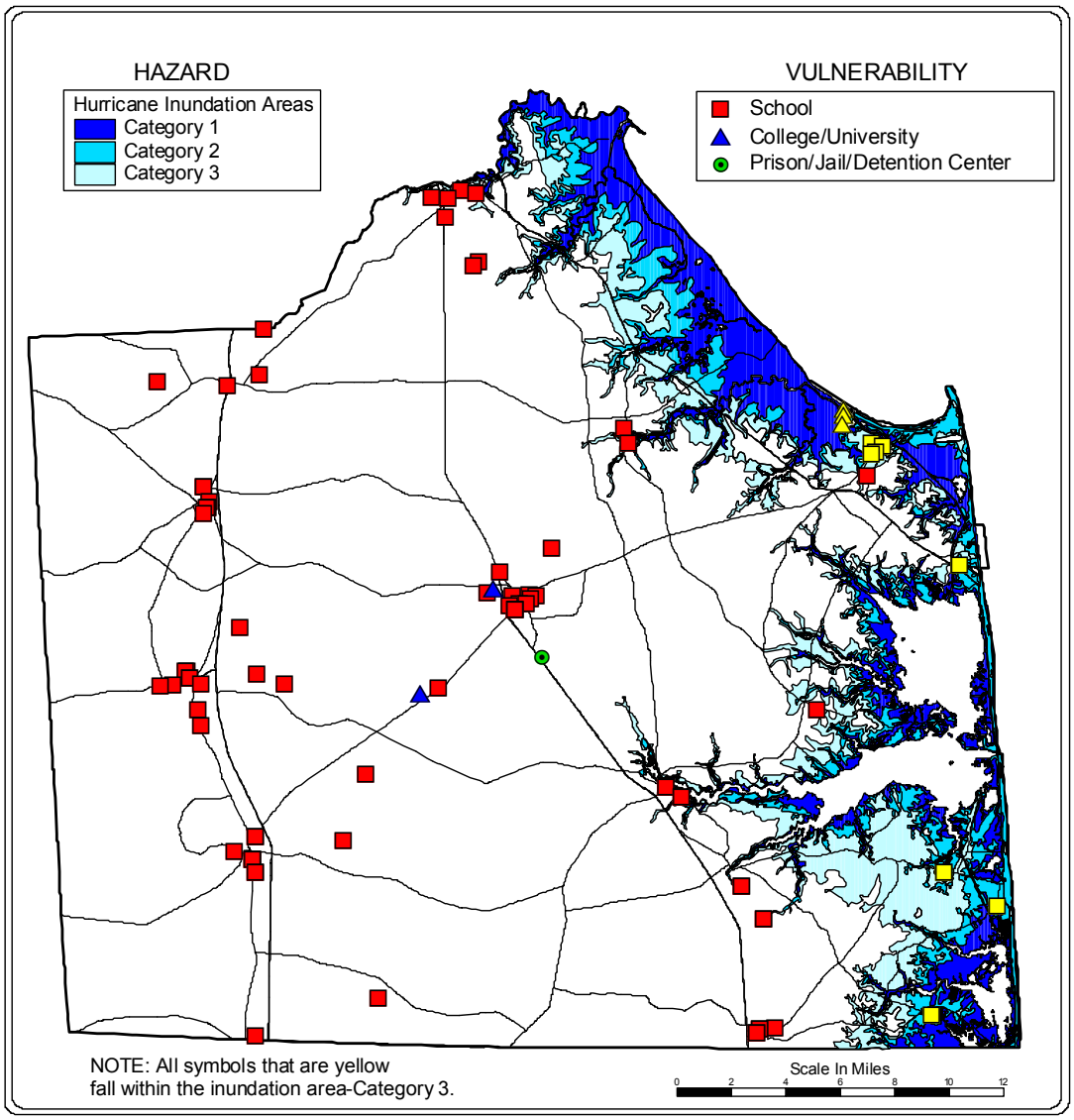
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 3.3
Selected Vulnerabilities within the Category 3-Hurricane Inundation Area: Employers and Government



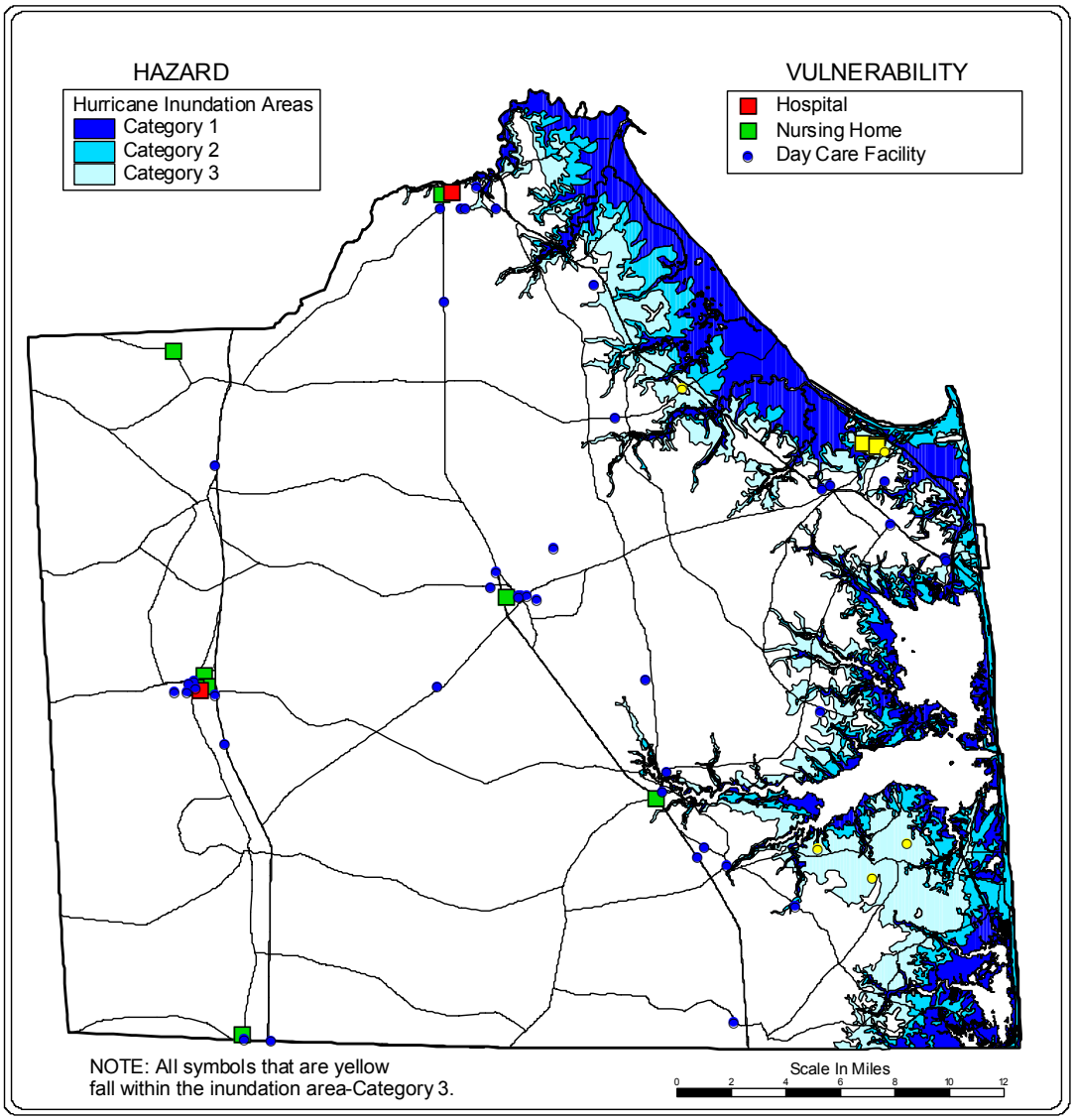
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 3.4
Selected Vulnerabilities within the Category 3-Hurricane Inundation Area
Education and Corrections



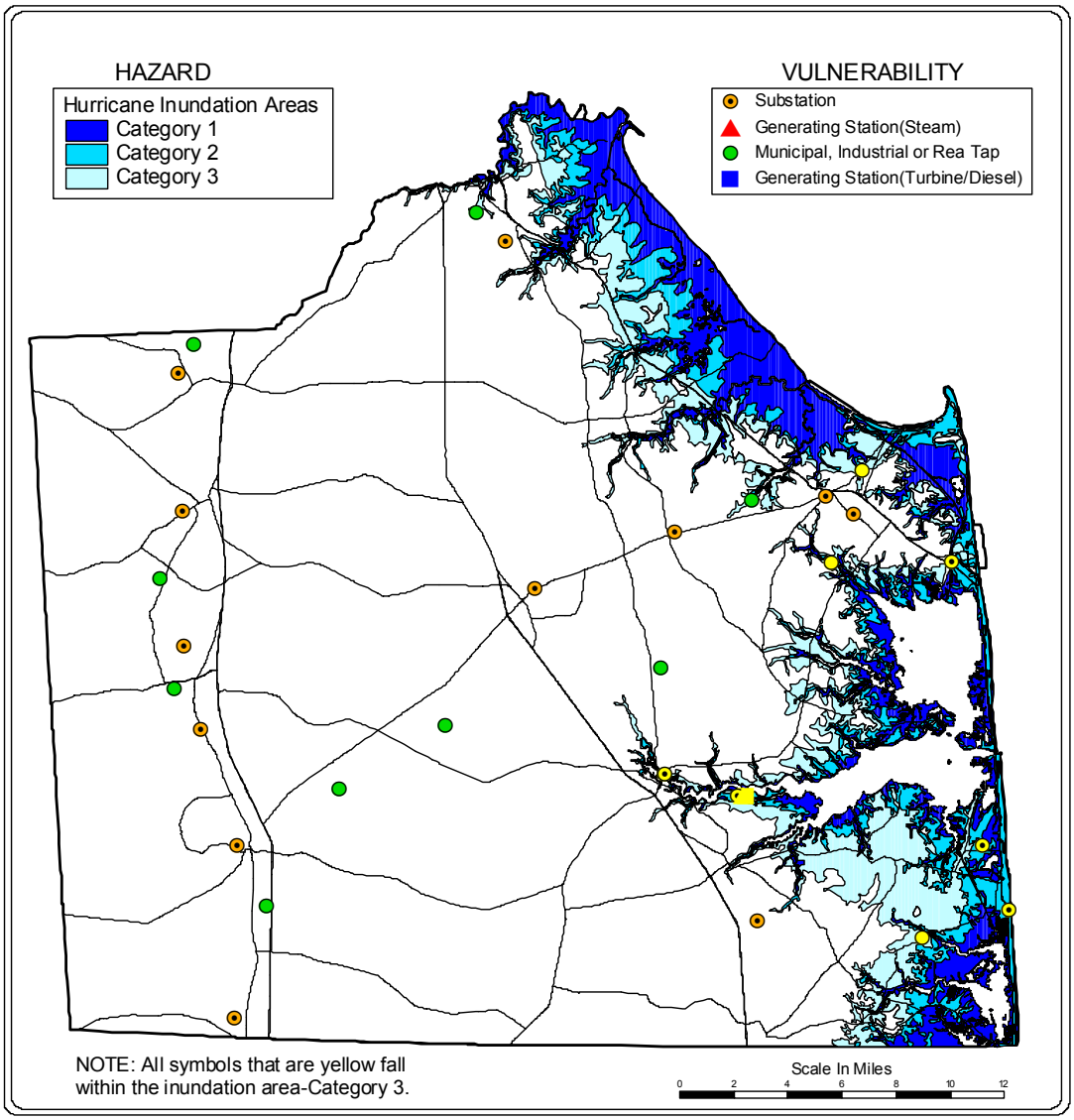
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 3.5
Selected Vulnerabilities within the Category 3-Hurricane Inundation Area:
Fragile Populations



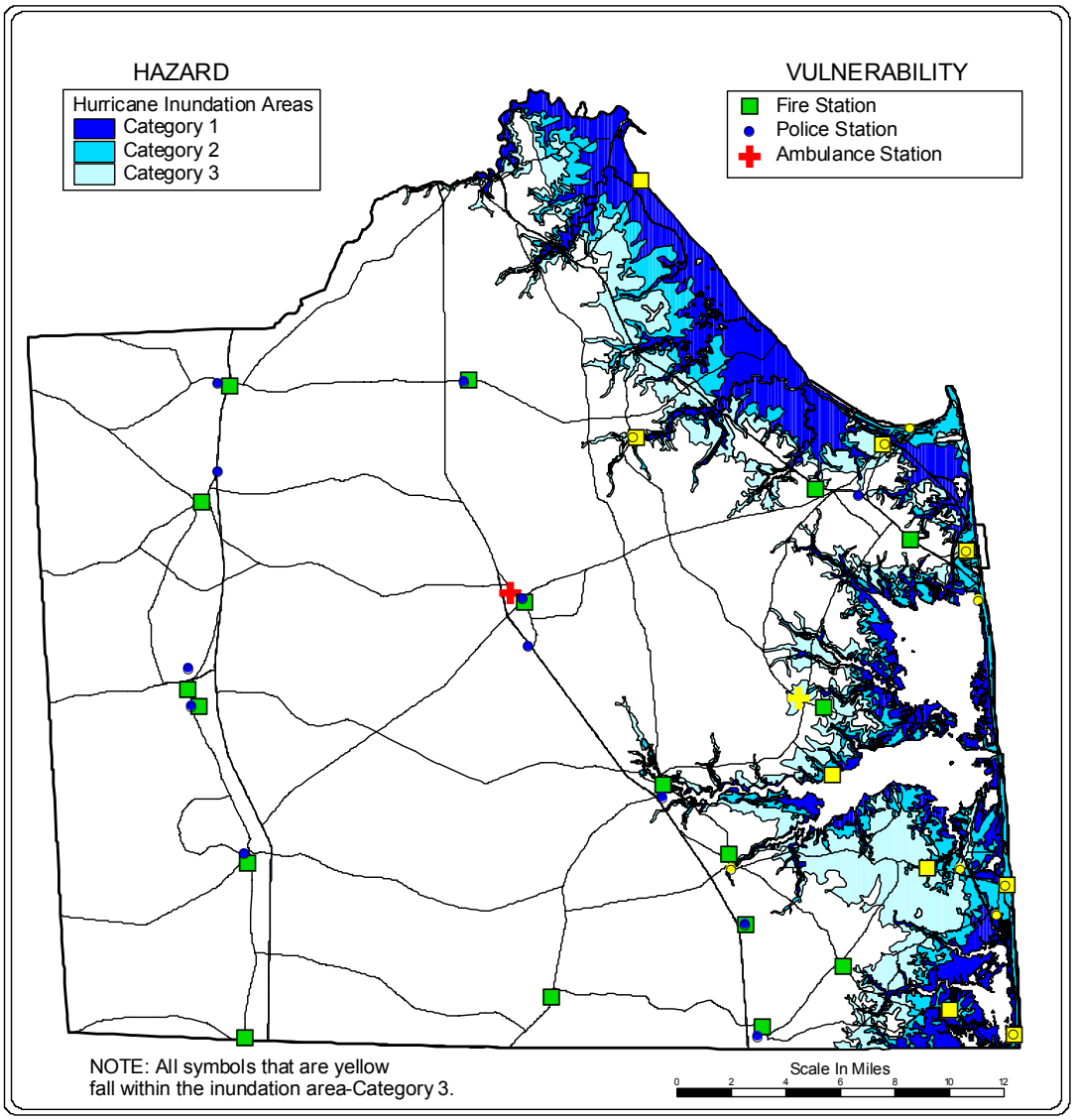
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 3.6
Selected Vulnerabilities within the Category 3-Hurricane Inundation Area:
Power Distribution



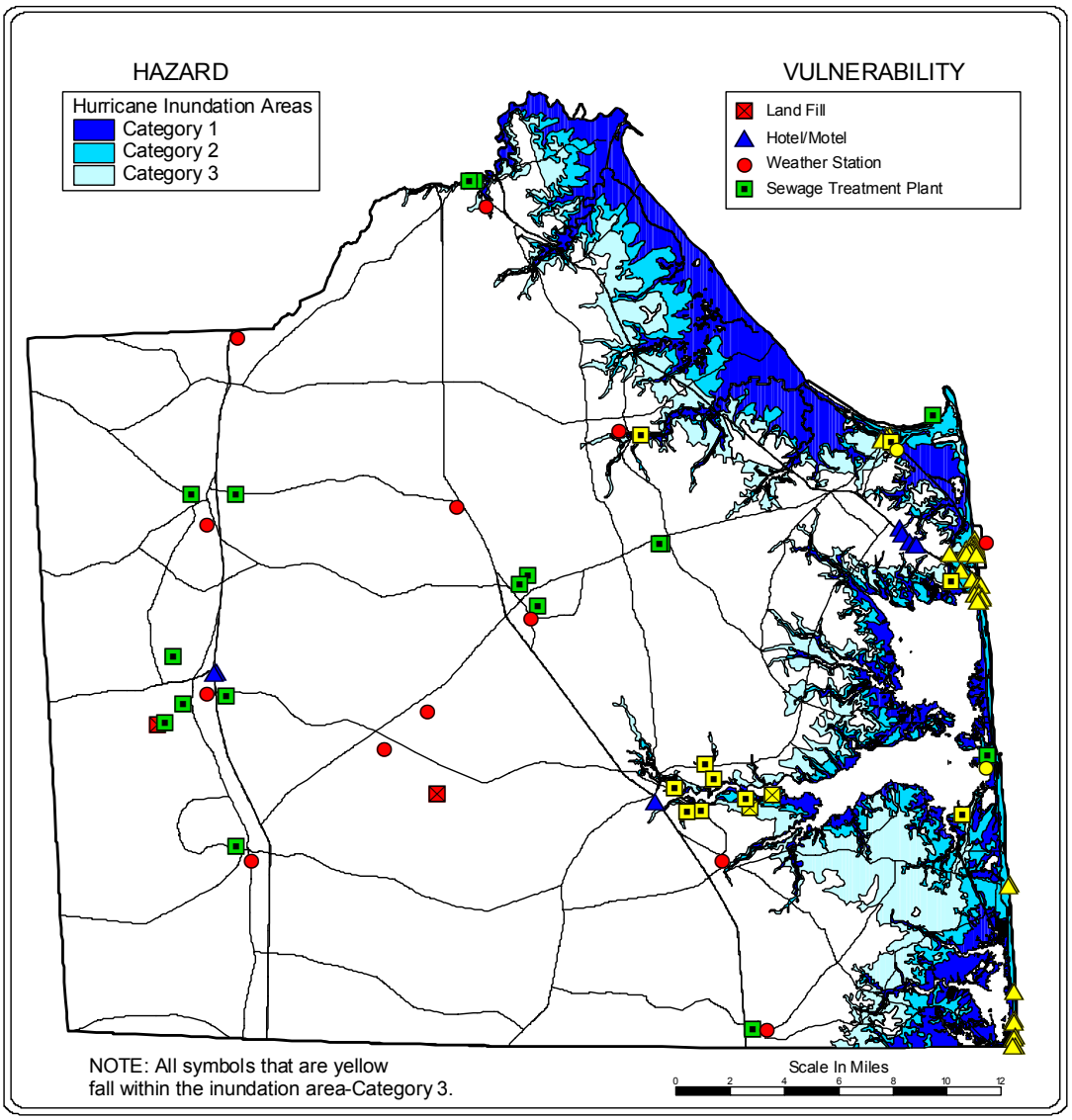
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 3.7
Selected Vulnerabilities within the Category 3-Hurricane Inundation Area: Emergency Services



Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 3.8
Selected Vulnerabilities within the Category 3-Hurricane Inundation Area: Other



Source: Center for Applied Demography & Survey Research, University of Delaware.

Dams

Background

Dams are an important part of the state's infrastructure. They provide irrigation water for crops and flood control for rivers, creeks, and streams. They also are a source of drinking water and under certain circumstances provide water-based recreation. If they are not maintained properly, they can be dangerous. Those that are approaching their fiftieth year are of particular concern since that is generally considered the design life of a dam.

In 1996, the Public Law 104-303 was signed into law. That act established the National Dam Safety Act, which is coordinated by FEMA. Its main function is to promote dam safety and mitigate the effects of any dam failures.

The hazards presented by dams have a somewhat different character than those identified with natural events, although the failure of a dam may be caused by a natural event. First, the area that will be affected by an unplanned release is fairly well defined. This makes the assessment of the vulnerabilities more precise assuming the information has been collected. Second, the size and the intensity of the event have a fairly well understood upper limit. If the contents of the dam storage basin are known, then the release is also predictable. While the upper limit or the maximum storage of the dam is known, the amount of water actually available for release may be somewhat less depending on current weather conditions. The third factor is the age of the dam. As the age of a dam increases and approaches its useful life, the probability of failure (absent any maintenance that extends its life) increases significantly. This probability is likely to be non-linear with very low probabilities in the early years and accelerating probabilities in later years.

The primary result of a dam failure is fast moving water. The main impact is usually property destruction, injury and loss of life. Depending on the nature of the vulnerabilities in its path, there will likely be damage to power and communications system, disruption of transportation and other government services, environmental damage, and health problems associated with water pollution, sewage and waste disposal, and secondary unplanned chemical releases. The impact of these secondary failures will extend both upstream and downstream depending on the type of failure and alternate sources of services available for those affected.

The source of data on dams in the State of Delaware is the National Dam Inventory. This resource lists each dam in the state and provides a number of key characteristics. The current database is based on information from 1995/96. There is a draft of the 1998 data available now but it does not seem to improve substantially on its predecessor. A careful review of this information suggests that it may be useful to have a state review of this information to see if any of the missing information could be added. Of particular interest are the date completed and the maximum storage capacity. In addition, little if any information is available about the frequency of inspection or the last time the dam was inspected. Priority for mitigation will depend on this type of data. Finally, all this work is predicated on the latitude and longitude of the dam appearing in the National Dam Inventory. There is no information as to how accurate those measurements are. Thus, it may be useful to consider getting a GPS location for each dam in Delaware to verify that information.

Sussex County Dams

There are 27 dams listed in the National Dam Inventory. Almost all of these dams are intended for recreational purposes. Only one dam is classified as used for irrigation and one other is classified for flood control. To date none of these dams has failed.

Taken together, these dams could impact nearly 1,900 people and 1,200 jobs. The current market value of residential property within 0.25 miles downstream from the dam is $32,400,000 and the total value of commercial, industrial, and utility property is approximately $15,700,000. These estimates do not include the value of state owned property that is not subject to the property tax and there are significant properties of that type in impacted areas. There is no record of a significant dam failure in Sussex County that has caused any loss of life or property. An estimated $36,000,000 in annual wages and $51,500,000 in annual revenues could potentially be lost. These are upper bound estimates since the exact drainage area of the dams has not as yet been digitized. Essentially, about 1% of the population, 2% of employment, and 0.5% of property is at risk from this hazard.

Estimating potential economic losses is hazardous at best. For example, at least some of the employment affected is government. It is unlikely that those people would be terminated in the case of a disaster. In other situations, where there are significant labor contracts (the automobile industry for one), 95% of wages may be paid for as long as a year even though the workplace is closed. Finally, in most cases the duration of the impact would be less than a year

and companies routinely have disaster recovery plans that would relocate employees to alternative sites.

All but four of the dams in Sussex County are classified as earthen dams. Three of the dams namely Wagamons, Records, and Millsboro are characterized as being "High Risk" for loss of life and property. Of the remaining 24, seven are classified as having "Low Risk" for loss of life and property with the remaining 17 having "Significant Risk". All three of the "High Risk" dams have Emergency Action Plans.

