Section 4: Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards.*

This section is broken down into the following sections:

- Assessing Vulnerability (Estimating Potential Losses, Essential Facilities)
- Analyzing Land Use and Development Trends

Assessing Vulnerability

The potential for loss, or the degree of vulnerability, was measured using four different factors: amount of county land area susceptible to a 100-year flood, the number of buildings potentially damaged, the amount of direct economic losses related to those buildings and a projected 100-year risk to repetitive loss areas. These four measures of loss help give a more complete picture of the complex issue of vulnerability to floods.

This subsection of the Plan provides estimates of future flood loss to existing infrastructure. Each of the loss calculations