Eleven dams in Sussex County are over 50 years old; Wagamons Pond (1815), Morris Mill Pond (1929), Hearns Pond (1900), Records Pond (1900), Chipman Pond (1915), Swiggets Pond (1941), Clendaniel Pond (1810), Cubbage Pond (1880), Millsboro Pond (1920), Trap Pond (1938), and Red Mill Pond (1925). Of those only Chipman Pond dam and the Trap Pond dam have a "Low Risk" rating for loss of life and property. Four of the dams do not have a "Year Built" in the database. Of those, Waples Pond, Goslee Mill Pond , and Marshall Mill Pond are rated as having a "Significant Risk" of damage.

Vulnerabilities

In the eight maps that follow, each of the 14 vulnerabilities identified as being within 0.25 miles downstream of one of the 27 dams is displayed. Any vulnerability that lies within the area of risk is coded yellow independent of its type. In some cases, the actual number of yellow symbols on the map may not agree with the list of affected vulnerabilities in the associated appendix table. This will happen when two vulnerabilities of the same type are co-located and thus have the same latitude and longitude and the same symbol. The hazard (dam) is also shown on the map. It has the symbol of an X within a light blue square.

Transportation. This category includes ports (however small), airports, and bridges. First, of all, there are no airports or ports/boat ramps in the buffer zone of any dam in Sussex County.

There are 22 bridges that could be affected by a dam failure in Sussex County. Both the bridges and the roadways they join are also subject to the impact of fast moving water. Bridges may be more critical because the time necessary to repair or reconstruct is likely to be far greater than to make a roadway passable. Of particular interest are those bridges that lie on evacuation routes. Five of the 22 bridges are on evacuation routes. Since a dam failure might reasonably

happen with a major flood, the loss of those evacuation routes could be crucial. The actual impact could best be determined by evaluating traffic network models that remove the affected road from the transportation system. In addition, it would be very useful to measure the average daily traffic count over each of the vulnerable bridges.

It is important to note that the roadways may be just as likely to be damaged although the duration of the failure is likely to be far less than in the case of a bridge. Many dams are the roadways themselves with spillways created for keeping the level well below the roadway.

Communications. There are no significant disruptions to communication facilities that would result from a dam failure in Sussex County. There is always the possibility of a secondary impact occurring outside of the 0.25-mile buffer zone, e.g. extended power outages.

Employers and Government. There are two major employers (Seaford School District and Career Associates, Inc.) located within the buffer zone of a dam in Sussex County. Of the entire list of government buildings in Sussex County only three are identified as vulnerable. These include the Milton town hall, and post offices in Milton and Laurel.

Education and Corrections. Five schools are located within the buffer zone around a dam. The largest of these are the Seaford High School, Seaford Central Elementary, and Seaford Middle School. No correctional facility or higher education facility in Sussex County is vulnerable to a dam failure.

Fragile Populations. There are no hospitals, daycare centers, or nursing homes in the buffer zone of a dam in Sussex County.

Power Distribution. Any power distribution facility that was a victim of a dam failure would undoubtedly cause problems far beyond the buffer zone of a dam. For that reason alone it is important to assess the risk to those facilities.

The only power distribution facilities within the buffer zone of a dam in Sussex County are the power distribution sub-stations located at Millsboro and Laurel.

Emergency Services. Police, fire, paramedic, and ambulance services are crucial on a daily basis. Any event such as the failure of a dam must be assessed to determine if the effectiveness of emergency services would be compromised.

The Milton police and the Millsboro volunteer fire company are within the buffer zone of a dam.

Other Services. This last group is a mixture of different kinds of vulnerabilities. Hotels/motels may need to be evacuated but they also can be a source of shelter. Land fills and sewage treatment plants are needed for the health and safety of the entire population. Weather stations may provide critical information for emergency services and emergency management.

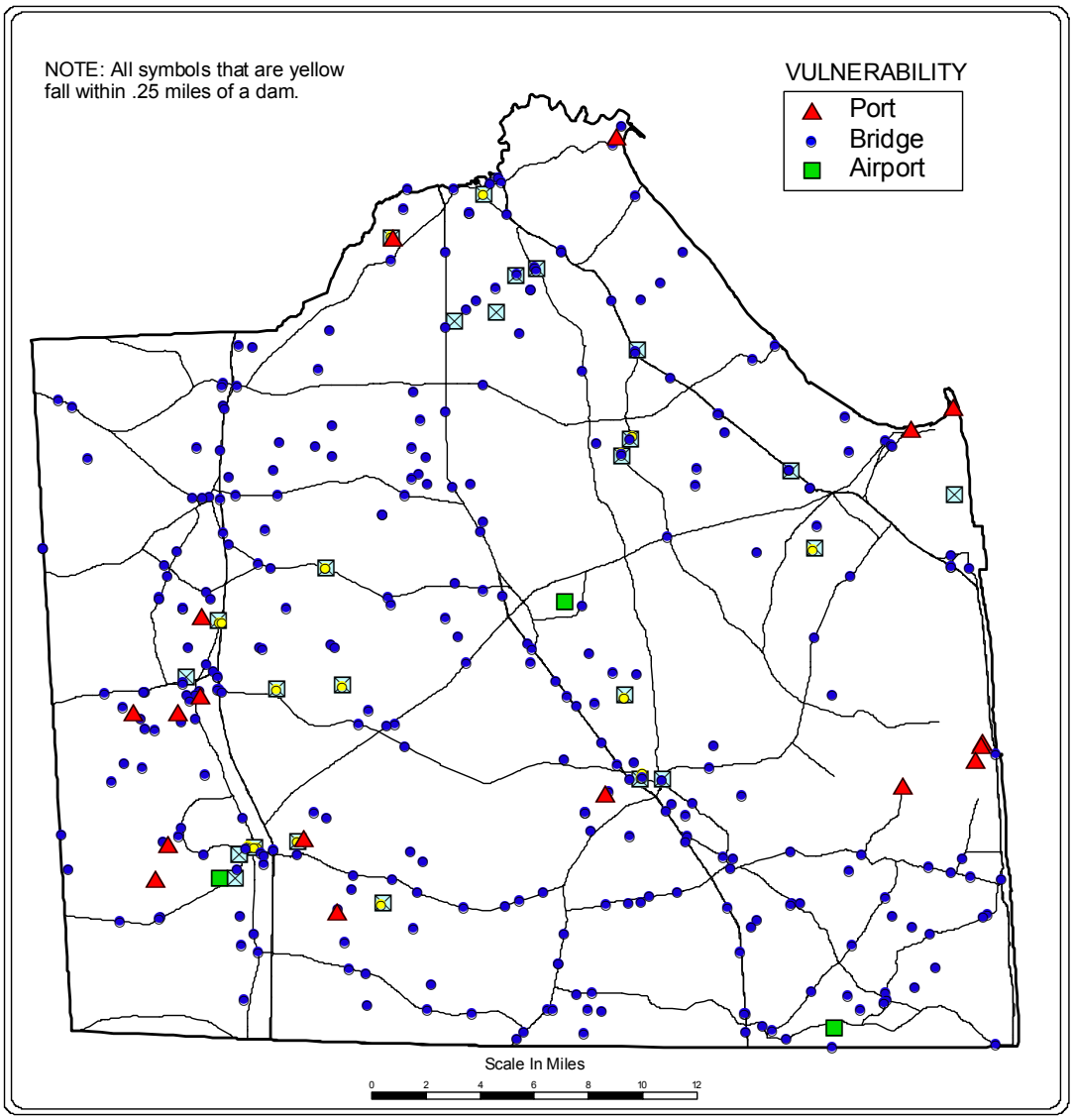
The sewage treatment plant in Laurel is within the buffer zone of an unnamed dam. No hotels, landfills, or weather stations are threatened.

Next Steps

There are a number of steps that could be taken to improve the accuracy of this risk assessment for dams:

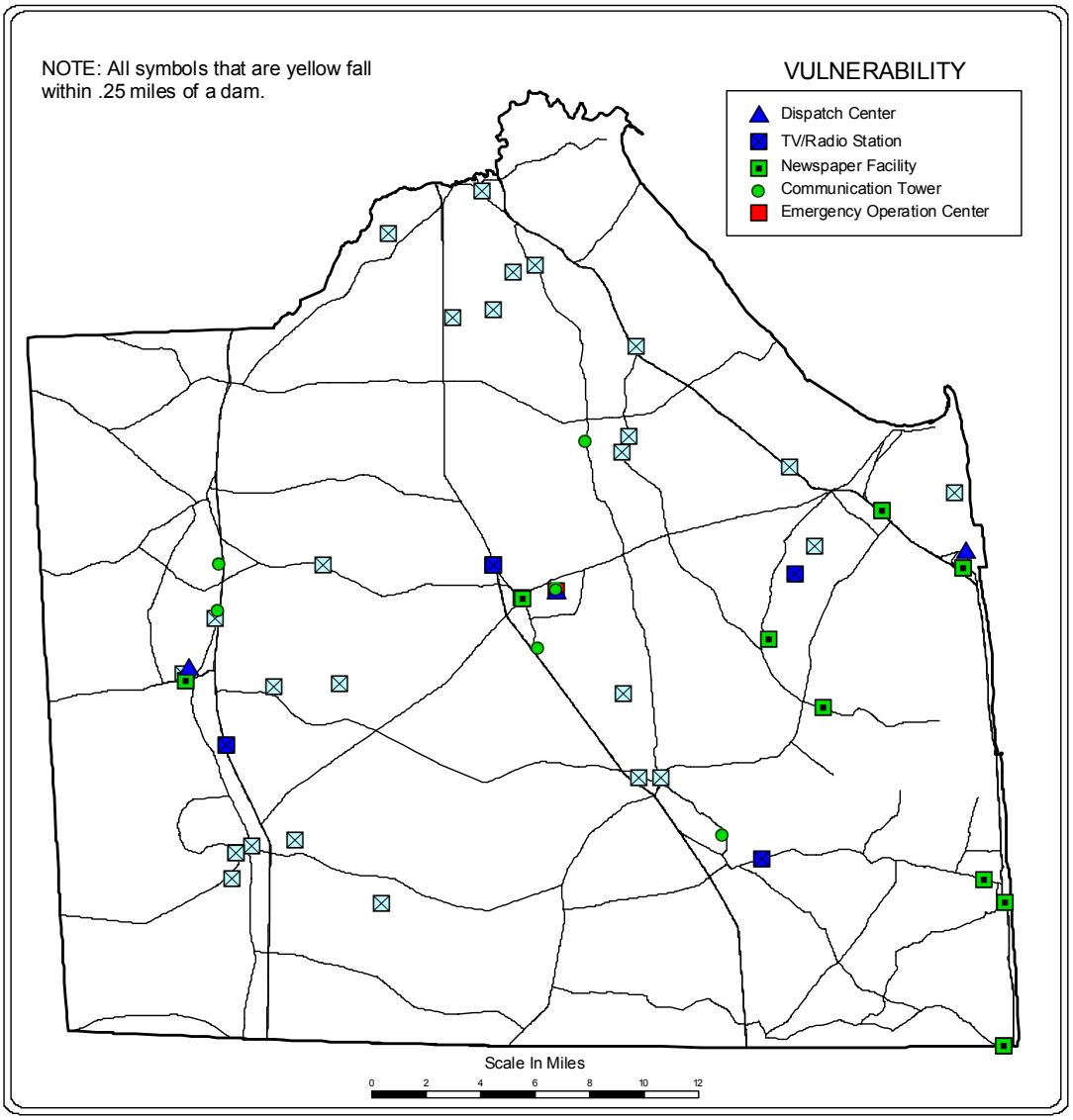
1. Validate the latitude and longitude of each Delaware dam in the National Dam Inventory with GPS, if it has not already been done.
2. Digitize the drainage basin of each dam should it fail. This will give a much more precise estimate of the primary impact than the buffer zone approach.
3. Begin to fill in any critical data that is not currently in the NDI.
4. Add average daily traffic counts for each bridge. Ask DELDOT to model the impact of losing each bridge.

Figure 4.1
Selected Vulnerabilities within 0.25 Miles of a Dam:
Transportation



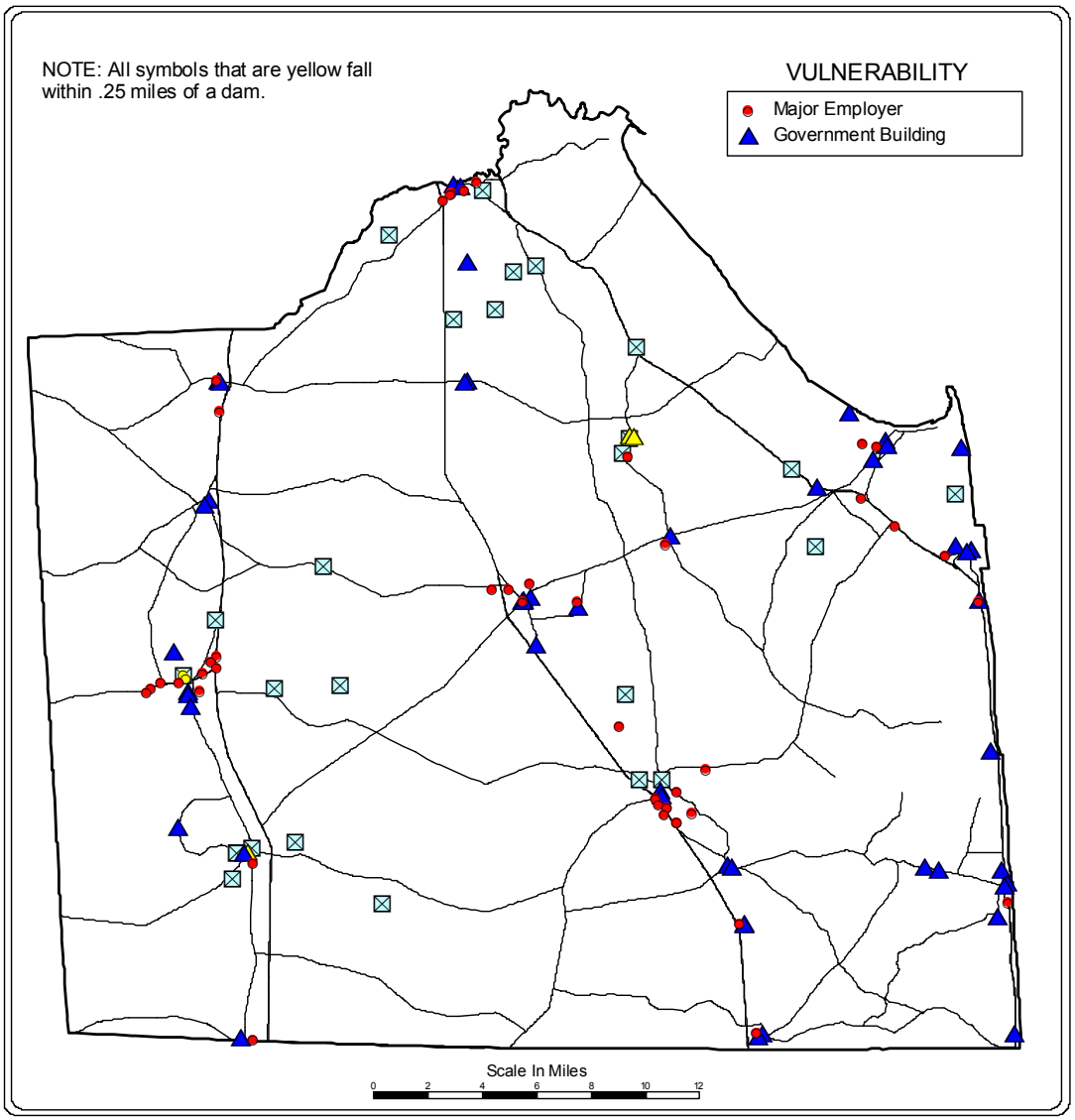
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 4.2
Selected Vulnerabilities within 0.25 Miles of a Dam:
Communications



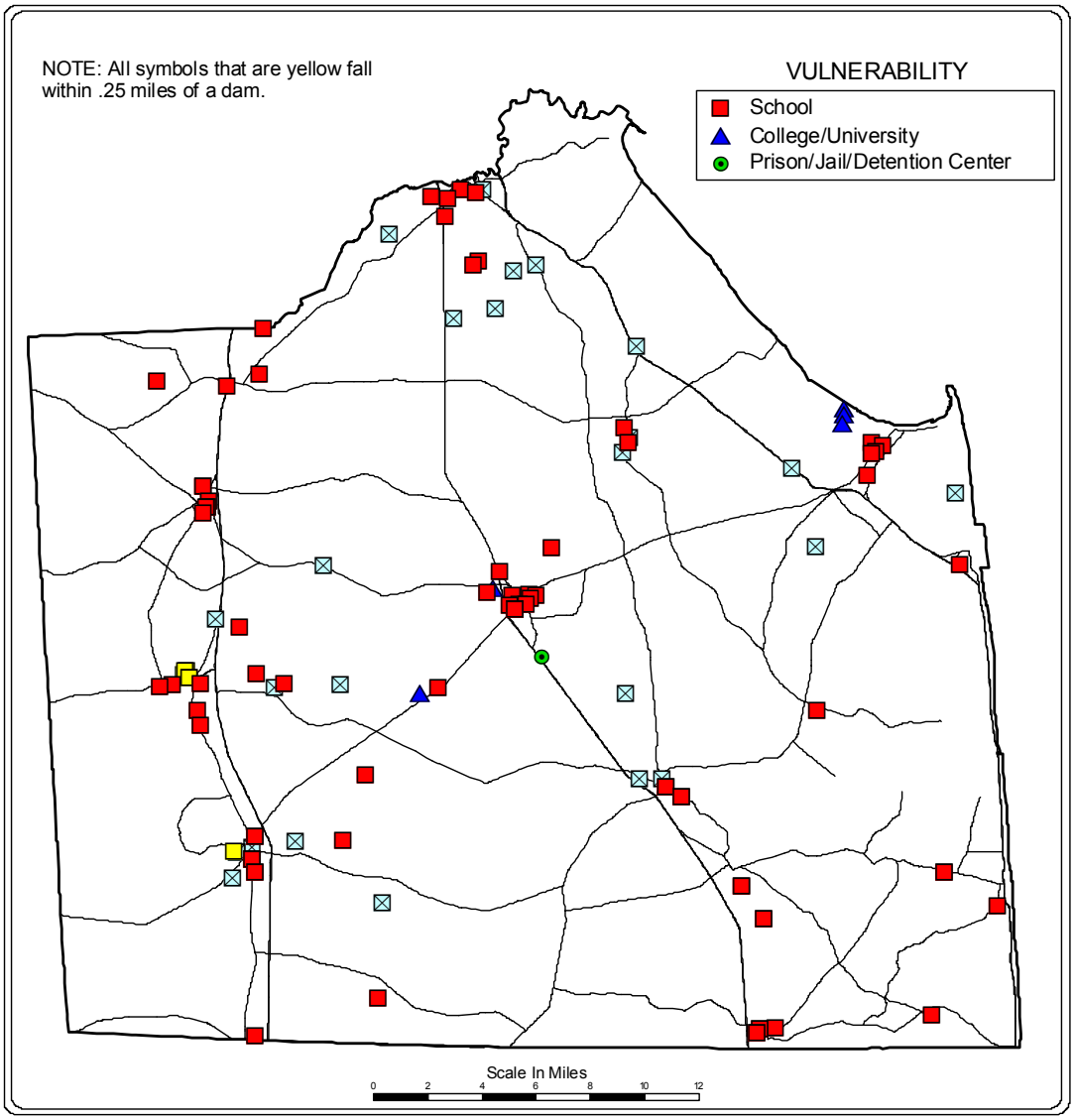
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 4.3
Selected Vulnerabilities within 0.25 Miles of a Dam:
Employers and Government



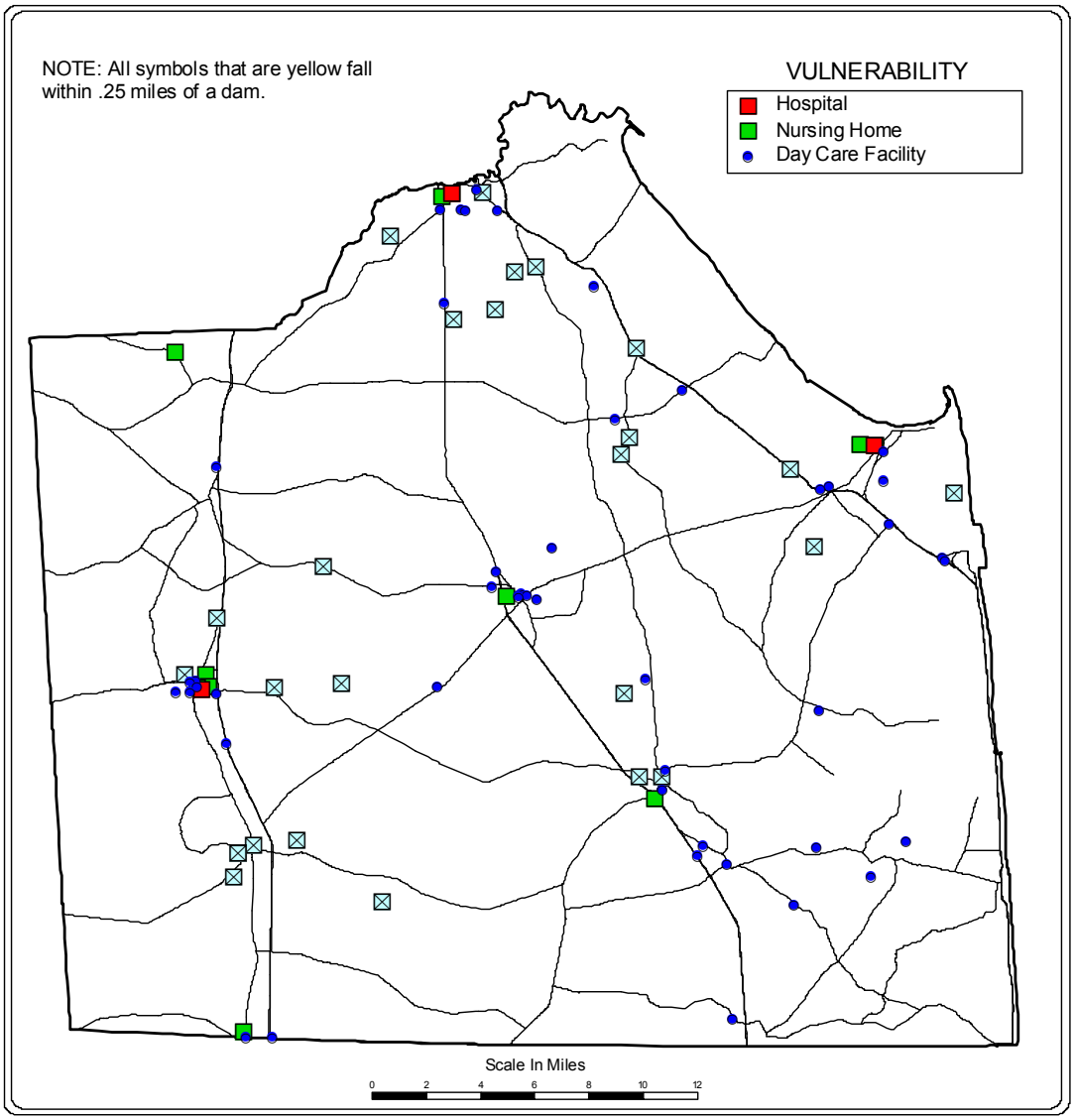
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 4.4
Selected Vulnerabilities within 0.25 Miles of a Dam:
Education and Corrections



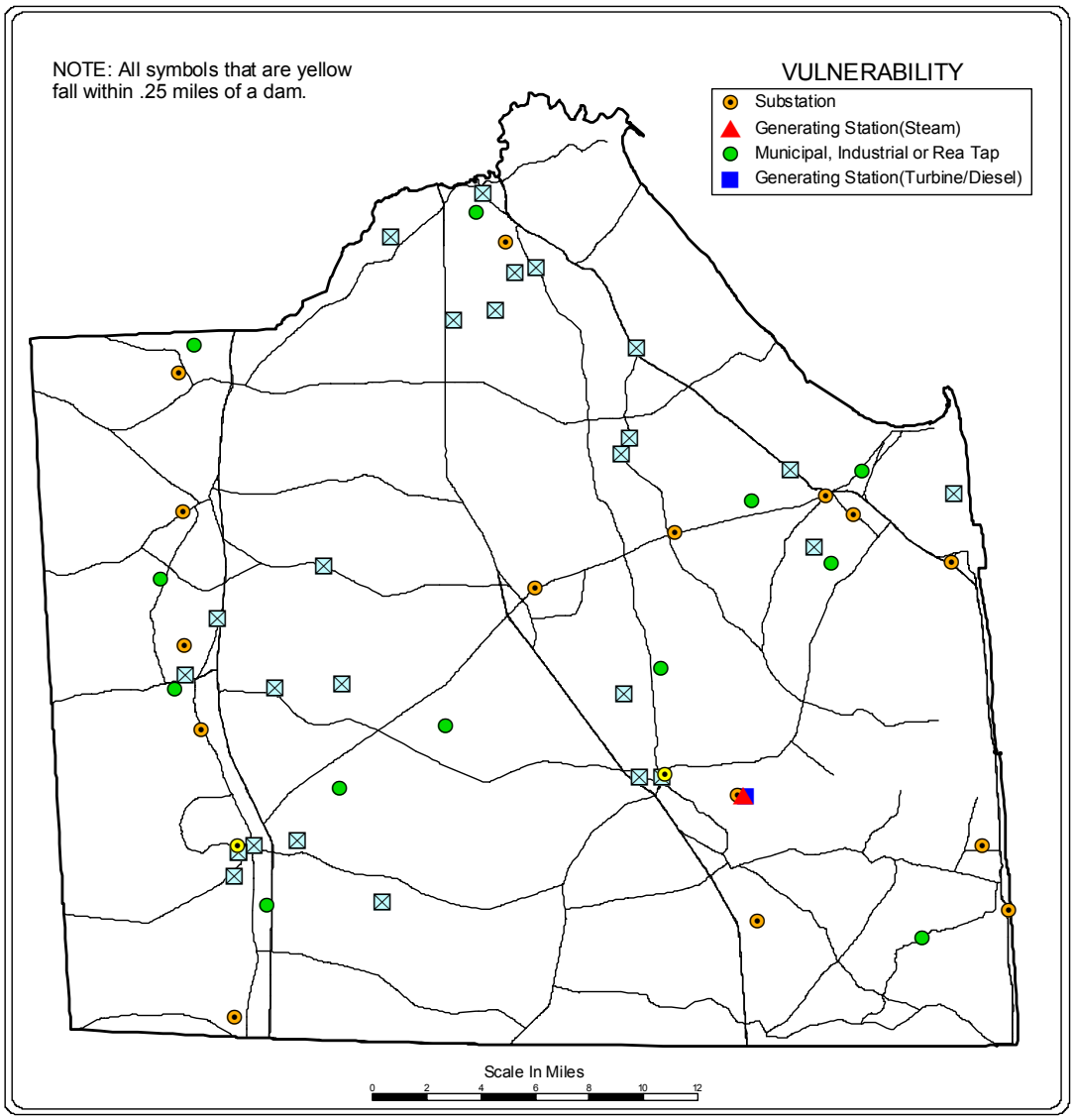
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 4.5
Selected Vulnerabilities within 0.25 Miles of a Dam:
Fragile Populations



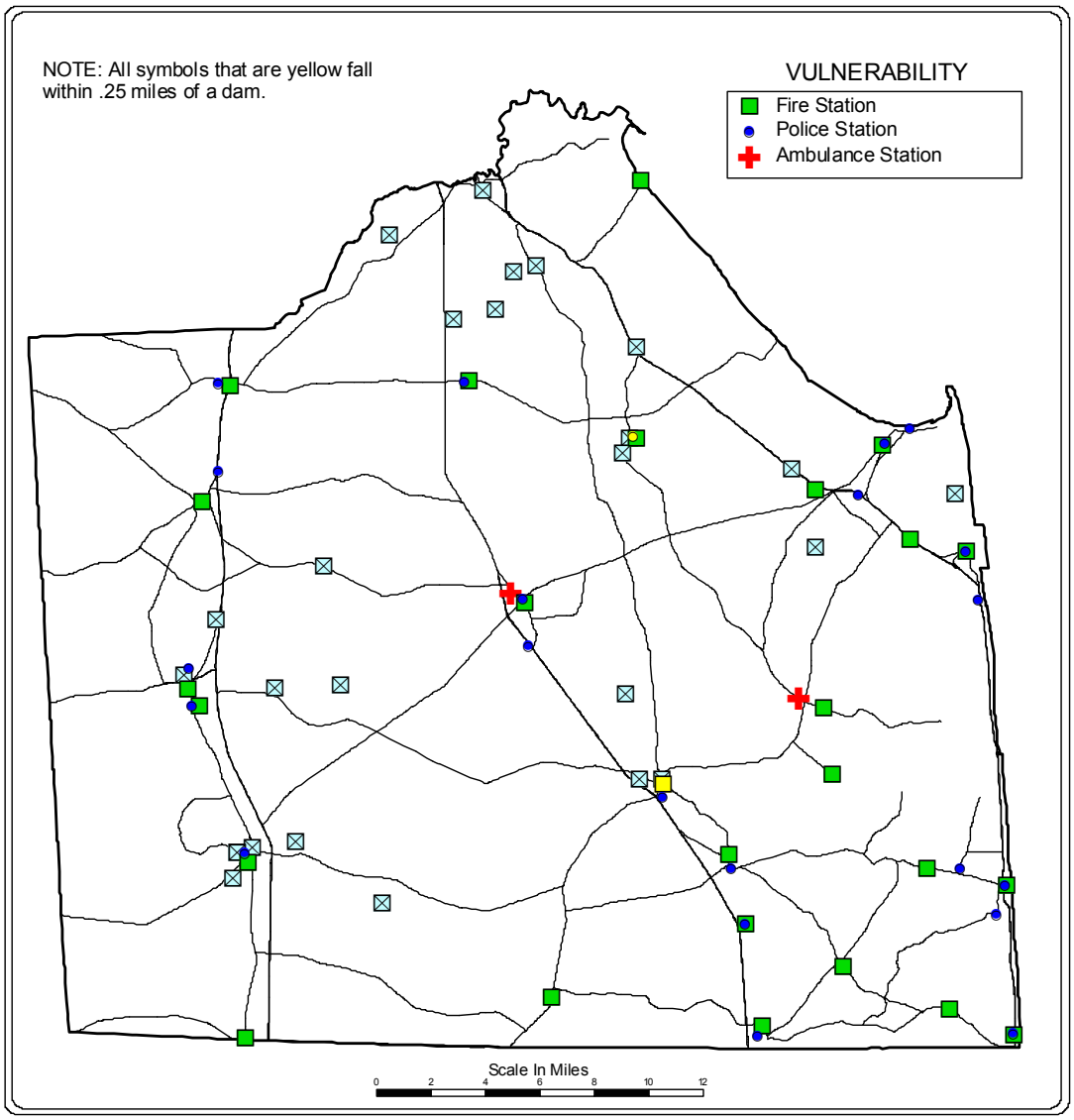
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 4.6
Selected Vulnerabilities within 0.25 Miles of a Dam:
Power Distribution



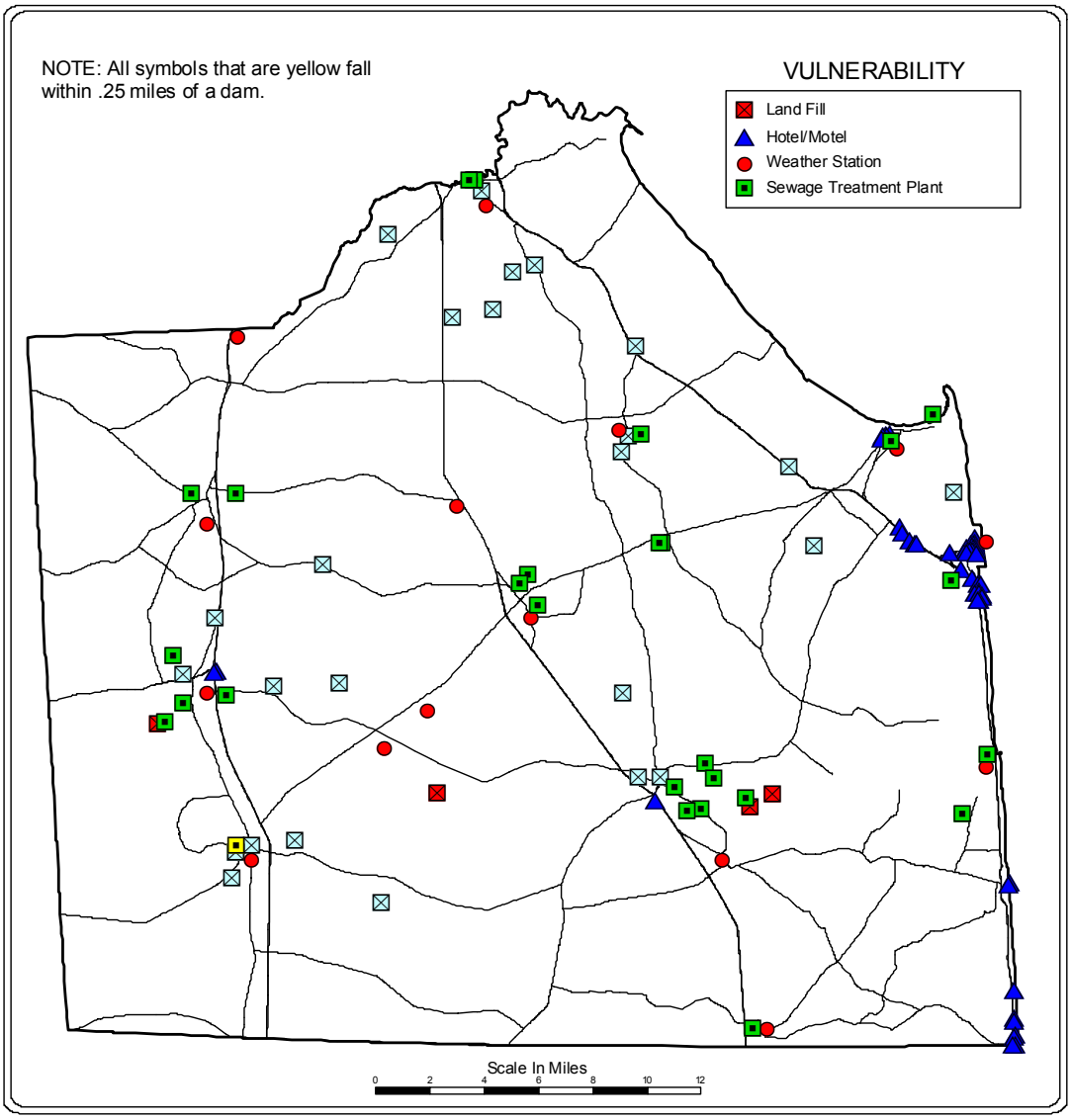
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 4.7
Selected Vulnerabilities within 0.25 Miles of a Dam:
Emergency Services



Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 4.8
Selected Vulnerabilities within 0.25 Miles of a Dam:
Other Services



Source: Center for Applied Demography & Survey Research, University of Delaware.

Hazardous Material Sites

Background

The use of hazardous materials is a fact of life. Under controlled conditions these materials provide beneficial products and services to everyone in Delaware. For example, people and companies depend on propane gas for heat and power. They also use refrigerants for food processing. Chemicals are used to treat sewage. All of these uses are planned and the outcome of their use is almost always positive. On rare occasions mistakes are made or equipment fails to operate properly and an unexpected release of those otherwise beneficial products occurs.

Unplanned releases are frequent relative to other hazards discussed here. They can have some long-term impacts, and the impacts are usually of medium intensity. The character of these releases is such that they cannot be predicted, i.e. they are almost always accidents. Mitigation strategies usually focus on the hazard rather than the vulnerability.

The hazardous materials sites present a somewhat different problem than natural phenomenon. The location of the potential problem is known. There is some knowledge about the frequency of toxic releases. What is difficult to estimate is the magnitude of the release and the distance it will travel. Those are subject to the weather conditions at the time of the release into the air or water. Under certain conditions the damage might be minimal, under other circumstances the effect could be lethal.

The primary result of an accident at a hazardous material site is usually a toxic release. This may be accompanied by fire and explosion, which can aid and exacerbate the problem. There will be problems on the site and depending on the circumstance the toxic release may leave the boundaries of the property. In benign situations, the result may be nothing more than a bad odor in the air. In more serious situations, the site itself and even contiguous areas may have to be evacuated. Depending on the toxicity of the release, there may be health problems and even loss of life. If the facility is next to a transportation facility, that facility may have to close until the situation is under control. There also may be water pollution if the release is of that type. Both the primary and secondary effects must be considered when assessing the hazard.

Sussex County Sites

There are 22 properties listed by the DNREC and EPA in Sussex County as capable of generating releases that have impact beyond their own property. These are the ones considered in this analysis. For the others, it is assumed that those companies/organizations have plans for coping with any problem that is limited to their own site.

According to the National Response Center, which is charged with receiving all reports of improper discharge of toxic materials, there were 199 reported releases of toxic materials in Sussex County from 1990 through 1998. Thirteen of these releases were to the air, 126 were water related, 54 were onto land, and the other six were not classified. The end results were 450 people evacuated, three deaths, and two injuries for all 199 events.

Taken together these hazardous material sites could impact nearly 2,900 people and 2,500 jobs. The current market value of residential property within 0.25 miles of the sites is $66,300,000 and the total value of commercial, industrial, and utility property is approximately $41,900,000. These estimates do not include the value of state owned property that is not subject to the property tax and there are significant properties of that type in impacted areas. An estimated $75,000,000 in annual wages and $107,000,000 in annual revenues could potentially be lost. These are upper bound estimates since the extent of any release will impact only a small part of the potential. Essentially 2% of the population, 4% of the employment, and 1% of the property in Sussex County is exposed to this hazard.

Estimating potential economic losses due to hazardous materials sites is itself hazardous at best. For example, at least some of the employment affected is government. It is unlikely that those people would be terminated in the case of a disaster. In other situations, where there are significant labor contracts (the automobile industry for one), 95% of wages may be paid for as long as a year even though the workplace is closed. Finally, in most cases the duration of the impact would be less than a year and companies routinely have disaster recovery plans that would relocate employees to alternative sites.

Vulnerabilities

In the eight maps that follow, each of the 14 vulnerabilities identified as being within a circle 0.25 miles in radius of one of the hazardous materials sites is displayed. Any vulnerability that lies within the area of risk is coded yellow independent of its type. In some cases, the actual

number of yellow symbols on the map may not agree with the list of affected vulnerabilities in the associated appendix table. This will happen when two vulnerabilities of the same type are co-located and thus have the same latitude and longitude and the same symbol. The hazard (site) is also shown on the map. It has the symbol of an X within a light blue circle.

Transportation. The impact on the transportation system is very different for a release of hazardous materials than for a physical phenomenon like a major flood or a dam failure. Both of those events are more likely to physically damage the facility. In this case, we are denied use of the facility for some period of time but the facility is not usually damaged. There have been a few notable exceptions to this rule when the transport of hazardous material produced a fire that heavily damaged a bridge on I495. This however is an exception particularly for fixed site releases being discussed here.

There are no airports or ports affected by hazardous materials sites in Sussex County. There are however seven bridges that are within the buffer zones of five sites using hazardous materials. Three of those bridges are on evacuation routes.

Communications. There are no communications facilities within the buffer zone of a hazardous materials site.

Employers and Government. There are 11 employers with 100 or more employees within 0.25 miles of a hazardous material site. However, seven of the 11 are the hazardous materials sites themselves. Only Delmarva Temporary Staff, Don Lee Margin Corp., First Omni Bank, and First National Bank of MD are outside of those sites.

Six government facilities are within 0.25 miles of a hazardous material site including the Milton, Frankford, and Selbyville town halls. The post offices in Milton, Frankford, and Selbyville are also at risk.

Education and Corrections. Five of the 84 schools in Sussex County are within the buffer zone of a hazardous material site. The largest of these are the Indian River Education Complex and the Selbyville Middle School and Intensive Learning Center. No correctional facility or higher education facility in Sussex County is within the buffer zone of a hazardous material site.

Fragile Populations. No nursing homes or hospitals are within a buffer zone, however there is one daycare center (Bayport) with a capacity of 129 children within a zone.

Power Distribution. The only power distribution facility that is within the buffer zone of a hazardous material site is a substation located near Georgetown.

Emergency Services. The Milton and Frankford volunteer fire companies as well as the police stations in Milton, Frankford and Selbyville are within the buffer zones of four different sites.

Other Services. One hotel (Pirates Cove) is within range of site. In addition, there are five sewage treatment plants that are located on hazardous materials sites along with two others that are not on hazardous materials sites (Milton and S.C. Johnson). No landfill or weather station is at risk.

Next Steps

There are several steps that could be taken to improve the information and further define the risk:

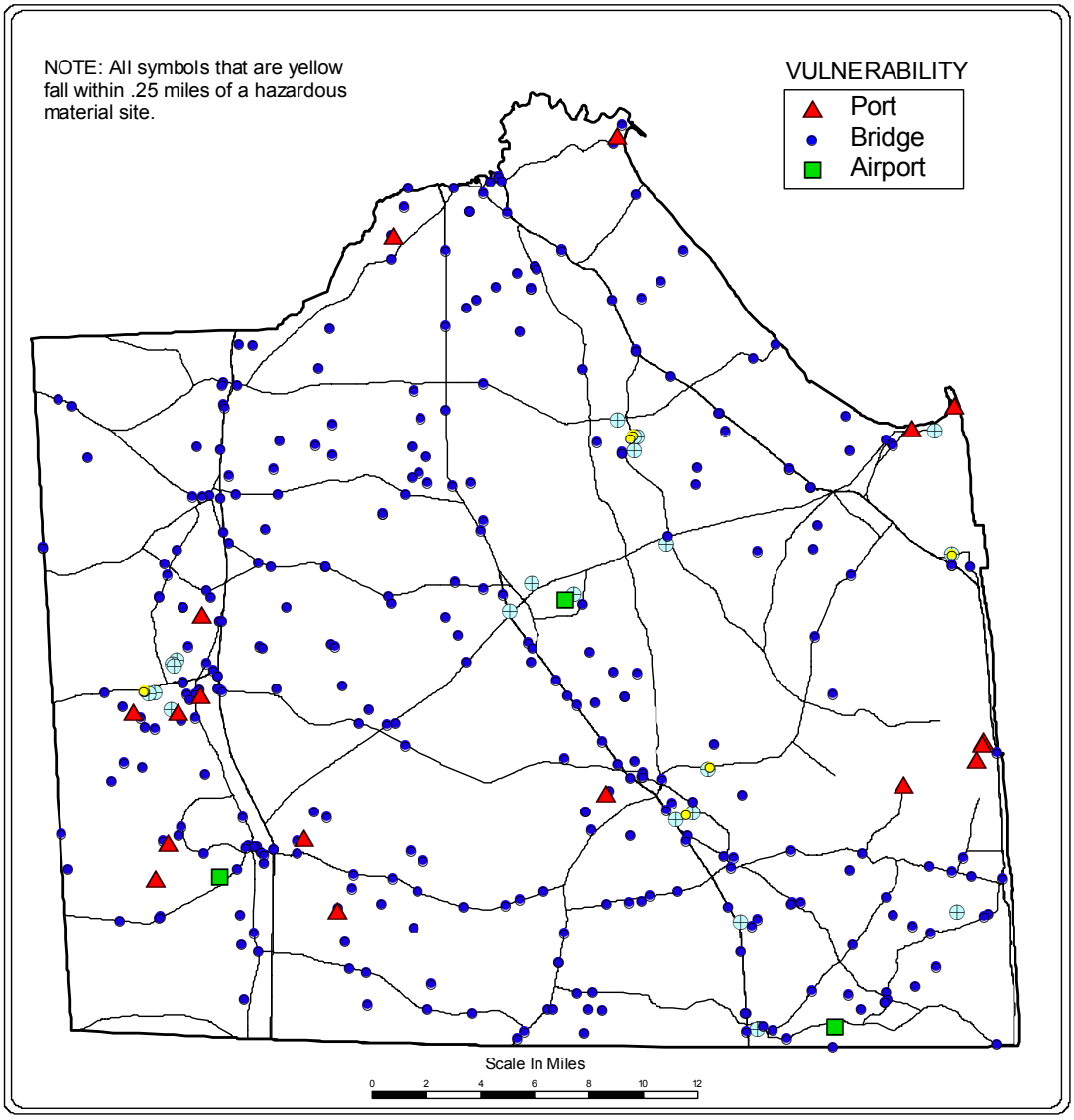
1. Add information to the database that says the nature of any likely event. For example, is it a gas explosion, release of ammonia, discharge of effluent, etc.

2. What medium would be affected (water, air, land)? Would any adjacent roadway have to be closed? What type of injuries might occur? Is evacuation likely? What is the likely range of the toxic effect?

3. Add additional information from regulators files into the database such as the date of any inspections, existence of a plan, adequacy of emergency planning, support of emergency services and history of any discharges.

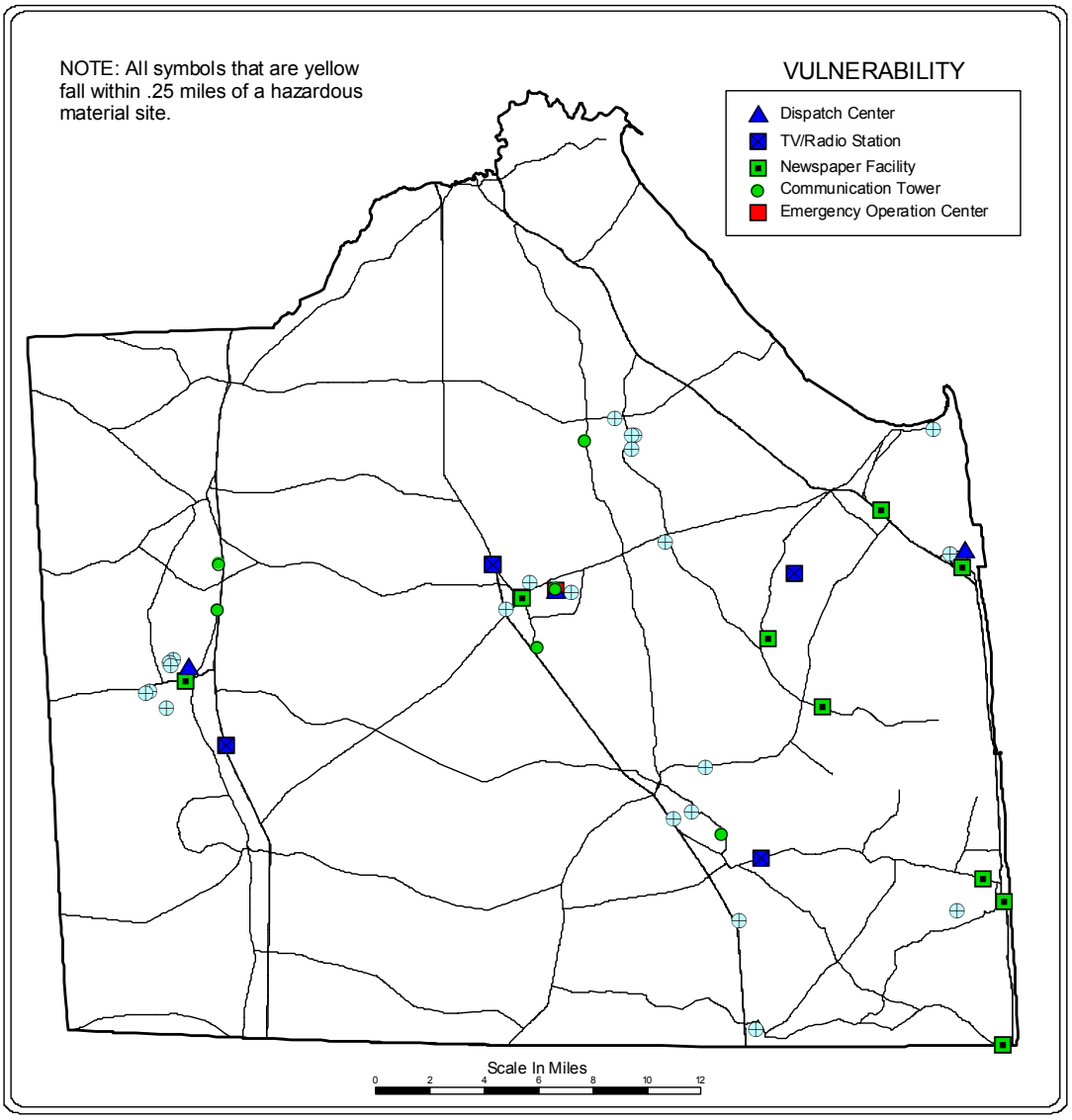
4. Determine the accuracy of the National Response Center information by cross checking information with the state regulators. Fill in any missing information if available.

Figure 5.1
Selected Vulnerabilities within 0.25 Miles of a Hazardous Material Site: Transportation



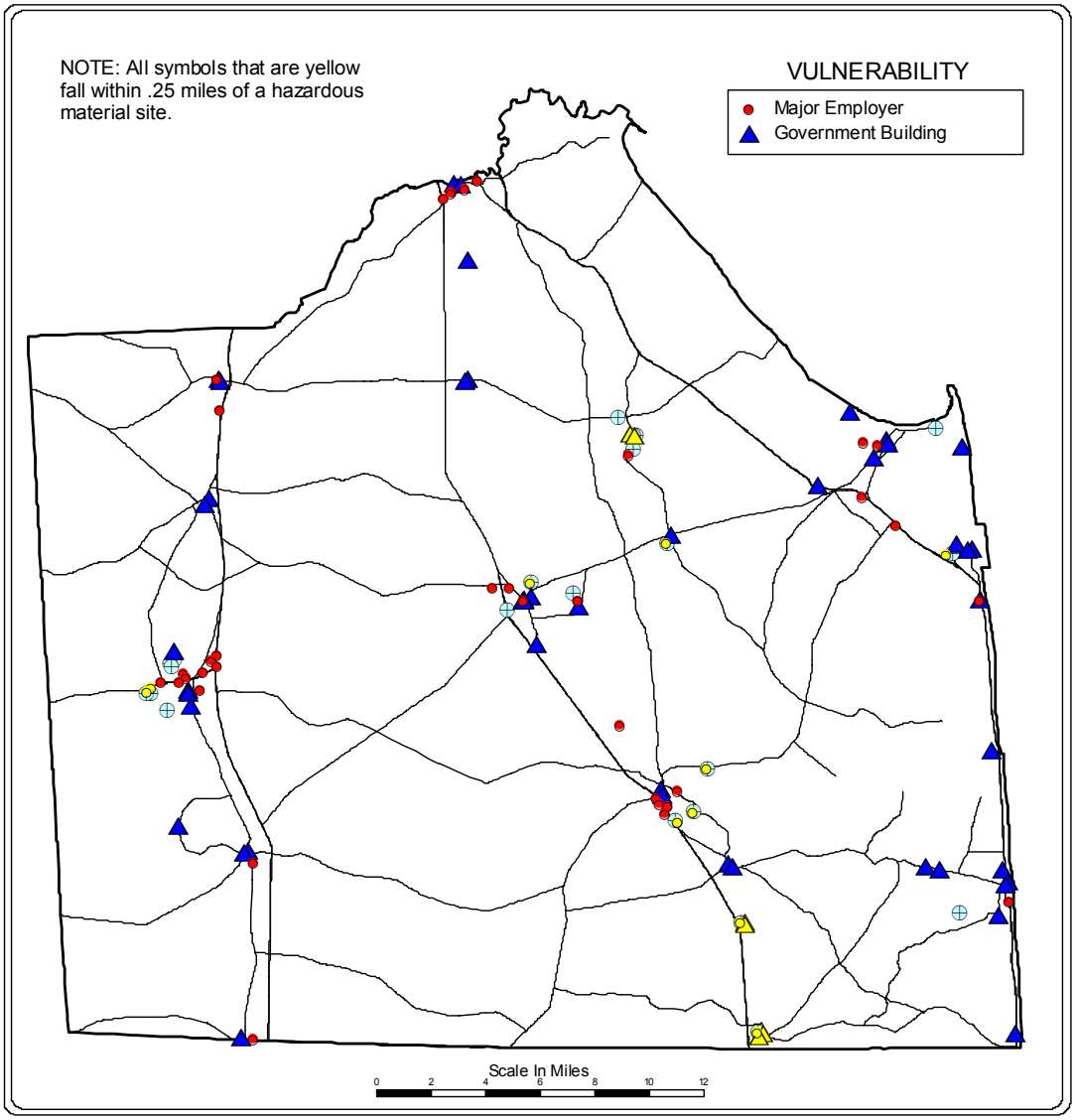
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 5.2
Selected Vulnerabilities within 0.25 Miles of a Hazardous Material Site: Communications



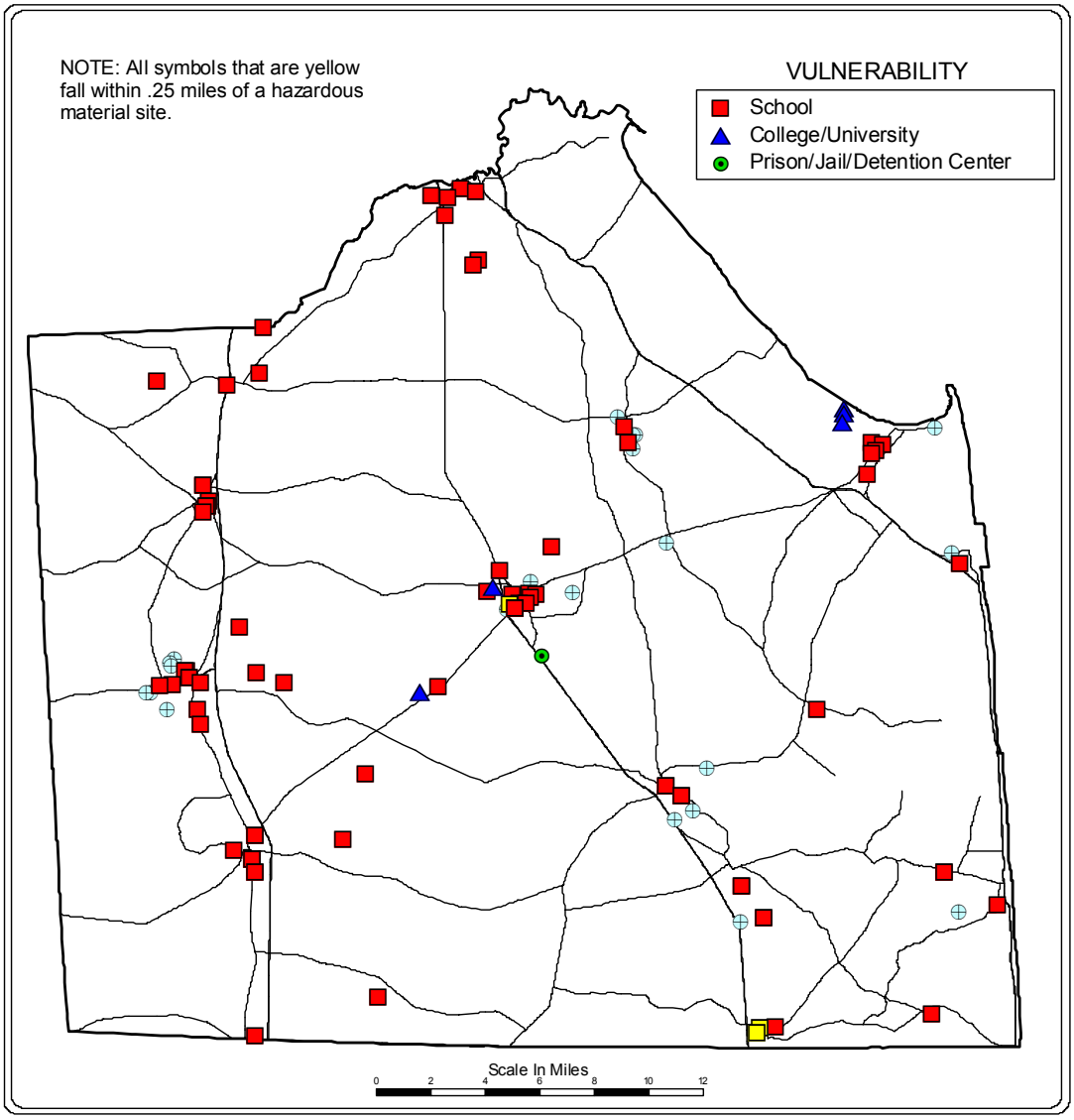
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 5.3
Selected Vulnerabilities within 0.25 Miles of a Hazardous Material Site: Employers and Government



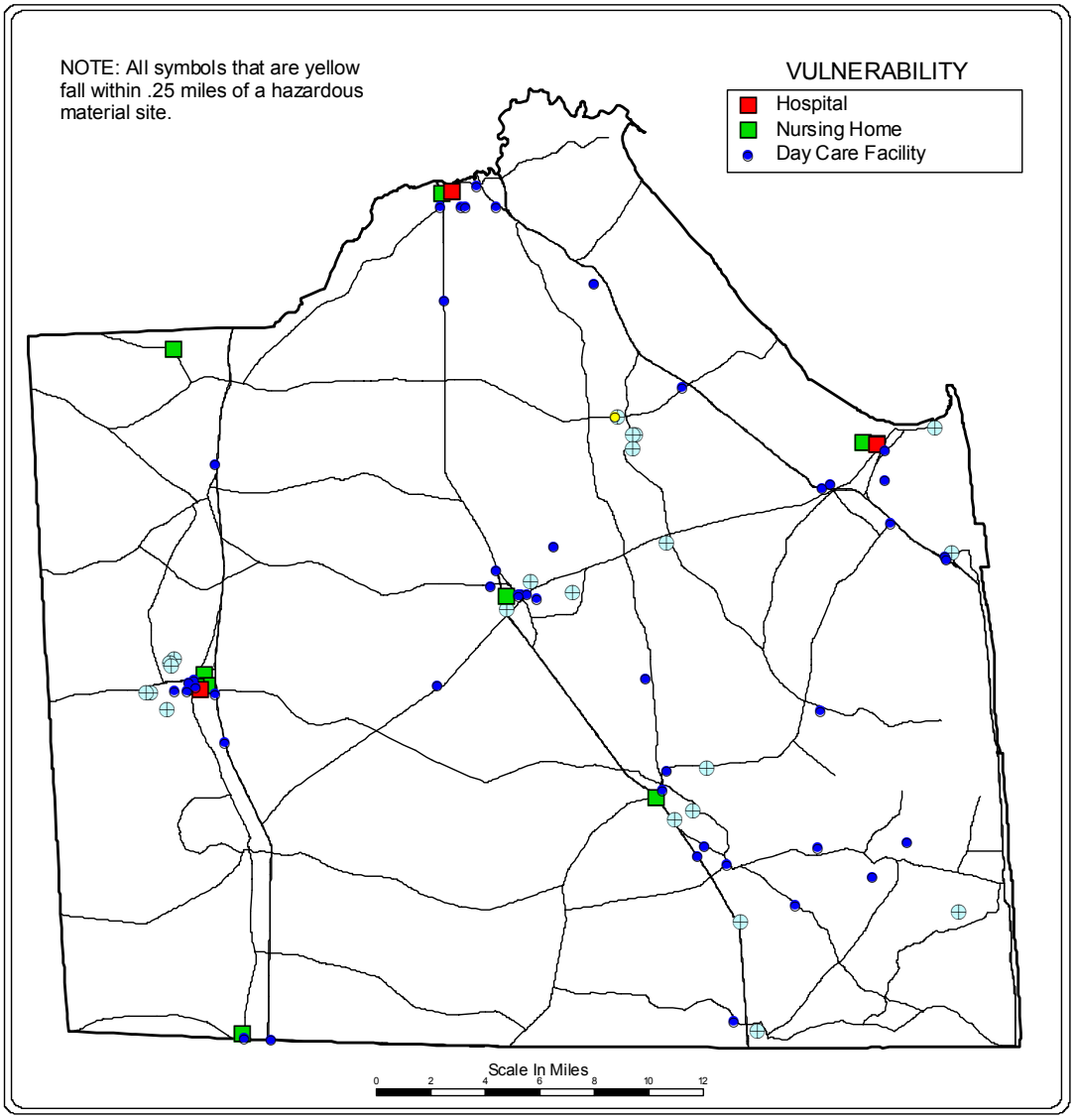
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 5.4
Selected Vulnerabilities within 0.25 Miles of a Hazardous Material Site:
Education and Corrections



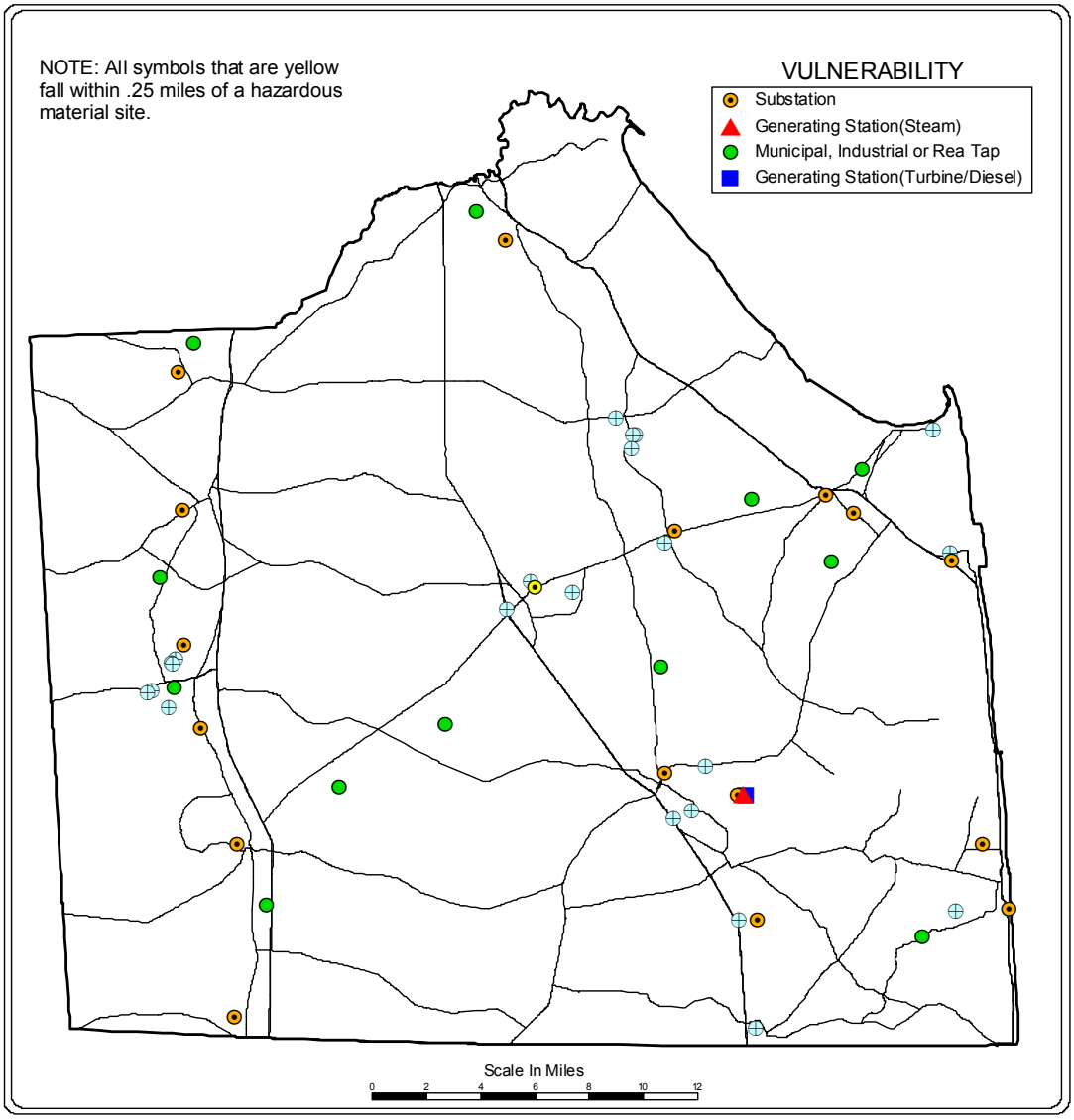
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 5.5
Selected Vulnerabilities within 0.25 Miles of a Hazardous Material Site:
Fragile Populations



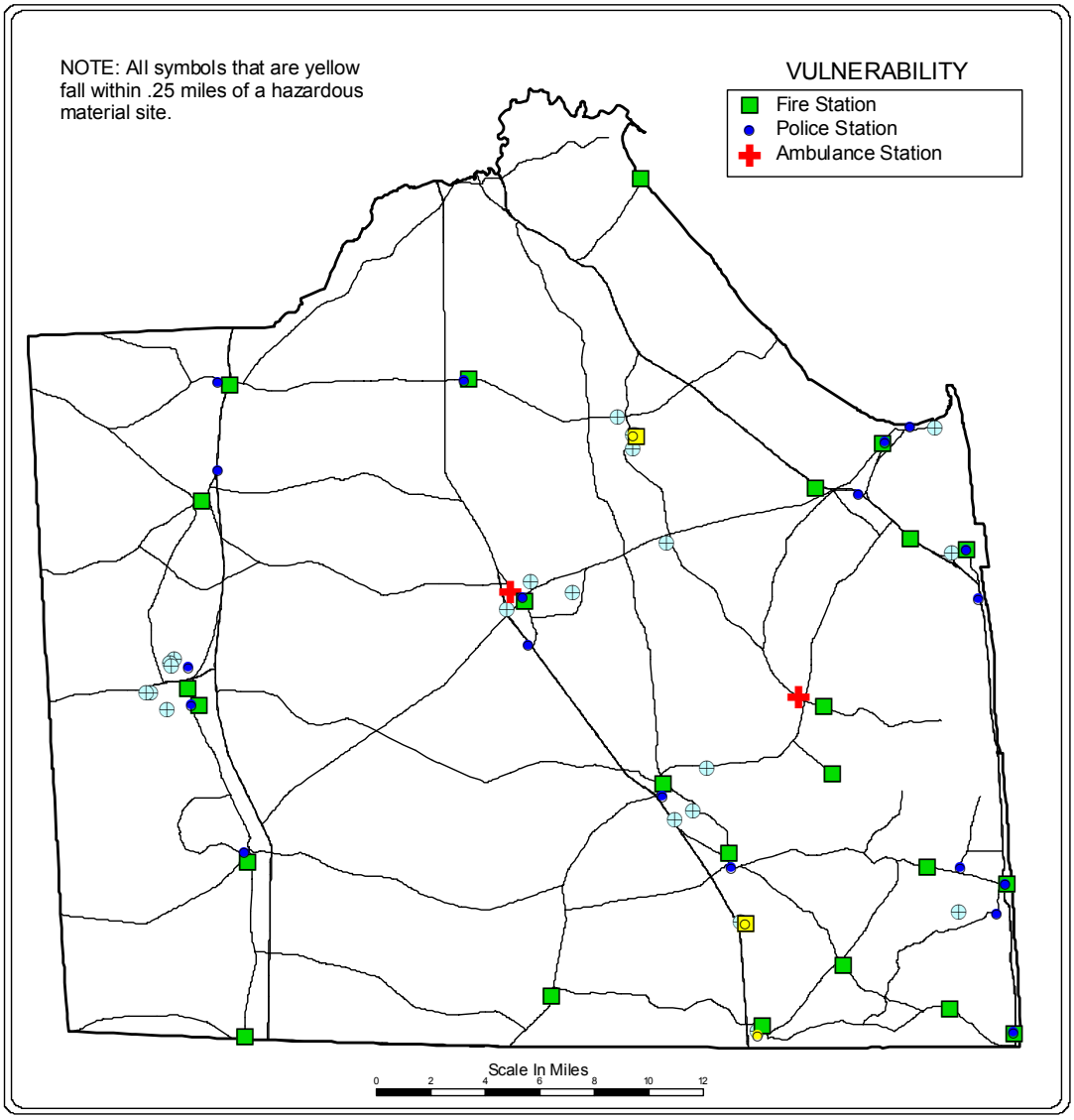
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 5.6
Selected Vulnerabilities within 0.25 Miles of a Hazardous Material Site: Power Distribution



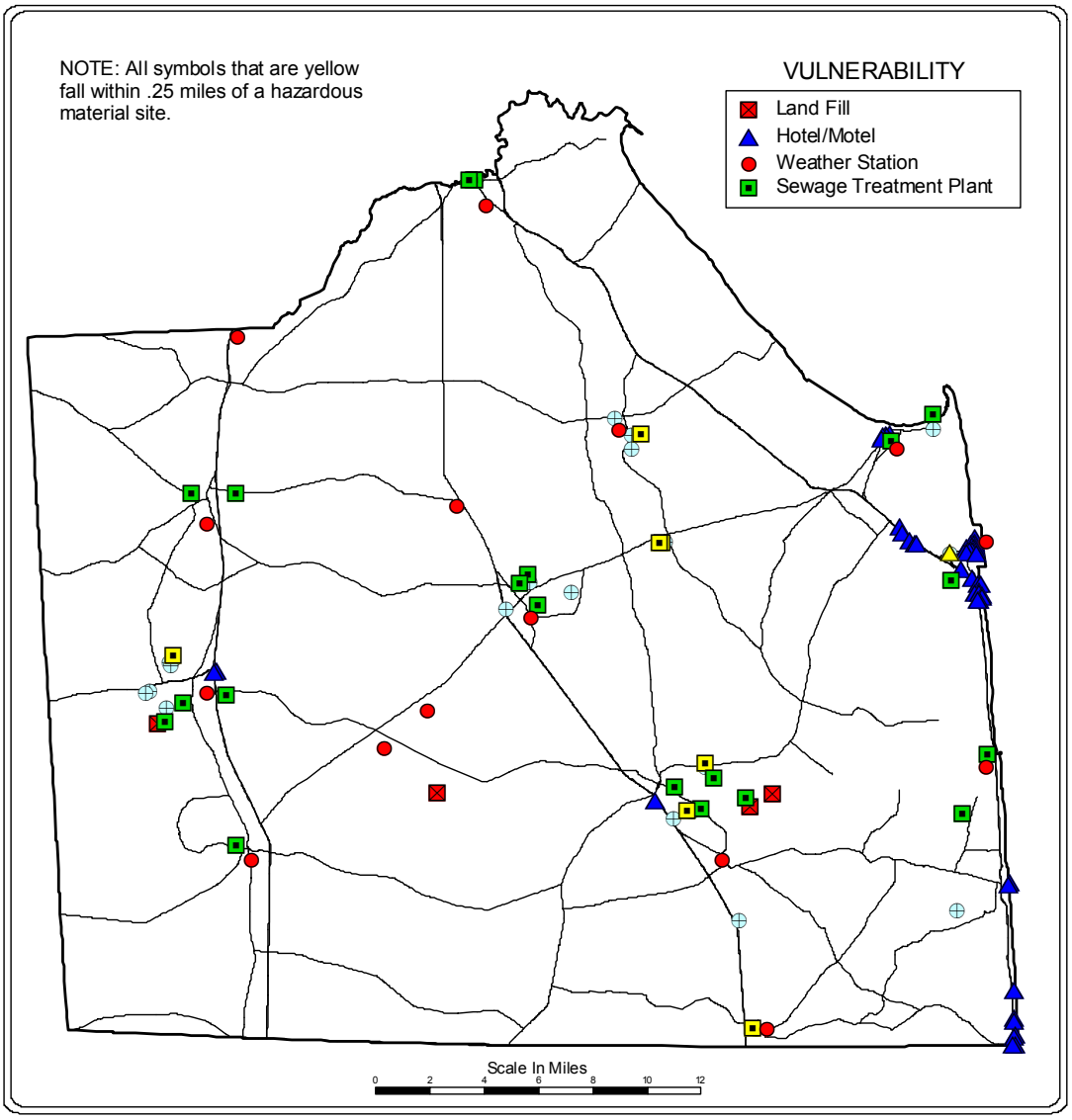
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 5.7
Selected Vulnerabilities within 0.25 Miles of a Hazardous Material Site: Emergency Services



Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 5.8
Selected Vulnerabilities within 0.25 Miles of a Hazardous Material Site: Other



Source: Center for Applied Demography & Survey Research, University of Delaware.

Nuclear Power Plants

Background

Releases of toxic materials from nuclear plants adjacent to Delaware are fortunately infrequent. In fact, no such release has ever occurred from the two plants within range of Sussex County. The range of intensity and duration of any release is substantial and that makes this a particularly difficult event to mitigate anywhere but at the hazard. Such releases should they occur would almost inevitably be the result of an accident and thus are not usually predictable in advance. They also could occur anytime of the year.

The damage caused by a toxic release is largely a function of the amount released, the amount of area affected, and the contents of the area.

The nuclear power plants present a somewhat different problem from natural phenomenon. The location of the potential problem is known. There is little knowledge about the frequency of radioactive releases. What is difficult to estimate is the magnitude of the release and the distance it will travel. Those are subject to the weather conditions at the time of the release into the air. Under certain conditions the damage might be minimal; under other circumstances the effect could be lethal.

The primary result of an accident at a nuclear power plant is usually a radioactive release. This may be accompanied by fire and explosion, which can aid and exacerbate the problem. There will be problems on the site and depending on the circumstance the toxic release may leave the boundaries of the property. In some situations, the resulting releases may be minimal, e.g. Three Mile Island (1979). In more serious situations, the site itself and even contiguous areas may have to be evacuated. In the most serious situations, e.g. Chernobyl (1986), the area was permanently evacuated, serious long-term damage was done to the food chain, and there were thousands of injuries and deaths.

Sussex County Nuclear Plants

There are two nuclear plants capable of affecting Sussex County. Both the 50-mile EPZ for Calvert Cliff and Salem intersect Sussex County.

The Calvert Cliff 50-mile EPZ (C50) includes 33,300 people and 18,400 jobs. The current market value of residential property affected is $909,000,000 and the total value of commercial, industrial, and utility property is approximately $456,000,000.

The Salem 50 mile EPZ (S50) includes 25,700 people and 6,500 jobs. The current market value of residential property affected is $756,000,000 and the total value of commercial, industrial, and utility property is approximately $205,000,000.

These estimates do not include the value of state owned property that is not subject to the property tax and there are significant properties of that type in impacted areas. These are upper bound estimates since the exact area of the flood is approximate and the location of the employment is an estimate.

Vulnerabilities

In the eight maps that follow, each of the 14 vulnerabilities identified as being within the various radiuses of the EPZs are displayed. Any vulnerability that lies within the area of a circle is at risk. In some cases, the actual number of symbols on the map may not agree with the list of affected vulnerabilities in the associated appendix table. This will happen when two vulnerabilities of the same type are co-located and thus have the same latitude and longitude and the same symbol.

Since the Salem 50 mile EPZ covers the entire county and there is no spatial differentiation, all vulnerabilities in all categories are at risk and will not be referred to further.

Transportation. Laurel airport is inside C50.

Six boat ramps are inside C50. Two additional boat ramps are inside S50.

There are 71 bridges inside of C50 with 12 bridges located on an evacuation route. A total of 82 bridges are inside S50 and 29 of those are on evacuation routes.

Communications. Of the seven TV/radio stations in Sussex County, two (WSUX and WJPY) are inside C50. One of six communication towers (Seaford Highway Yard) is inside C50 while another (Milton Tower) is inside S50. The Seaford 911 Center is also inside C50. None of the Emergency Operations Centers are within C50 or S50.

Two newspapers (Sussex Post and the Leader) are inside C50.

Employers and Government. There are eight major employers within S50 and an additional 13 inside C50. There are eight government facilities within C50 including town halls in Seaford, Blades, and Laurel. An additional nine government facilities are within S50 including town halls in Milford, Greenwood, Ellendale, and Milton.

Education and Corrections. Of the 84 schools in Sussex County, 20 are within the C50 EPZ with an additional 15 inside S50.

Fragile Populations. Four of the nursing homes in Sussex County are inside C50 with three more inside S50.

Nine daycare facilities are inside C50 with an additional 10 daycare facilities within S50.

The Nanticoke Hospital is inside C50 with Milford Memorial being located within S50.

Power Distribution. Three power taps are within C50. An additional two taps are located within S50. Five substations are within C50 with two more within S50. No generating plants are with the EPZ of either nuclear power plant.

Emergency Services. Police departments in Seaford, Blades, and Laurel are within C50 while those in Ellendale, Greenwood, Milton, and State Troop #5 are within S50.

There are four fire companies within C50 including Seaford, Blades, Laurel, and Delmar. Slaughter Beach, Ellendale, Greenwood, and Milton are within S50.

Other Services. There are two hotels within the C50 EPZ (Best Western and Holiday Inn). Five sewage treatment plants are within C50 with an additional five located within S50. One landfill is inside C50. Two weather stations are within C50 (Seaford and Laurel). Three more are within S50 (Milford, Greenwood, and Milton). All five are private facilities.

Next Steps

There are several additional issues that could improve the utility of this information. Since hazard mitigation is under the management of the US Department of Energy and the plant operators, the primary strategy will probably be evacuation. The extent of the evacuation will depend on the weather and the size of the release.

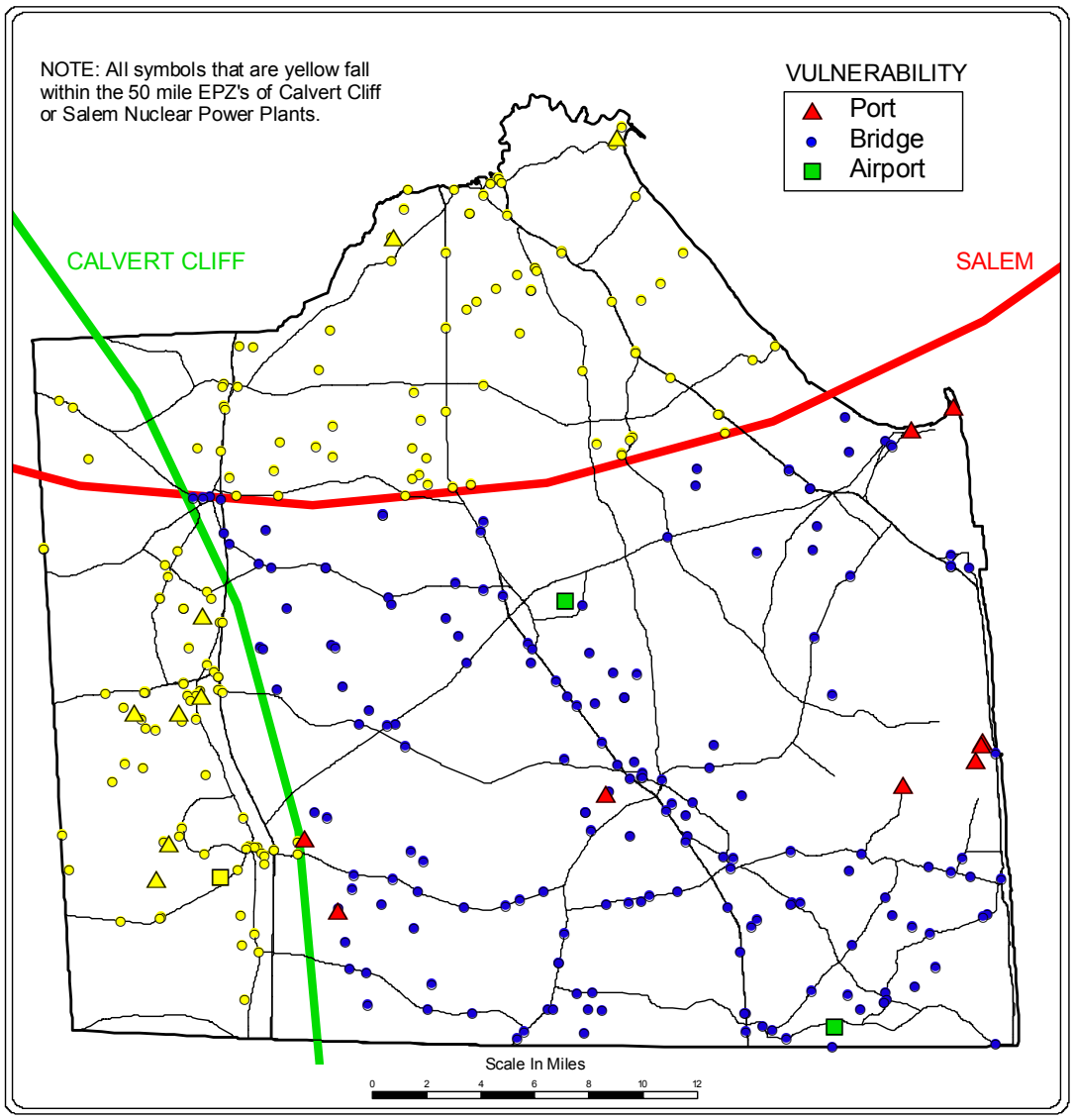
1. Build a new layer in the geographic information system using the DEMA segmentation of the EPZs. Calculate the populations and employment that might have to be evacuated.

2. Obtain weather information by time of year that might suggest the parts of the county that might have a greater risk.

3. Identify farms along with crops and livestock that might be subjected to ingestion of radioactive material.

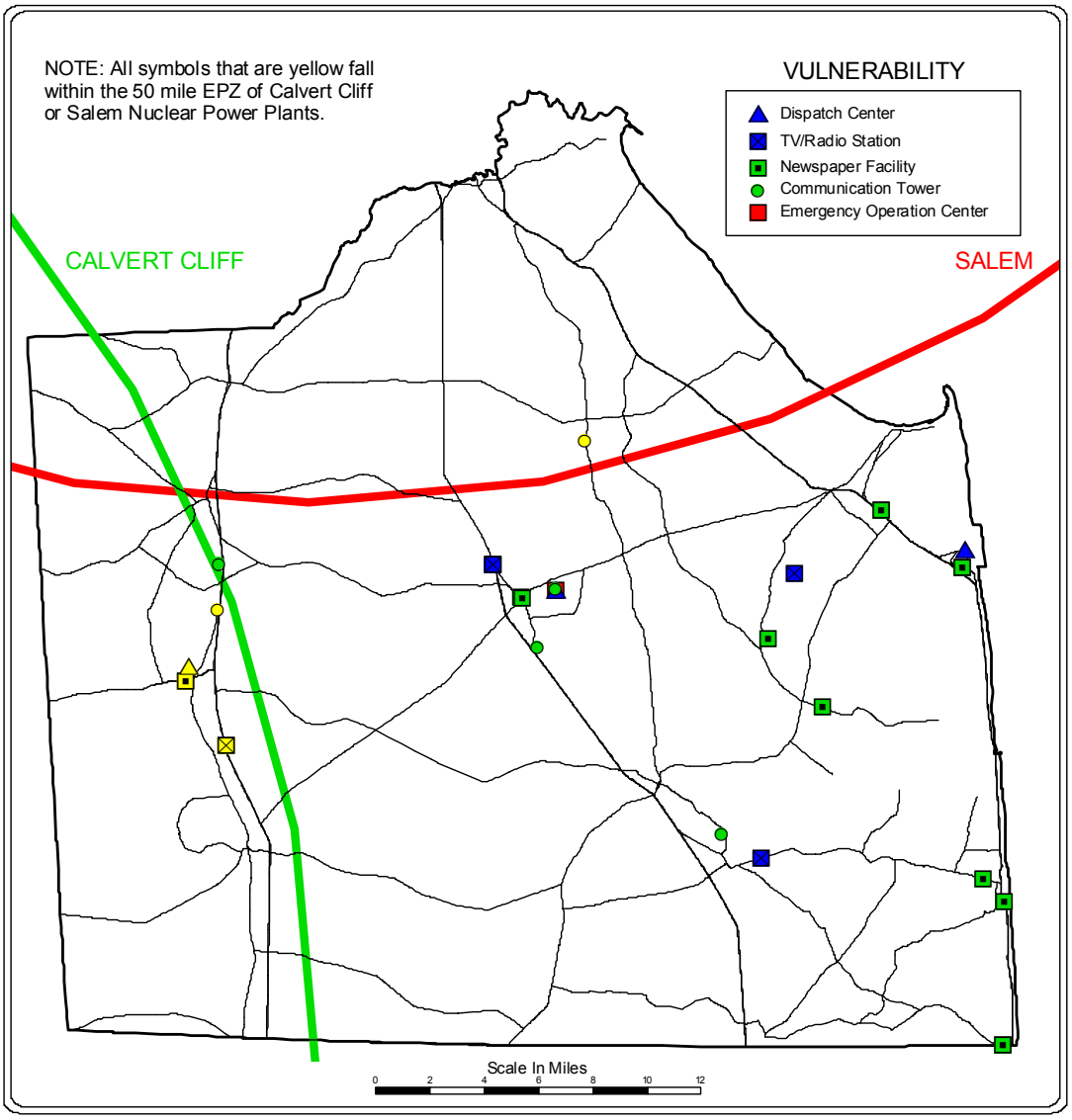
4. Add capacity information to all facilities both private and public that might have to be evacuated.

Figure 6.1
Selected Vulnerabilities within 10/20/50 Mile EPZs of Nuclear Power Plants: Transportation



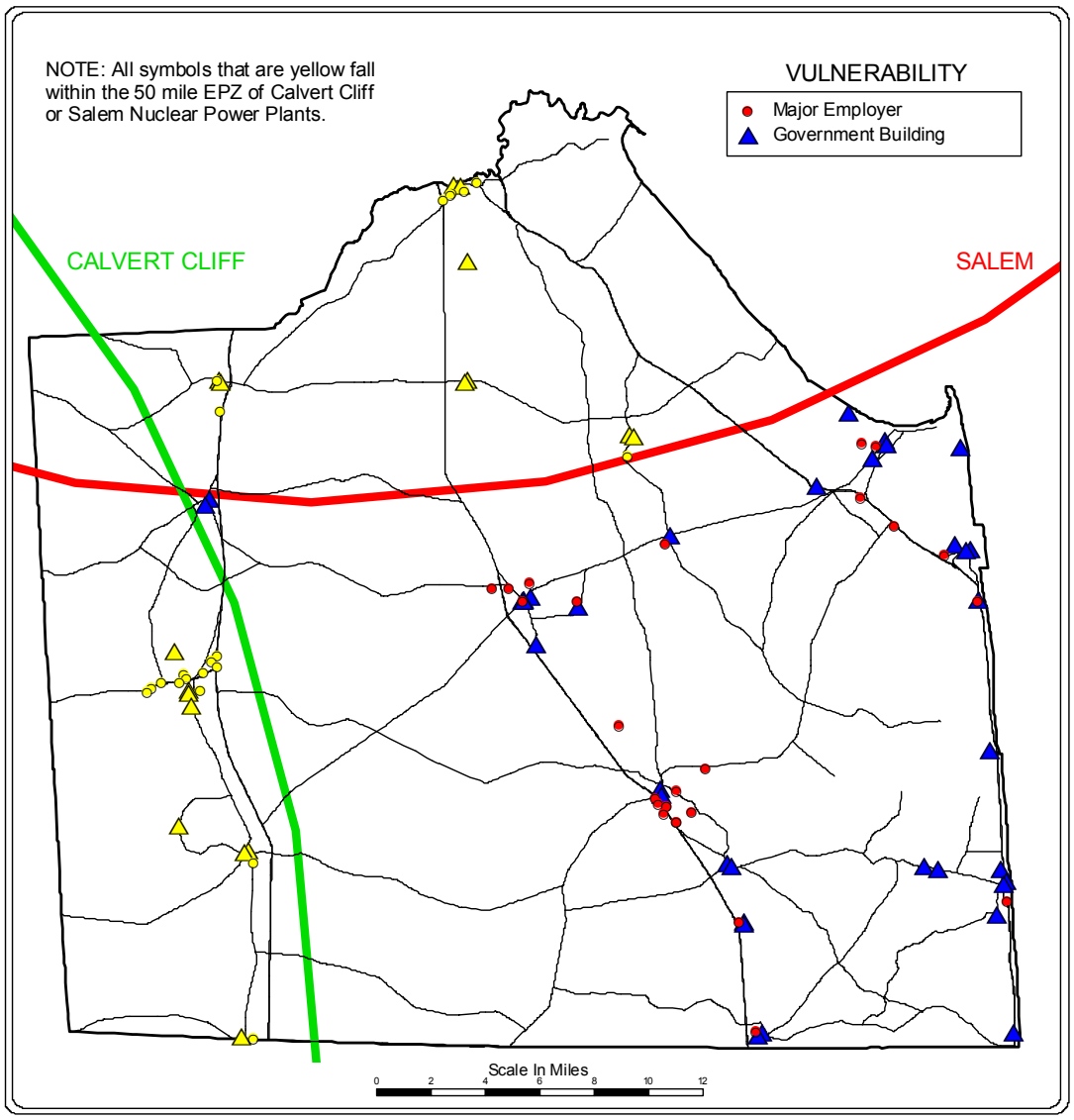
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 6.2
Selected Vulnerabilities within 10/20/50 Mile EPZs of Nuclear Power Plants: Communications



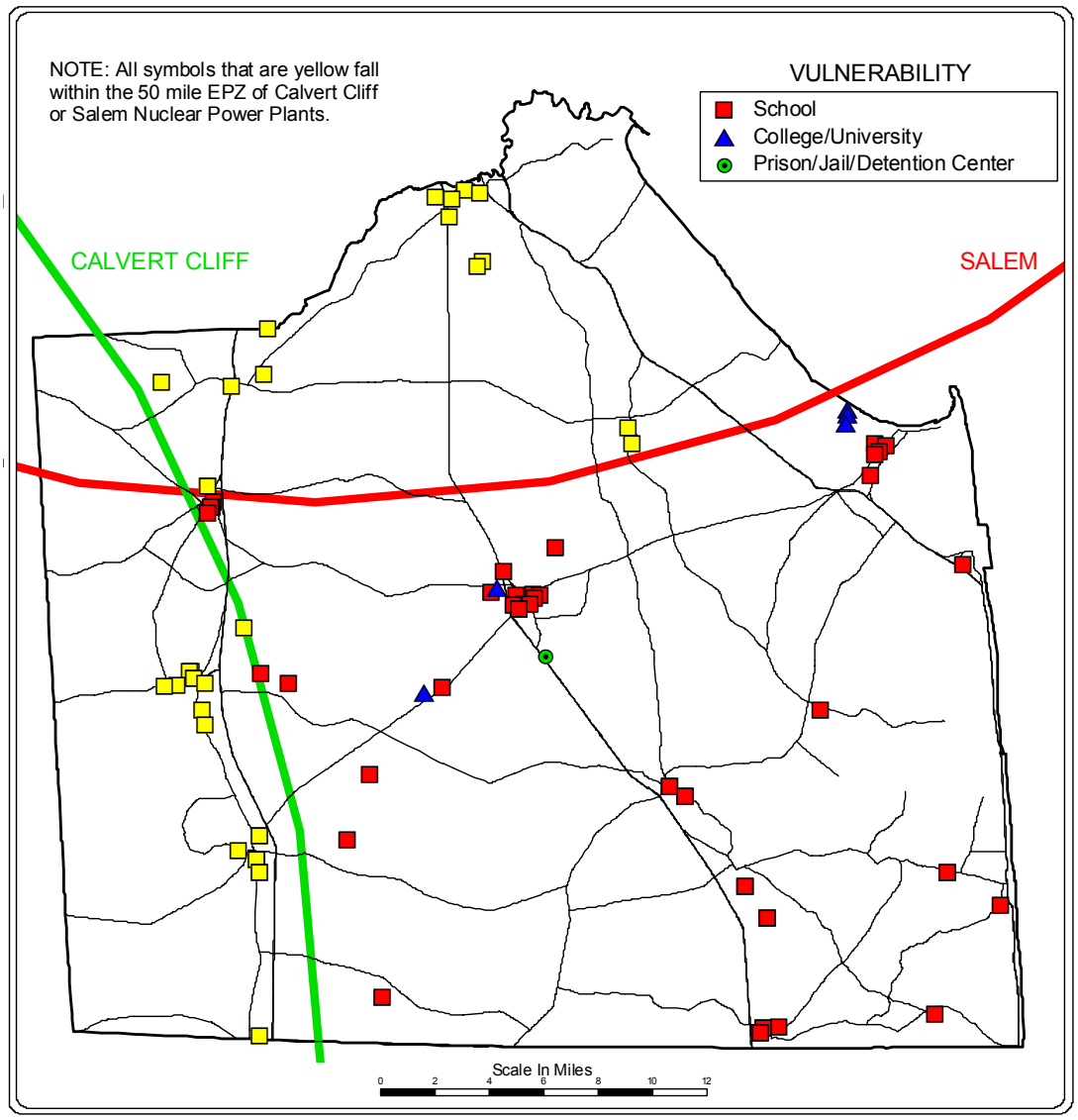
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 6.3
Selected Vulnerabilities within 10/20/50 Mile EPZs of Nuclear Power Plants: Employers and Government



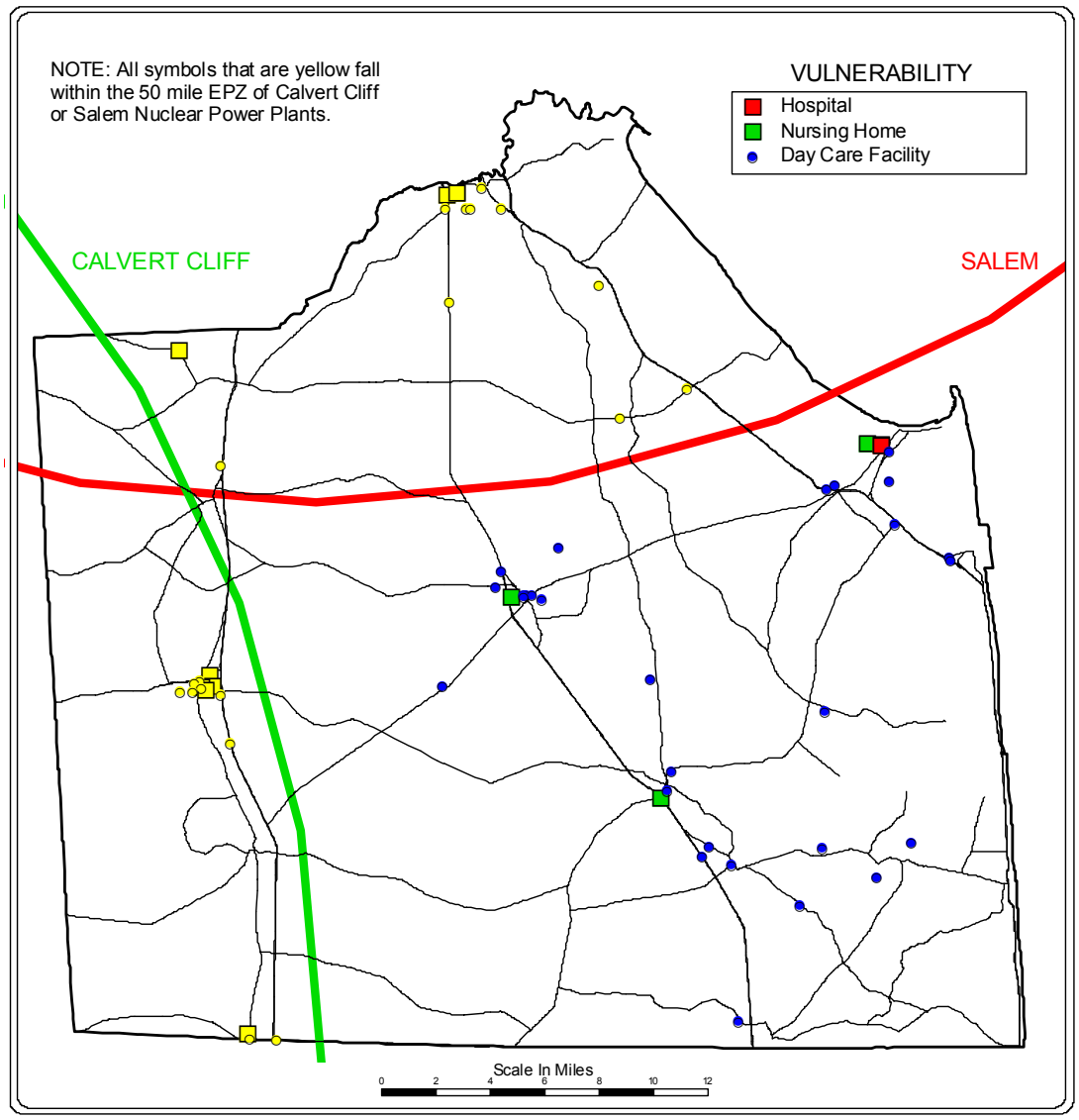
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 6.4
Selected Vulnerabilities within 10/20/50 Mile EPZs of Nuclear Power Plants: Education and Corrections



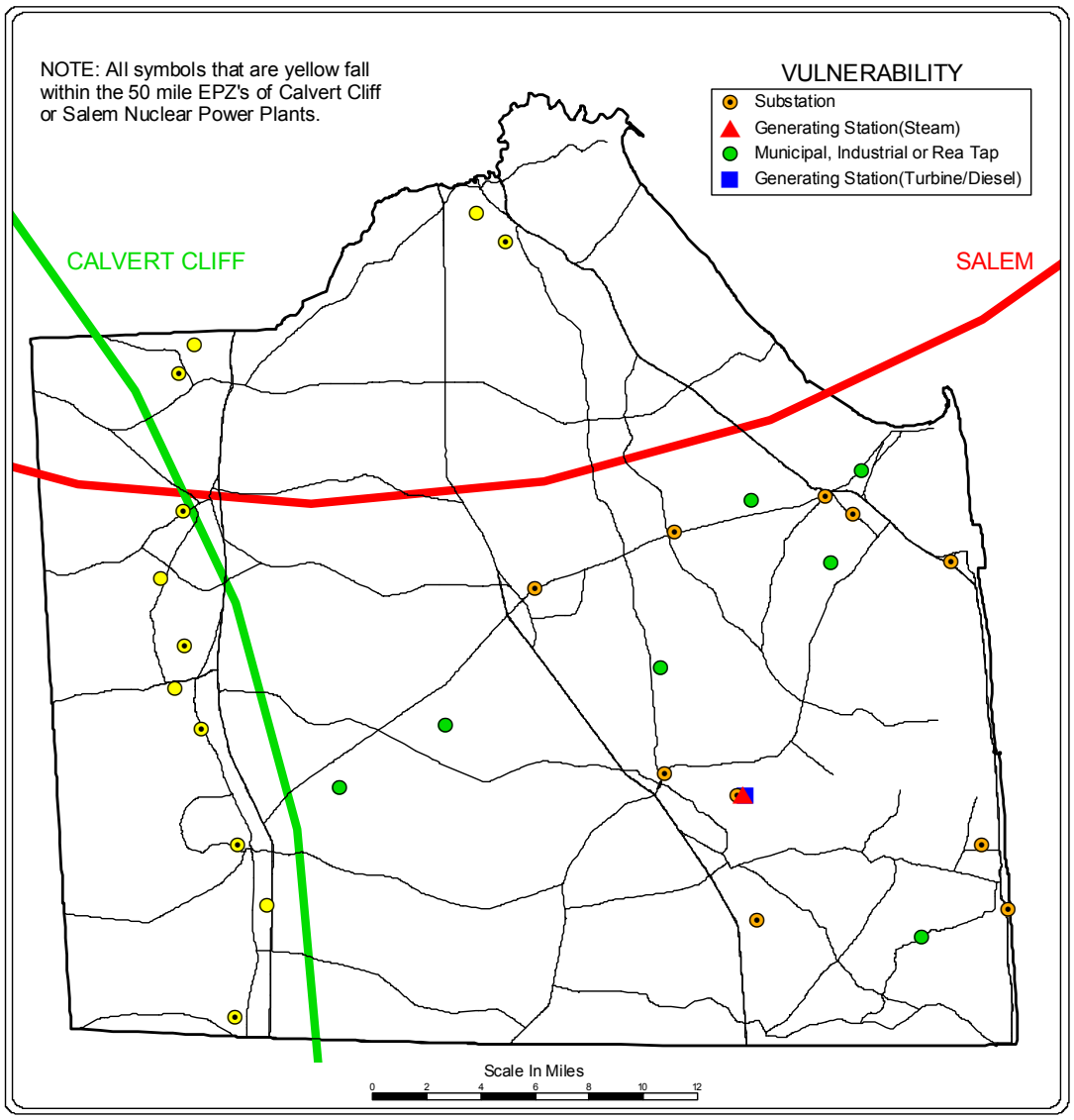
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 6.5
Selected Vulnerabilities within 10/20/50 Mile EPZs of Nuclear Power Plants: Fragile Populations



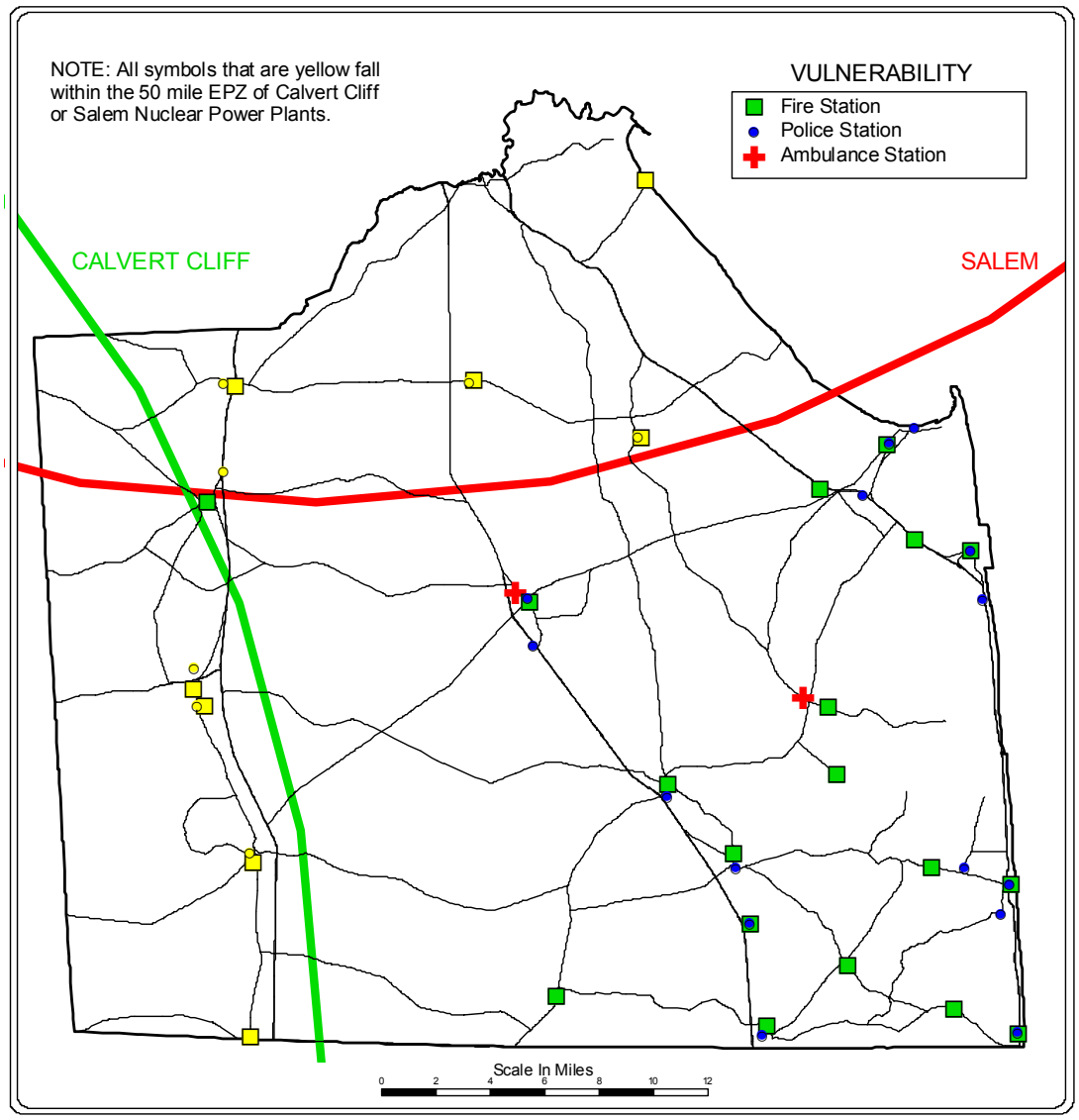
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 6.6
Selected Vulnerabilities within 10/20/50 Mile EPZs of Nuclear Power Plants: Power Distribution



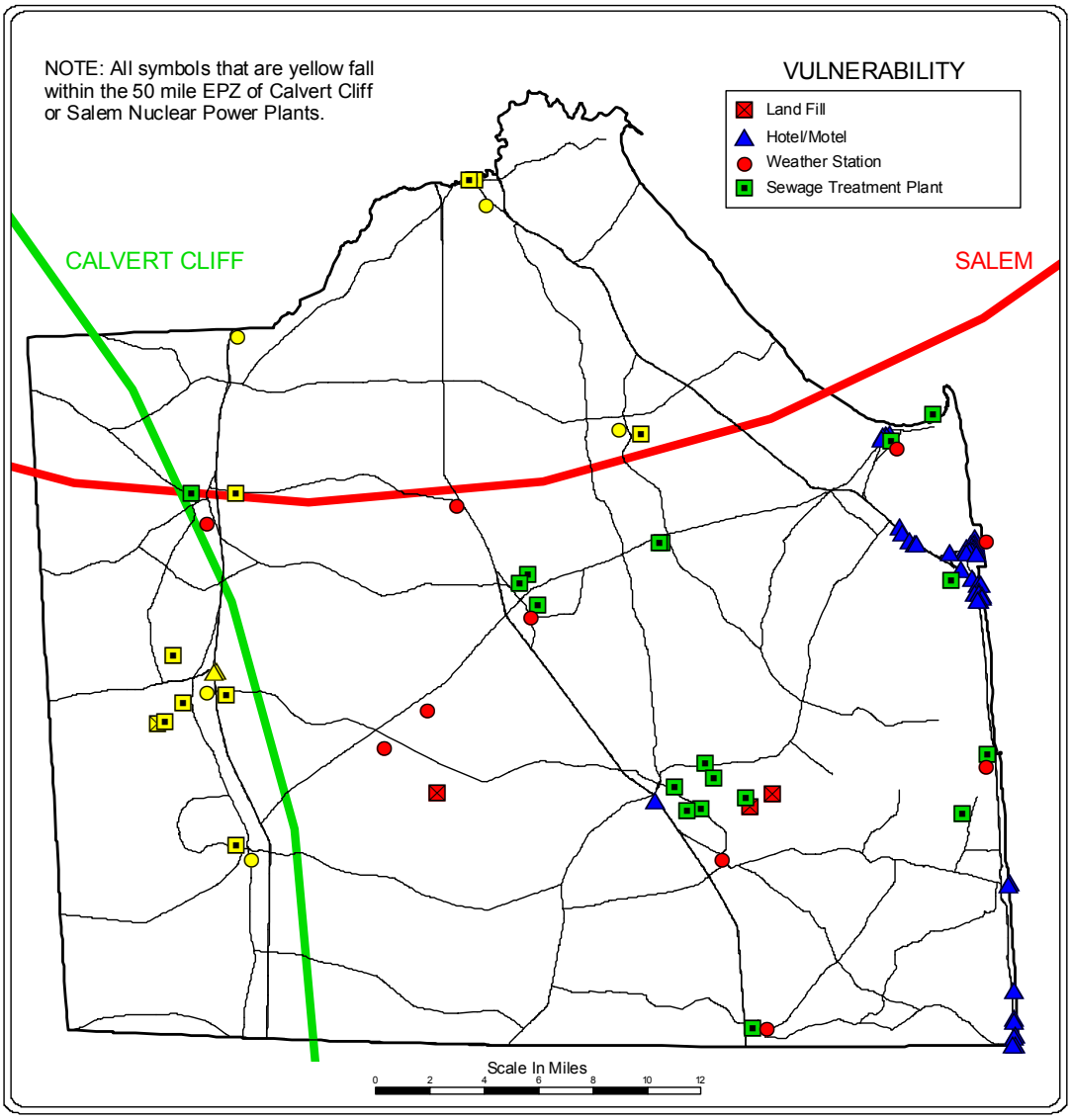
Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 6.7
Selected Vulnerabilities within 10/20/50 Mile EPZs of Nuclear Power Plants: Emergency Services



Source: Center for Applied Demography & Survey Research, University of Delaware.

Figure 6.8
Selected Vulnerabilities within 10/20/50 Mile EPZs of Nuclear Power Plants: Other



Source: Center for Applied Demography & Survey Research, University of Delaware.

Observations

After completing this analysis, it is possible to reach a number of conclusions. It is important to understand that these conclusions are arrived at within a framework of economic and policy analysis and not particularly from the point of view of disaster research or emergency management.

The most fruitful area to focus on is probably the hazardous materials sites. They are clearly the most frequent events and have a potential for serious damage including loss of life, injury, disruption of the transportation system, and damage to the economy. While no single event may do all of this, the potential losses coupled with the frequency of such events are significant. There is also a significant possibility of an event occurring because of the onset of another event such as a flood. This interaction at a critical time may make management of the release more difficult.

Further, since the strategy is largely one of hazard mitigation with sensitivity to the interaction with the vulnerabilities, there is a significant coordination role to be played. Many different emergency services may respond to such an event. The level of knowledge and training related to these events may vary significantly. Frequently, those first to respond are the first casualties in a toxic or explosive release.

In addition, the regulatory authority may or may not routinely and systematically advise all that could respond what they will be facing. This is another role that emergency management, if it is not already doing so, may well be able to assist in. There is definitely room for improving the information set available for managing these incidents.

The second most frequent event is the 50-year flood. There have been no 100-year floods in parts of Sussex County during this century. Since the expected value of costs avoided is related to frequency, mitigation efforts might better be focused on vulnerabilities in 50-year floods, which includes the 25-year flood as well. This will exclude some vulnerabilities listed in this report, but all of those included will be at risk more often. Since floods are generally low intensity events with short-term impact, sharpening the focus to the most vulnerable may enhance the

effectiveness of the planning effort and make any restrictive mitigation efforts easier to sell. Further, this approach may aid the valuation calculus as well.

The third area in terms of frequency is the failure of a dam. There have been incidents of this type and the results were damaging to the transportation system. More importantly, there may have been an interaction with a 25-year flood that occurred in the same year. Like the case with floods and hazardous materials, these two hazards probably should be managed in concert. The initiating event may be the flood, but the high intensity, long term impact may be the dam failure. Dam failures are more likely to be avoided by hazard mitigation rather than vulnerability mitigation.

The fourth area, a Category 3 hurricane has never occurred and may never occur simply because Delaware is a physically small place. Florida, which has suffered through 24 of these events this century has 25 times the land area of Delaware for a target, has 20 times the coast line and faces hurricanes from two directions. Delaware is on the periphery of hurricane paths along with Maryland which also has not experienced a Category 3 hurricane, and Virginia which has had one this century. In contrast, North Carolina has had 11. If one looks at all hurricanes, Category 1 through 5, Delaware has been struck by none, Maryland by one, Virginia by four, North Carolina by 25, and Florida by 57. Planning for such a low probability event of this type may be of little value. This is especially true since planning for floods covers much the same area as the Category 3 inundation area.

Finally, planning and mitigation for an event at one of the two nuclear power plants is probably prudent but has an extremely low probability given current experience. The plants are not under Delaware's control and thus are not open to hazard mitigation, which is rightly the purview of the Department of Energy and the operator of the facility. Any release that would occur would presumably be accidental and thus is not predictable. Should a release of any size occur at Salem that would cross the Delaware River, the idea that a 10/20/50 mile zone could be accurately forecast seems remote. In all probability, the primary strategy would have to be an orderly evacuation. The implication is that a great deal of interstate coordination would be required by all the emergency management agencies since there would be considerable cross-border movements. In these circumstances, the integrity of the evacuation routes becomes paramount.

The one topic that runs through all of the hazards consistently is the transportation system. Very few of the vulnerabilities, if any, are without alternatives as long as the populations and/or services can be moved to other locations. A major problem will develop if those affected by the hazard are isolated and have to withstand the brunt of the event.

The transportation system can withstand the loss of bridges as long as there are alternatives. When the St. Georges Bridge was closed, traffic was rerouted to Reedy Point or Summit bridges. There was a loss of time and a redistribution of the traffic. When the railroad bridge over the canal was closed, freight was moved to truck. True there are higher costs in terms of time and money, but the system does not fail.

The real problems begin when a vulnerability and its alternatives fail simultaneously, e.g. all bridges over the C&D Canal fail simultaneously and the population becomes isolated. This could happen when an area is serviced by a single road and a bridge on that road fails. There is a very real need to identify these situations if they exist.

The other situation occurs when the transportation system fails in that it cannot move people out of the way fast enough. That is, there are bottlenecks, which occur because the roads are being used at levels beyond their capacity or there are failures in the system that diminished its capacity, e.g. a bridge fails on an evacuation route and a less capable alternative must be used.

Both situations need to be modeled to identify both roads and bridges that could fail if one or more of the hazards occur. If that has already been done, then the database of vulnerabilities needs to be updated with that information.

APPENDIX A

100-year Flood Vulnerabilities

Hazard	Layer	Name	ADC Grid
flood	bridge	120	A-23
flood	bridge	111	B-16
flood	bridge	212	B-37
flood	bridge	112	C-16
flood	bridge	308	C-39
flood	bridge	221	D-30
flood	bridge	219	E-31
flood	bridge	214	E-33
flood	bridge	213	E-34
flood	bridge	217	F-31
flood	port	CRAIGS POND RAMP	F-31
flood	bridge	215	F-32
flood	bridge	206	F-34
flood	bridge	227	G-24
flood	bridge	226	G-25
flood	bridge	225	G-25
flood	bridge	216	G-32
flood	landfill	DUPONT SEAFORD	G-32
flood	bridge	307	G-37
flood	bridge	127	H-23
flood	bridge	9005	H-26
flood	bridge	224	H-26
flood	bridge	211	H-31
flood	port	SEAFORD RAMP	H-31
flood	stp	21	H-31
flood	stp	27	H-31
flood	bridge	163	H-37
flood	bridge	306	H-37
flood	bridge	141	J-18
flood	bridge	114	J-20
flood	bridge	9004	J-20
flood	stp	24	J-20
flood	bridge	231	J-25
flood	port	HEARNS POND RAMP	J-26
flood	bridge	203	J-29
flood	bridge	242	J-30
flood	bridge	151	J-30
flood	bridge	9006	J-30
flood	port	BLADES MARINA	J-30
flood	bridge	107	K-15
flood	bridge	105	K-15
flood	government	GREENWOOD POST OFFICE	K-15
flood	police	GREENWOOD	K-15

Hazard	Layer	Name	ADC Grid
flood	bridge	143	K-16
flood	bridge	144	K-16
flood	bridge	145	K-18
flood	bridge	131	K-19
flood	bridge	146	K-20
flood	bridge	146A	K-21
flood	bridge	236	K-25
flood	bridge	202	K-27
flood	bridge	255	K-27
flood	bridge	947	K-29
flood	bridge	253S	K-29
flood	bridge	253N	K-29
flood	bridge	254N	K-30
flood	bridge	254S	K-30
flood	wstall	15	K-30
flood	bridge	102	L-13
flood	wstall	5	L-13
flood	bridge	108	L-15
flood	bridge	129	L-20
flood	stp	25	L-20
flood	bridge	161	L-37
flood	bridge	9007	L-37
flood	stp	12	L-37
flood	subst	LAUREL(LOCATION)	L-37
flood	bridge	312	L-39
flood	bridge	377	L-41
flood	bridge	335	L-42
flood	school	BEULAH LAND CHRISTIAN ACADEMY	M-12
flood	bridge	103	M-13
flood	bridge	128	M-22
flood	bridge	237	M-28
flood	bridge	238	M-28
flood	bridge	152	M-37
flood	bridge	329	M-37
flood	bridge	162	M-37
flood	bridge	302	M-42
flood	bridge	336	M-43
flood	bridge	140	N-18
flood	bridge	149	N-19
flood	bridge	130	N-20
flood	bridge	232	N-24
flood	bridge	235	N-26
flood	bridge	365S	N-38

Hazard	Layer	Name	ADC Grid
flood	bridge	365N	N-38
flood	bridge	362	P-37
flood	port	CHIPMAN POND RAMP	P-37
flood	bridge	314	P-38
flood	bridge	106	Q-14
flood	bridge	139	Q-18
flood	bridge	642	Q-24
flood	bridge	643	Q-24
flood	bridge	239	Q-28
flood	bridge	368	Q-36
flood	bridge	323	Q-36
flood	bridge	121	R-17
flood	bridge	133	R-18
flood	bridge	240	R-28
flood	bridge	249	R-30
flood	bridge	348	R-39
flood	bridge	349	R-40
flood	bridge	357	R-42
flood	bridge	337	R-43
flood	bridge	247	S-31
flood	bridge	315	S-39
flood	bridge	338	S-44
flood	bridge	354	S-45
flood	bridge	636	T-21
flood	bridge	132	T-21
flood	bridge	644	T-25
flood	bridge	653	T-26
flood	bridge	659	T-32
flood	bridge	316	T-39
flood	bridge	630	U-20
flood	bridge	634	U-20
flood	bridge	676	U-32
flood	bridge	907	U-6
flood	bridge	631	V-20
flood	bridge	342	V-38
flood	bridge	617	W-20
flood	bridge	656	W-26
flood	bridge	9002	W-6
flood	bridge	686	X-25
flood	bridge	657	X-27
flood	stp	30	X-5
flood	bridge	935	X-7
flood	bridge	941	Y-11

Hazard	Layer	Name	ADC Grid
flood	bridge	927	Y-5
flood	bridge	932	Y-6
flood	bridge	940	Z-10
flood	bridge	937	AA-10
flood	bridge	938	AA-10
flood	bridge	936	AA-10
flood	stp	7	AA-24
flood	bridge	663	AA-28
flood	bridge	922	AA-9
flood	bridge	920	AA-9
flood	bridge	923	AA-9
flood	bridge	670	CC-33
flood	bridge	933N	CC-9
flood	bridge	933S	CC-9
flood	bridge	918	DD-14
flood	bridge	592	DD-36
flood	bridge	593	DD-36
flood	bridge	164	EE-3
flood	port	CEDAR CREEK RAMP	EE-3
flood	bridge	509	EE-33
flood	bridge	530	EE-35
flood	bridge	815N	FF-13
flood	bridge	815S	FF-13
flood	bridge	809	FF-18
flood	bridge	808	FF-18
flood	bridge	806	FF-18
flood	fd	MILTON VFC (Co. 85)	FF-18
flood	government	MILTON POST OFFICE	FF-18
flood	bridge	925	FF-2
flood	bridge	508	FF-34
flood	bridge	546	FF-37
flood	bridge	924	FF-6
flood	bridge	817	GG-11
flood	stp	19	GG-18
flood	bridge	9001	GG-34
flood	bridge	526	GG-34
flood	fd	MEMORIAL VFC (Co. 89)	GG-5
flood	bridge	818	HH-10
flood	bridge	814	HH-15
flood	bridge	514	HH-34
flood	stp	18	HH-35
flood	bridge	507	HH-36
flood	bridge	525	JJ-35

Hazard	Layer	Name	ADC Grid
flood	stp	17	JJ-36
flood	bridge	523	JJ-37
flood	bridge	504	JJ-37
flood	bridge	820	JJ-9
flood	bridge	155N	KK-16
flood	bridge	155S	KK-16
flood	bridge	518	KK-32
flood	stp	14	KK-33
flood	bridge	516	KK-34
flood	stp	15	KK-34
flood	stp	16	KK-36
flood	bridge	717	LL-17
flood	bridge	424	LL-38
flood	government	DAGSBORO POST OFFICE	LL-38
flood	wstall	14	LL-38
flood	bridge	410	LL-43
flood	bridge	811	MM-14
flood	bridge	720	MM-23
flood	gensts	INDIAN RIVER(LOCATION)	MM-35
flood	gensttd	INDIAN RIVER(LOCATION)	MM-35
flood	stp	6	MM-35
flood	bridge	442	MM-41
flood	bridge	443	MM-41
flood	bridge	402	MM-46
flood	school	SELBYVILLE MS INTENSIVE LEARNING CENTER	MM-46
flood	school	SELBYVILLE MIDDLE SCHOOL	MM-46
flood	stp	26	MM-46
flood	bridge	812	NN-13
flood	landfill	DP&L INDIAN RIVER OLD LANDFILL	NN-35
flood	bridge	376	NN-46
flood	bridge	435	NN-46
flood	bridge	718	PP-19
flood	bridge	719	PP-19
flood	bridge	425	PP-38
flood	bridge	440	PP-40
flood	bridge	445	PP-40
flood	bridge	713	QQ-23
flood	bridge	709	QQ-27
flood	college	UNIVERSITY OF DELAWARE(Lewes)	RR-16
flood	college	UofD-COLLEGE OF MARINE STUDIES	RR-17
flood	college	UofD-RESEARCH PARK	RR-17
flood	bridge	723	RR-30
flood	fd	INDIAN RIVER VFC (Co. 80)	RR-34

Hazard	Layer	Name	ADC Grid
flood	government	U.S. COAST GUARD STATION	SS-16
flood	bridge	715	SS-17
flood	bridge	714	SS-18
flood	bridge	708	SS-24
flood	bridge	ADC	TT-45
flood	bridge	438	TT-45
flood	bridge	9003	UU-18
flood	bridge	154A	UU-18
flood	hotel	BEACON MOTEL	UU-18
flood	hotel	ANGLERS MOTEL	UU-18
flood	hotel	CAPE HENLOPEN MOTEL	UU-18
flood	stp	13	UU-18
flood	port	HOLTS LANDING ST PK RAMP	UU-34
flood	bridge	439	UU-44
flood	bridge	450	UU-45
flood	police	DE RIVER & BAY AUTHO	VV-17
flood	port	CAPE MAY/LEWES FERRY	VV-17
flood	bridge	431	VV-41
flood	bridge	460	VV-44
flood	bridge	456	WW-42
flood	bridge	476	WW-43
flood	school	ROONEYS HOME SCHOOL	WW-46
flood	port	CAPE HENLOPEN ST PK FISHING PIER	XX-16
flood	government	U.S. NAVAL RESERVE	XX-18
flood	bridge	153	XX-23
flood	dispatch	REHOBOTH BEACH 911 CENTER	XX-23
flood	fd	REHOBOTH BEACH VFC (Co. 86-Sta #1)	XX-23
flood	government	HENLOPEN ACRES TOWN HALL	XX-23
flood	government	REHOBOTH BEACH TOWN HALL	XX-23
flood	hotel	BREAKERS MOTEL	XX-23
flood	hotel	SANDCASTLE	XX-23
flood	hotel	DINNER BELL INN	XX-23
flood	hotel	HIGH SEAS MOTEL	XX-23
flood	police	REHOBOTH BEACH	XX-23
flood	bridge	150N	XX-24
flood	bridge	150S	XX-24
flood	hotel	WALLS APARTMENTS	XX-24
flood	newspaper	DELAWARE BEACHCOMBER	XX-24
flood	newspaper	DELAWARE COAST PRESS	XX-24
flood	school	REHOBOTH ELEMENTARY SCHOOL	XX-24
flood	subst	REHOBOTH(LOCATION)	XX-24
flood	stp	20	XX-25
flood	stp	2	XX-36

Hazard	Layer	Name	ADC Grid
flood	bridge	454	XX-38
flood	government	REHOBOTH BEACH POST OFFICE	YY-23
flood	hotel	HENLOPEN HOTEL	YY-23
flood	hotel	ONE VIRGINIA AVENUE	YY-23
flood	hotel	EDGEWATER HOUSE	YY-23
flood	hotel	PLEASANT INN LODGE	YY-23
flood	hotel	BOARDWALK PLAZA HOTEL	YY-23
flood	hotel	PATRICIAN TOWERS	YY-23
flood	hotel	SUMMER PLACE HOTEL	YY-23
flood	hotel	ATLANTIC SANDS HOTEL	YY-23
flood	hotel	ADMIRAL HOTEL	YY-23
flood	hotel	LORD BALTIMORE LODGE	YY-23
flood	hotel	SEA ESTA II	YY-23
flood	hotel	ATLANTIC BUDGET INN DOWNTOWN	YY-23
flood	hotel	BEACH VIEW MOTEL	YY-23
flood	hotel	BRIGHTON SUITES HOTEL	YY-23
flood	hotel	OCEANUS MOTEL	YY-23
flood	hotel	THE WILMINGTON	YY-23
flood	hotel	STAR OF THE SEA CONDOMINIUMS	YY-23
flood	bridge	707	YY-24
flood	government	DEWEY BEACH TOWN HALL	YY-25
flood	hotel	ATLANTIC OCEANSIDE SUITES	YY-25
flood	hotel	SEA ESTA I	YY-25
flood	hotel	ATLANTIC VIEW MOTEL	YY-25
flood	hotel	SAND PALACE	YY-25
flood	hotel	BAY RESORT	YY-25
flood	hotel	ATLANTIC OCEANSIDE MOTEL	YY-25
flood	hotel	THE SURF CLUB	YY-25
flood	hotel	ADAMS OCEAN FRONT MOTEL	YY-25
flood	police	DEWEY BEACH	YY-25
flood	hotel	DEWEY BEACH SUITES & HOTEL	YY-26
flood	hotel	BEST WESTERN(GOLDEN LEAF)	YY-26
flood	hotel	SEA ESTA III	YY-26
flood	mjremp	DEWEY BEACH ENTERPRISES	YY-26
flood	port	INDIAN RIVER RAMP	YY-32
flood	port	INDIAN RIVER INLET MARINA	YY-32
flood	port	INDIAN RIVER INLET MARINA	YY-33
flood	wstall	28	YY-34
flood	subst	CEDAR NECK(LOCATION)	YY-37
flood	bridge	429	YY-39
flood	newspaper	RESORT REAL ESTATE GUIDE	YY-39
flood	bridge	455	YY-41
flood	bridge	156	ZZ-33

Hazard	Layer	Name	ADC Grid
flood	government	U.S. COAST GUARD STATION	ZZ-33
flood	stp	1	ZZ-33
flood	bridge	050	ZZ-39
flood	fd	BETHANY BEACH (Co. 70-Sta #1)	ZZ-39
flood	government	DELAWARE NATIONAL GUARD	ZZ-39
flood	government	BETHANY BEACH POST OFFICE	ZZ-39
flood	government	BETHANY BEACH TOWN HALL	ZZ-39
flood	police	BETHANY BEACH	ZZ-39
flood	mjremp	C M F PAYMASTER INC.	ZZ-40
flood	newspaper	THE WAVE NEWSPAPER	ZZ-40
flood	school	BETHANY HOME SCHOOL	ZZ-40
flood	bridge	453	ZZ-41
flood	government	SOUTH BETHANY TOWN HALL	ZZ-41
flood	police	SOUTH BETHANY BEACH	ZZ-41
flood	bridge	437	ZZ-47
flood	newspaper	CABLE CHANNELS MAGAZ	ZZ-47
flood	newspaper	OCEANA MAGAZINE	ZZ-47
flood	hotel	BLUE SURF MOTEL	AAA-39
flood	hotel	BETHANY ARMS MOTEL & APTS	AAA-39
flood	subst	BETHANY(LOCATION)	AAA-41
flood	hotel	FENWICK TOWERS CONDOS	AAA-44
flood	government	FENWICK ISLAND TOWN HALL	AAA-46
flood	hotel	SANDS MOTEL & APTS.	AAA-46
flood	hotel	ISKANDERS ISLAND INN	AAA-46
flood	police	FENWICK ISLAND	AAA-46
flood	fd	BETHANY BEACH SUBSTATION (Co. 70-Sta #2)	AAA-47
flood	hotel	FENWICK SEA CHARM MOTEL & APTS	AAA-47
flood	hotel	FENWICK ISLANDER MOTEL	AAA-47
flood	hotel	COREL SANDS APTS.	AAA-47
flood	hotel	ATLANTIC BUDGET INN	AAA-47

APPENDIX B

Category 3 Hurricane Inundation Vulnerabilities

Hazard	Layer	Name	ADC Grid
inundation	bridge	9002	W-6
inundation	government	MILFORD POST OFFICE	X-5
inundation	bridge	927	Y-5
inundation	mjremp	SEA WATCH INTERNATIONAL	Y-5
inundation	bridge	932	Y-6
inundation	bridge	937	AA-10
inundation	bridge	938	AA-10
inundation	bridge	936	AA-10
inundation	bridge	922	AA-9
inundation	bridge	920	AA-9
inundation	bridge	923	AA-9
inundation	bridge	9008	DD-18
inundation	bridge	816	EE-11
inundation	port	CEDAR CREEK RAMP	EE-3
inundation	bridge	815N	FF-13
inundation	bridge	815S	FF-13
inundation	bridge	809	FF-18
inundation	bridge	808	FF-18
inundation	bridge	9000	FF-18
inundation	bridge	806	FF-18
inundation	fd	MILTON VFC (Co. 85)	FF-18
inundation	government	MILTON POST OFFICE	FF-18
inundation	government	MILTON TOWN HALL	FF-18
inundation	police	MILTON	FF-18
inundation	bridge	925	FF-2
inundation	bridge	672	FF-30
inundation	bridge	673	FF-30
inundation	bridge	9009	FF-33
inundation	bridge	924	FF-6
inundation	bridge	817	GG-11
inundation	stp	19	GG-18
inundation	bridge	9001	GG-34
inundation	fd	MEMORIAL VFC (Co. 89)	GG-5
inundation	bridge	818	HH-10
inundation	bridge	814	HH-15
inundation	subst	MILLSBORO(LOCATION)	HH-34
inundation	bridge	9011	HH-35
inundation	stp	18	HH-35
inundation	bridge	507	HH-36
inundation	mjremp	ROSES	HH-36
inundation	daycare	EAGLE'S NEST DAY CARE	JJ-15
inundation	bridge	823	JJ-19

Hazard	Layer	Name	ADC Grid
inundation	bridge	716	JJ-20
inundation	bridge	525	JJ-35
inundation	bridge	9012	JJ-36
inundation	stp	17	JJ-36
inundation	bridge	820	JJ-9
inundation	bridge	155N	KK-16
inundation	bridge	155S	KK-16
inundation	bridge	518	KK-32
inundation	stp	14	KK-33
inundation	bridge	516	KK-34
inundation	stp	15	KK-34
inundation	stp	16	KK-36
inundation	bridge	717	LL-17
inundation	subst	INDIAN RIVER(LOCATION)	LL-35
inundation	bridge	424	LL-38
inundation	government	DAGSBORO TOWN HALL	LL-38
inundation	police	DAGSBORO	LL-38
inundation	bridge	811	MM-14
inundation	bridge	9010	MM-35
inundation	gensts	INDIAN RIVER(LOCATION)	MM-35
inundation	gnsttd	INDIAN RIVER(LOCATION)	MM-35
inundation	stp	6	MM-35
inundation	landfill	DELMARVA POWER & LIGHT INDIAN RIVER	MM-36
inundation	bridge	812	NN-13
inundation	landfill	DP&L INDIAN RIVER OLD LANDFILL	NN-35
inundation	bridge	718	PP-19
inundation	bridge	719	PP-19
inundation	paramedic	MID SUSSEX RESCUE (Co. 91)	PP-30
inundation	bridge	440	PP-40
inundation	bridge	713	QQ-23
inundation	bridge	709	QQ-27
inundation	daycare	LITTLE HEARTS LEARNING CENTER, INC.	QQ-38
inundation	college	UNIVERSITY OF DELAWARE(Lewes)	RR-16
inundation	college	UofD-COLLEGE OF MARINE STUDIES	RR-17
inundation	college	UofD-RESEARCH PARK	RR-17
inundation	mirea	ROBINSVILLE(LOCATION)	RR-24
inundation	bridge	723	RR-30
inundation	fd	INDIAN RIVER VFC (Co. 80)	RR-34
inundation	government	U.S. COAST GUARD STATION	SS-16
inundation	bridge	715	SS-17
inundation	bridge	714	SS-18
inundation	mjremp	HARBOR HEALTH CARE & REHABILITATION CENTER	SS-18
inundation	nhome	HARBOR HEALTH CARE & REHABILITATION CENTER	SS-18

Hazard	Layer	Name	ADC Grid
inundation	mirea	LEWES_LOCATION)	SS-19
inundation	bridge	426	SS-38
inundation	bridge	447	SS-39
inundation	bridge	461	SS-45
inundation	bridge	462	SS-45
inundation	daycare	LEWES CHILD DEVELOPMENT CENTER	TT-18
inundation	fd	LEWES VFC (Co. 82-Sta #1)	TT-18
inundation	government	LEWES POST OFFICE	TT-18
inundation	government	LEWES TOWN HALL	TT-18
inundation	hospital	BEEBE MEDICAL CENTER	TT-18
inundation	hotel	NEW DEVON INN	TT-18
inundation	mjremp	BEEBE MEDICAL CENTER	TT-18
inundation	nhome	LEWES CONVALESCENT CENTER	TT-18
inundation	police	LEWES	TT-18
inundation	school	SUSSEX CONSORTIUM	TT-18
inundation	school	MORNINGSTAR ACADEMY	TT-18
inundation	school	LEWES MIDDLE SCHOOL	TT-18
inundation	school	SHIELDS (Richard A.) ELEMENTARY SCHOOL	TT-18
inundation	government	ARMY RESERVE CENTER	TT-19
inundation	daycare	UNION WESLEY CARE-A-LOT CHILD CARE	TT-39
inundation	bridge	ADC	TT-45
inundation	bridge	438	TT-45
inundation	bridge	154	UU-18
inundation	bridge	9003	UU-18
inundation	bridge	154A	UU-18
inundation	hotel	BEACON MOTEL	UU-18
inundation	hotel	ANGLERS MOTEL	UU-18
inundation	hotel	CAPE HENLOPEN MOTEL	UU-18
inundation	stp	13	UU-18
inundation	wstall	33	UU-18
inundation	port	HOLTS LANDING ST PK RAMP	UU-34
inundation	bridge	432	UU-40
inundation	bridge	452	UU-41
inundation	bridge	439	UU-44
inundation	bridge	450	UU-45
inundation	police	DE RIVER & BAY AUTHO	VV-17
inundation	port	CAPE MAY/LEWES FERRY	VV-17
inundation	daycare	VILLAGE SQUARE CHILD CARE	VV-37
inundation	fd	MILLVILLE VFC (Co. 84)	VV-38
inundation	government	MILLVILLE TOWN HALL	VV-38
inundation	bridge	431	VV-41
inundation	mirea	BAYARD & DIRICKSON(LOCATION)	VV-42
inundation	bridge	427	WW-38

Hazard	Layer	Name	ADC Grid
inundation	government	OCEAN VIEW/MILLVILLE/CLARKSVILLE POST OFF	WW-39
inundation	school	BALTIMORE (Lord) ELEMENTARY SCHOOL	WW-39
inundation	school	BALTIMORE (Lord) ES INTENSIVE LEARNING CTR.	WW-39
inundation	bridge	456	WW-42
inundation	bridge	476	WW-43
inundation	school	ROONEYS HOME SCHOOL	WW-46
inundation	port	CAPE HENLOPEN ST PK FISHING PIER	XX-16
inundation	government	U.S. NAVAL RESERVE	XX-18
inundation	dispatch	REHOBOTH BEACH 911 CENTER	XX-23
inundation	fd	REHOBOTH BEACH VFC (Co. 86-Sta #1)	XX-23
inundation	government	HENLOPEN ACRES TOWN HALL	XX-23
inundation	government	REHOBOTH BEACH TOWN HALL	XX-23
inundation	hotel	BREAKERS MOTEL	XX-23
inundation	hotel	SANDCASTLE	XX-23
inundation	hotel	DINNER BELL INN	XX-23
inundation	hotel	HIGH SEAS MOTEL	XX-23
inundation	hotel	PIRATES COVE	XX-23
inundation	police	REHOBOTH BEACH	XX-23
inundation	hotel	WALLS APARTMENTS	XX-24
inundation	newspaper	DELAWARE BEACHCOMBER	XX-24
inundation	newspaper	DELAWARE COAST PRESS	XX-24
inundation	school	REHOBOTH ELEMENTARY SCHOOL	XX-24
inundation	subst	REHOBOTH(LOCATION)	XX-24
inundation	stp	20	XX-25
inundation	stp	2	XX-36
inundation	bridge	454	XX-38
inundation	police	OCEAN VIEW	XX-38
inundation	bridge	428	XX-39
inundation	fd	ROXANA VFC SUBSTATION (Co. 90-Sta #2)	XX-45
inundation	government	REHOBOTH BEACH POST OFFICE	YY-23
inundation	hotel	HENLOPEN HOTEL	YY-23
inundation	hotel	ONE VIRGINIA AVENUE	YY-23
inundation	hotel	EDGEWATER HOUSE	YY-23
inundation	hotel	PLEASANT INN LODGE	YY-23
inundation	hotel	BOARDWALK PLAZA HOTEL	YY-23
inundation	hotel	PATRICIAN TOWERS	YY-23
inundation	hotel	SUMMER PLACE HOTEL	YY-23
inundation	hotel	ATLANTIC SANDS HOTEL	YY-23
inundation	hotel	ADMIRAL HOTEL	YY-23
inundation	hotel	LORD BALTIMORE LODGE	YY-23
inundation	hotel	SEA ESTA II	YY-23
inundation	hotel	ATLANTIC BUDGET INN DOWNTOWN	YY-23
inundation	hotel	BEACH VIEW MOTEL	YY-23

Hazard	Layer	Name	ADC Grid
inundation	hotel	BRIGHTON SUITES HOTEL	YY-23
inundation	hotel	OCEANUS MOTEL	YY-23
inundation	hotel	THE WILMINGTON	YY-23
inundation	hotel	STAR OF THE SEA CONDOMINIUMS	YY-23
inundation	bridge	707	YY-24
inundation	government	DEWEY BEACH TOWN HALL	YY-25
inundation	hotel	ATLANTIC OCEANSIDE SUITES	YY-25
inundation	hotel	SEA ESTA I	YY-25
inundation	hotel	ATLANTIC VIEW MOTEL	YY-25
inundation	hotel	SAND PALACE	YY-25
inundation	hotel	BAY RESORT	YY-25
inundation	hotel	ATLANTIC OCEANSIDE MOTEL	YY-25
inundation	hotel	THE SURF CLUB	YY-25
inundation	hotel	ADAMS OCEAN FRONT MOTEL	YY-25
inundation	police	DEWEY BEACH	YY-25
inundation	hotel	DEWEY BEACH SUITES & HOTEL	YY-26
inundation	hotel	BEST WESTERN(GOLDEN LEAF)	YY-26
inundation	hotel	SEA ESTA III	YY-26
inundation	mjremp	DEWEY BEACH ENTERPRISES	YY-26
inundation	port	INDIAN RIVER RAMP	YY-32
inundation	port	INDIAN RIVER INLET MARINA	YY-33
inundation	wstall	28	YY-34
inundation	subst	CEDAR NECK(LOCATION)	YY-37
inundation	newspaper	RESORT REAL ESTATE GUIDE	YY-39
inundation	bridge	455	YY-41
inundation	government	U.S. COAST GUARD STATION	ZZ-33
inundation	bridge	050	ZZ-39
inundation	fd	BETHANY BEACH (Co. 70-Sta #1)	ZZ-39
inundation	government	DELAWARE NATIONAL GUARD	ZZ-39
inundation	government	BETHANY BEACH POST OFFICE	ZZ-39
inundation	government	BETHANY BEACH TOWN HALL	ZZ-39
inundation	police	BETHANY BEACH	ZZ-39
inundation	mjremp	C M F PAYMASTER INC.	ZZ-40
inundation	newspaper	THE WAVE NEWSPAPER	ZZ-40
inundation	school	BETHANY HOME SCHOOL	ZZ-40
inundation	bridge	453	ZZ-41
inundation	government	SOUTH BETHANY TOWN HALL	ZZ-41
inundation	police	SOUTH BETHANY BEACH	ZZ-41
inundation	newspaper	CABLE CHANNELS MAGAZ	ZZ-47
inundation	newspaper	OCEANA MAGAZINE	ZZ-47
inundation	hotel	BLUE SURF MOTEL	AAA-39
inundation	hotel	BETHANY ARMS MOTEL & APTS	AAA-39
inundation	subst	BETHANY(LOCATION)	AAA-41

Hazard	Layer	Name	ADC Grid
inundation	hotel	FENWICK TOWERS CONDOS	AAA-44
inundation	government	FENWICK ISLAND TOWN HALL	AAA-46
inundation	hotel	SANDS MOTEL & APTS.	AAA-46
inundation	hotel	ISKANDERS ISLAND INN	AAA-46
inundation	police	FENWICK ISLAND	AAA-46
inundation	fd	BETHANY BEACH SUBSTATION (Co. 70-Sta #2)	AAA-47
inundation	hotel	FENWICK SEA CHARM MOTEL & APTS	AAA-47
inundation	hotel	FENWICK ISLANDER MOTEL	AAA-47
inundation	hotel	COREL SANDS APTS.	AAA-47
inundation	hotel	ATLANTIC BUDGET INN	AAA-47

APPENDIX C

Dam Vulnerabilities

Hazard	Layer	Name	ADC Grid
dam	mjremp	SEAFORD SCHOOL DISTRICT	H-29
dam	school	SEAFORD CENTRAL ELEMENTARY SCHOOL	H-29
dam	mjremp	CAREER ASSOCIATES INC.	J-29
dam	school	SEAFORD SENIOR HIGH SCHOOL	J-29
dam	school	SEAFORD MIDDLE SCHOOL	J-29
dam	school	SUSSEX ORTHOPEDIC FCLTY & VISUALLY HCP UNIT	J-29
dam	bridge	202	K-27
dam	bridge	255	K-27
dam	bridge	161	L-37
dam	stp	12	L-37
dam	subst	LAUREL(LOCATION)	L-37
dam	school	DUNBAR (Paul Laurence) SCHOOL	L-38
dam	bridge	152	M-37
dam	bridge	329	M-37
dam	bridge	162	M-37
dam	government	LAUREL POST OFFICE	M-38
dam	bridge	251	N-30
dam	bridge	362	P-37
dam	bridge	642	Q-24
dam	bridge	643	Q-24
dam	bridge	249	R-30
dam	bridge	347	T-40
dam	bridge	909	T-8
dam	bridge	932	Y-6
dam	bridge	922	AA-9
dam	bridge	809	FF-18
dam	bridge	9000	FF-18
dam	government	MILTON POST OFFICE	FF-18
dam	government	MILTON TOWN HALL	FF-18
dam	police	MILTON	FF-18
dam	bridge	672	FF-30
dam	bridge	673	FF-30
dam	bridge	9001	GG-34
dam	bridge	527	GG-34
dam	fd	MILLSBORO VFC (Co. 83)	HH-34
dam	subst	MILLSBORO(LOCATION)	HH-34
dam	bridge	713	QQ-23

APPENDIX D

Hazardous Material Site Vulnerabilities

Hazard	Layer	Name	ADC Grid
hazmat	bridge	220	F-30
hazmat	bridge	222	F-30
hazmat	mjremp	DON LEE MARGIN CORP	G-30
hazmat	mjremp	PENCO CORPORATION	G-30
hazmat	stp	23	H-28
hazmat	school	J AND J GOOSS FAMILY HOME SCHOOL	Z-26
hazmat	mjremp	PERDUE FARMS INC.	AA-25
hazmat	subst	SUSSEX(LOCATION)	AA-25
hazmat	daycare	BAYPORT RECREATION CENTER	EE-17
hazmat	bridge	809	FF-18
hazmat	bridge	808	FF-18
hazmat	fd	MILTON VFC (Co. 85)	FF-18
hazmat	government	MILTON POST OFFICE	FF-18
hazmat	government	MILTON TOWN HALL	FF-18
hazmat	police	MILTON	FF-18
hazmat	stp	19	GG-18
hazmat	mjremp	ALLEN FAMILY FOODS	HH-23
hazmat	stp	11	HH-23
hazmat	stp	10	HH-23
hazmat	mjremp	FIRST OMNI BANK N A	HH-36
hazmat	mjremp	FIRST NATIONAL BANK OF MD	HH-36
hazmat	bridge	9012	JJ-36
hazmat	mjremp	VLASIC FOODS	JJ-36
hazmat	stp	17	JJ-36
hazmat	stp	14	KK-33
hazmat	bridge	516	KK-34
hazmat	mjremp	TOWNSENDS INC.	KK-34
hazmat	mjremp	MOUNTAIRE FARMS INC.	LL-41
hazmat	fd	FRANKFORD VFC (Co. 76)	MM-41
hazmat	government	FRANKFORD POST OFFICE	MM-41
hazmat	government	FRANKFORD TOWN HALL	MM-41
hazmat	police	FRANKFORD	MM-41
hazmat	government	SELBYVILLE POST OFFICE	MM-46
hazmat	mjremp	MOUNTAIRE FARMS	MM-46
hazmat	school	SELBYVILLE MS INTENSIVE LEARNING	MM-46
hazmat	school	SELBYVILLE MIDDLE SCHOOL	MM-46
hazmat	school	SOUTHERN DE SCHOOL OF THE ARTS	MM-46
hazmat	school	INDIAN RIVER EDUCATION COMPLEX	MM-46
hazmat	stp	26	MM-46
hazmat	government	SELBYVILLE TOWN HALL	MM-47
hazmat	police	SELBYVILLE	MM-47
hazmat	mjremp	DELMARVA TEMPORARY STAFF	WW-23
hazmat	bridge	153	XX-23

Hazard	Layer	Name	ADC Grid
hazmat	hotel	PIRATES COVE	XX-23

APPENDIX E

10/20/50 Nuclear Plant EPZ Vulnerabilities

Hazard	Layer	Name	ADC Grid	C50	S50
nuclear	bridge	937	AA-10		Y
nuclear	bridge	938	AA-10		Y
nuclear	bridge	936	AA-10		Y
nuclear	bridge	939	AA-12		Y
nuclear	bridge	922	AA-9		Y
nuclear	bridge	920	AA-9		Y
nuclear	bridge	923	AA-9		Y
nuclear	daycare	SLAUGHTER NECK ED. & COMM. CTR	DD-10		Y
nuclear	bridge	918	DD-14		Y
nuclear	bridge	9008	DD-18		Y
nuclear	tower	MILTON TOWER(LOCATION)	DD-18		Y
nuclear	bridge	816	EE-11		Y
nuclear	daycare	BAYPORT RECREATION CENTER	EE-17		Y
nuclear	bridge	164	EE-3		Y
nuclear	port	CEDAR CREEK RAMP	EE-3		Y
nuclear	bridge	815N	FF-13		Y
nuclear	bridge	815S	FF-13		Y
nuclear	school	BRITTINGHAM (H. O.) ELEMENTARY SCHOOL	FF-17		Y
nuclear	wstall	18	FF-17		Y
nuclear	bridge	809	FF-18		Y
nuclear	bridge	808	FF-18		Y
nuclear	bridge	9000	FF-18		Y
nuclear	bridge	806	FF-18		Y
nuclear	fd	MILTON VFC (Co. 85)	FF-18		Y
nuclear	government	MILTON POST OFFICE	FF-18		Y
nuclear	government	MILTON TOWN HALL	FF-18		Y
nuclear	police	MILTON	FF-18		Y
nuclear	school	MILTON MIDDLE SCHOOL	FF-18		Y
nuclear	mjremp	DRAPER CANNING CO.	FF-19		Y
nuclear	bridge	925	FF-2		Y
nuclear	bridge	924	FF-6		Y
nuclear	bridge	817	GG-11		Y
nuclear	stp	19	GG-18		Y
nuclear	fd	MEMORIAL VFC (Co. 89)	GG-5		Y
nuclear	bridge	818	HH-10		Y
nuclear	bridge	814	HH-15		Y
nuclear	daycare	EAGLE'S NEST DAY CARE	JJ-15		Y
nuclear	bridge	820	JJ-9		Y
nuclear	bridge	155N	KK-16		Y
nuclear	bridge	155S	KK-16		Y
nuclear	bridge	717	LL-17		Y
nuclear	bridge	811	MM-14		Y
nuclear	bridge	812	NN-13		Y

Hazard	Layer	Name	ADC Grid	C50	S50
nuclear	bridge	120	A-23	Y	
nuclear	bridge	122	A-23	Y	
nuclear	bridge	111	B-16	Y	Y
nuclear	bridge	212	B-37	Y	
nuclear	bridge	112	C-16	Y	Y
nuclear	bridge	308	C-39	Y	
nuclear	bridge	933N	CC-9		Y
nuclear	bridge	933S	CC-9		Y
nuclear	bridge	118	D-19	Y	Y
nuclear	bridge	221	D-30	Y	
nuclear	bridge	219	E-31	Y	
nuclear	bridge	214	E-33	Y	
nuclear	bridge	213	E-34	Y	
nuclear	bridge	310	E-41	Y	
nuclear	bridge	220	F-30	Y	
nuclear	bridge	222	F-30	Y	
nuclear	bridge	217	F-31	Y	
nuclear	port	CRAIGS POND RAMP	F-31	Y	
nuclear	bridge	215	F-32	Y	
nuclear	bridge	206	F-34	Y	
nuclear	school	CORBIN CHRISTIAN SCHOOL	G-15		Y
nuclear	bridge	230	G-24	Y	
nuclear	bridge	227	G-24	Y	
nuclear	mirea	TAYLOR(LOCATION)	G-24	Y	
nuclear	bridge	226	G-25	Y	
nuclear	bridge	225	G-25	Y	
nuclear	mjremp	PEEBLES INC.	G-30	Y	
nuclear	mjremp	DON LEE MARGIN CORP	G-30	Y	
nuclear	mjremp	PENCO CORPORATION	G-30	Y	
nuclear	school	WEST SEAFORD ELEMENTARY SCHOOL	G-30	Y	
nuclear	bridge	216	G-32	Y	
nuclear	landfill	DUPONT SEAFORD	G-32	Y	
nuclear	bridge	307	G-37	Y	
nuclear	port	TUSSOCK POND RAMP	G-39	Y	
nuclear	bridge	366	G-41	Y	
nuclear	bridge	311	G-41	Y	
nuclear	nhome	COUNTRY REST HOME	H-14		Y
nuclear	subst	GREENWOOD(LOCATION)	H-15		Y
nuclear	subst	BRIDGEVILLE(LOCATION)	H-21	Y	
nuclear	bridge	127	H-23	Y	
nuclear	bridge	9005	H-26	Y	
nuclear	bridge	224	H-26	Y	
nuclear	government	MILITARY SITE	H-28	Y	

Hazard	Layer	Name	ADC Grid	C50	S50
nuclear	stp	23	H-28	Y	
nuclear	subst	NORTH SEAFORD(LOCATION)	H-28	Y	
nuclear	bridge	257W	H-29	Y	
nuclear	bridge	257E	H-29	Y	
nuclear	mjremp	SEAFORD SCHOOL DISTRICT	H-29	Y	
nuclear	school	SEAFORD CENTRAL ELEMENTARY SCHOOL	H-29	Y	
nuclear	bridge	258	H-30	Y	
nuclear	daycare	CHILDREN'S PLACE	H-30	Y	
nuclear	mirea	SEAFORD(LOCATION)	H-30	Y	
nuclear	mjremp	EASTERN SHORE MARKETS INC.	H-30	Y	
nuclear	school	SEAFORD CHRISTIAN ACADEMY	H-30	Y	
nuclear	bridge	211	H-31	Y	
nuclear	port	SEAFORD RAMP	H-31	Y	
nuclear	stp	21	H-31	Y	
nuclear	stp	27	H-31	Y	
nuclear	government	BETHEL POST OFFICE	H-36	Y	
nuclear	bridge	163	H-37	Y	
nuclear	bridge	306	H-37	Y	
nuclear	port	PORTSVILLE MILLPOND RAMP	H-37	Y	
nuclear	mirea	KRATZ(LOCATION)	J-13		Y
nuclear	bridge	141	J-18		Y
nuclear	school	WOODBRIDGE EARLY CHILDHOOD EDUCATION CENTER	J-20		Y
nuclear	school	SUSSEX COUNTY SECONDARY ALTERNATIVE SCHOOL	J-20		Y
nuclear	bridge	231	J-25	Y	
nuclear	port	HEARNS POND RAMP	J-26	Y	
nuclear	bridge	241	J-28	Y	
nuclear	bridge	203	J-29	Y	
nuclear	daycare	SDCC&F /HEAD START CENTER	J-29	Y	
nuclear	dispatch	SEAFORD 911 CENTER	J-29	Y	
nuclear	mjremp	AMES	J-29	Y	
nuclear	mjremp	CAREER ASSOCIATES INC.	J-29	Y	
nuclear	newspaper	SUSSEX POST	J-29	Y	
nuclear	newspaper	LEADER	J-29	Y	
nuclear	nhome	SEAFORD CENTER	J-29	Y	
nuclear	police	SEAFORD	J-29	Y	
nuclear	school	SEAFORD SENIOR HIGH SCHOOL	J-29	Y	
nuclear	school	SEAFORD MIDDLE SCHOOL	J-29	Y	
nuclear	school	SUSSEX ORTHOPEDIC FCLTY & VISUALLY HCP UNIT	J-29	Y	
nuclear	bridge	242	J-30	Y	
nuclear	bridge	151	J-30	Y	
nuclear	bridge	9006	J-30	Y	
nuclear	daycare	THE LIGHTED PATHWAY DAY CARE CENTER	J-30	Y	
nuclear	daycare	SMALL WONDERS CHILD CARE CENTER	J-30	Y	

Hazard	Layer	Name	ADC Grid	C50	S50
nuclear	daycare	RIVERSIDE DAY TREATMENT	J-30	Y	
nuclear	fd	SEAFORD VFC (Co. 87)	J-30	Y	
nuclear	government	SEAFORD TOWN HALL	J-30	Y	
nuclear	government	SEAFORD POST OFFICE	J-30	Y	
nuclear	hospital	NANTICOKE MEMORIAL	J-30	Y	
nuclear	mjremp	NANTICOKE MEMORIAL	J-30	Y	
nuclear	nhome	LIFECARE AT LOFLAND PARK	J-30	Y	
nuclear	port	BLADES MARINA	J-30	Y	
nuclear	school	Douglass (Frederick) INTERMEDIATE SCHOOL	J-30	Y	
nuclear	bridge	204	J-31	Y	
nuclear	fd	BLADES VFC (Co. 71)	J-31	Y	
nuclear	government	BLADES TOWN HALL	J-31	Y	
nuclear	police	BLADES	J-31	Y	
nuclear	school	SEAFORD KINDERGARTEN	J-31	Y	
nuclear	school	CHILD CRAFT COMPANY (The)	J-32	Y	
nuclear	subst	DUPONT SEAFORD(LOCATION)	J-32	Y	
nuclear	bridge	207	J-34	Y	
nuclear	bridge	305	J-38	Y	
nuclear	bridge	107	K-15		Y
nuclear	bridge	105	K-15		Y
nuclear	government	GREENWOOD TOWN HALL	K-15		Y
nuclear	government	GREENWOOD POST OFFICE	K-15		Y
nuclear	mjremp	GREENWOOD TRUST COMPANY	K-15		Y
nuclear	police	GREENWOOD	K-15		Y
nuclear	bridge	143	K-16		Y
nuclear	bridge	144	K-16		Y
nuclear	mjremp	DELAWARE ELECTRIC COOPERATIVE	K-16		Y
nuclear	bridge	145	K-18		Y
nuclear	bridge	131	K-19		Y
nuclear	daycare	LAVERTY LANE CHILD CARE CENTER	K-19		Y
nuclear	police	STATE TROOP 5	K-19		Y
nuclear	bridge	236	K-25	Y	
nuclear	tower	SEAFORD HIGHWAY YARD(LOCATION)	K-26	Y	
nuclear	bridge	202	K-27	Y	
nuclear	bridge	255	K-27	Y	
nuclear	mjremp	WAL-MART ASSOCIATES INC.	K-28	Y	
nuclear	mjremp	ROSES	K-28	Y	
nuclear	bridge	947	K-29	Y	
nuclear	bridge	253S	K-29	Y	
nuclear	bridge	253N	K-29	Y	
nuclear	hotel	BEST WESTERN	K-29	Y	
nuclear	hotel	HOLIDAY INN	K-29	Y	
nuclear	mjremp	FOOD LION	K-29	Y	

Hazard	Layer	Name	ADC Grid	C50	S50
nuclear	bridge	254N	K-30	Y	
nuclear	bridge	254S	K-30	Y	
nuclear	bridge	243	K-30	Y	
nuclear	daycare	CHILD CRAFT COMPANY	K-30	Y	
nuclear	nhome	METHODIST MANOR HOUSE	K-30	Y	
nuclear	wstall	15	K-30	Y	
nuclear	daycare	RAINBOW DAYCARE AND PRE-SCHOOL	K-32	Y	
nuclear	airport	LAUREL AIRPORT	K-39	Y	
nuclear	bridge	102	L-13		Y
nuclear	wstall	5	L-13		Y
nuclear	bridge	108	L-15		Y
nuclear	fd	GREENWOOD VFC (Co. 78)	L-15		Y
nuclear	school	WOODBRIDGE ELEMENTARY SCHOOL	L-15		Y
nuclear	bridge	129	L-20		Y
nuclear	stp	25	L-20		Y
nuclear	school	FLEAGLE (David G.) ELEMENTARY SCHOOL	L-27	Y	
nuclear	stp	22	L-30	Y	
nuclear	tvrad	WSUX LOVE FM98	L-33	Y	
nuclear	tvrad	WJPY THE TOUCH	L-33	Y	
nuclear	bridge	301	L-36	Y	
nuclear	bridge	161	L-37	Y	
nuclear	bridge	9007	L-37	Y	
nuclear	stp	12	L-37	Y	
nuclear	subst	LAUREL(LOCATION)	L-37	Y	
nuclear	government	LAUREL TOWN HALL	L-38	Y	
nuclear	police	LAUREL	L-38	Y	
nuclear	school	DUNBAR (Paul Laurence) SCHOOL	L-38	Y	
nuclear	bridge	312	L-39	Y	
nuclear	bridge	377	L-41	Y	
nuclear	bridge	335	L-42	Y	
nuclear	bridge	9013	L-45	Y	
nuclear	nhome	CHANCELLOR CARE CENTER OF DELMAR	L-46	Y	
nuclear	subst	NELSON(LOCATION)	L-46	Y	
nuclear	daycare	LIL' RED HEN NURSERY SCHOOL	L-47	Y	
nuclear	fd	DELMAR VFC (Co. 74	L-47	Y	
nuclear	government	DELMAR POST OFFICE	L-47	Y	
nuclear	school	BEULAH LAND CHRISTIAN ACADEMY	M-12		Y
nuclear	bridge	103	M-13		Y
nuclear	school	GREENWODD MENNONITE SCHOOL	M-15		Y
nuclear	bridge	152	M-37	Y	
nuclear	bridge	329	M-37	Y	
nuclear	bridge	162	M-37	Y	
nuclear	school	NORTH LAUREL ES INTENSIVE LEARNING CENTER	M-37	Y	

Hazard	Layer	Name	ADC Grid	C50	S50
nuclear	school	NORTH LAUREL ELEMENTARY SCHOOL	M-37	Y	
nuclear	bridge	313	M-38	Y	
nuclear	bridge	320	M-38	Y	
nuclear	bridge	330	M-38	Y	
nuclear	fd	LAUREL VFC (Co. 81)	M-38	Y	
nuclear	government	LAUREL POST OFFICE	M-38	Y	
nuclear	mjremp	LAUREL SCHOOL DISTRICT	M-38	Y	
nuclear	school	LAUREL CENTRAL MS INTENSIVE LEARNING CENTER	M-38	Y	
nuclear	school	LAUREL INTERMEDIATE SCHOOL	M-38	Y	
nuclear	school	LAUREL IS INTENSIVE LEARNING CENTER	M-38	Y	
nuclear	school	LAUREL CENTRAL MIDDLE SCHOOL	M-38	Y	
nuclear	wstall	13	M-38	Y	
nuclear	school	LAUREL SENIOR HIGH SCHOOL	M-39	Y	
nuclear	school	LAUREL HS INTENSIVE LEARNING CENTER	M-39	Y	
nuclear	mirea	SHORT(LOCATION)	M-40	Y	
nuclear	bridge	302	M-42	Y	
nuclear	bridge	336	M-43	Y	
nuclear	mjremp	DELMAR SCHOOL DISTRICT	M-47	Y	
nuclear	school	DELMAR JUNIOR-SENIOR HIGH SCHOOL	M-47	Y	
nuclear	bridge	140	N-18		Y
nuclear	bridge	149	N-19		Y
nuclear	bridge	130	N-20		Y
nuclear	bridge	365S	N-38	Y	
nuclear	bridge	365N	N-38	Y	
nuclear	daycare	BUILDING BLOCKS DAY CARE CENTER, INC.	N-47	Y	
nuclear	bridge	362	P-37	Y	
nuclear	bridge	314	P-38	Y	
nuclear	bridge	101	Q-12		Y
nuclear	bridge	106	Q-14		Y
nuclear	bridge	139	Q-18		Y
nuclear	bridge	121	R-17		Y
nuclear	bridge	133	R-18		Y
nuclear	bridge	909	T-8		Y
nuclear	port	ABBOTTS POND RAMP	T-8		Y
nuclear	bridge	911	T-9		Y
nuclear	bridge	627	U-18		Y
nuclear	bridge	630	U-20		Y
nuclear	bridge	634	U-20		Y
nuclear	bridge	908	U-6		Y
nuclear	bridge	907	U-6		Y
nuclear	bridge	625	V-15		Y
nuclear	bridge	626	V-17		Y
nuclear	bridge	628	V-19		Y

Hazard	Layer	Name	ADC Grid	C50	S50
nuclear	bridge	629	V-19		Y
nuclear	bridge	631	V-20		Y
nuclear	school	MILFORD FIRST BAPTIST CHRISTIAN SCHOOL	V-6		Y
nuclear	daycare	JENNIE WREN DAY CARE	W-11		Y
nuclear	bridge	902	W-12		Y
nuclear	bridge	623	W-16		Y
nuclear	bridge	617	W-20		Y
nuclear	bridge	9002	W-6		Y
nuclear	hospital	MILFORD MEMORIAL	W-6		Y
nuclear	mjremp	BAYHEALTH MEDICAL CENTER	W-6		Y
nuclear	mjremp	DENTSPLY INTERNATIONAL	W-6		Y
nuclear	mjremp	MILFORD SCHOOL DISTRICT	W-6		Y
nuclear	nhome	MILFORD MEMORIAL HOSPITAL TRANSITIONAL CARE	W-6		Y
nuclear	nhome	MILFORD CENTER	W-6		Y
nuclear	school	MILFORD MIDDLE SCHOOL	W-6		Y
nuclear	daycare	AS WE GROW CHILD CARE AND DEVELOPMENT CENTER	W-7		Y
nuclear	school	DUPONT ACADEMY	W-7		Y
nuclear	bridge	903	W-9		Y
nuclear	bridge	9014	X-11		Y
nuclear	fd	ELLENDALE VFC (Co. 75)	X-15		Y
nuclear	government	ELLENDALE POST OFFICE	X-15		Y
nuclear	government	ELLENDALE TOWN HALL	X-15		Y
nuclear	police	ELLENDALE	X-15		Y
nuclear	bridge	9015	X-20		Y
nuclear	government	MILFORD POST OFFICE	X-5		Y
nuclear	stp	30	X-5		Y
nuclear	government	MILFORD CITY HALL	X-6		Y
nuclear	mjremp	IC ISAACS & CO LP	X-6		Y
nuclear	school	RAINBOW VALLEY SCHOOL	X-6		Y
nuclear	bridge	935	X-7		Y
nuclear	bridge	930	X-7		Y
nuclear	daycare	THE BREAKFAST CLUB	X-7		Y
nuclear	daycare	ALL ABOUT ME CHILD CARE CENTER	X-7		Y
nuclear	government	LINCOLN POST OFFICE	X-9		Y
nuclear	school	MORRIS (Evelyn I.) EARLY CHILDHOOD CENTER	X-9		Y
nuclear	bridge	941	Y-11		Y
nuclear	bridge	915	Y-15		Y
nuclear	bridge	927	Y-5		Y
nuclear	mjremp	SEA WATCH INTERNATIONAL	Y-5		Y
nuclear	stp	28	Y-5		Y
nuclear	stp	29	Y-5		Y
nuclear	bridge	932	Y-6		Y
nuclear	daycare	DROP-A-TOT II	Y-6		Y

Hazard	Layer	Name	ADC Grid	C50	S50
nuclear	school	ROSS (Lulu M.) ELEMENTARY SCHOOL	Y-6		Y
nuclear	mirea	MILFORD(LOCATION)	Y-7		Y
nuclear	wstall	41	Y-7		Y
nuclear	school	CHRISTAIN TABERNACLE ACADEMY	Y-9		Y
nuclear	bridge	940	Z-10		Y
nuclear	bridge	003N	Z-5		Y
nuclear	bridge	003S	Z-5		Y
nuclear	bridge	002	Z-5		Y
nuclear	bridge	001	Z-7		Y
nuclear	daycare	COUNTRY KIDS DAY CARE CENTER, INC.	Z-7		Y
nuclear	subst	MILFORD(LOCATION)	Z-8		Y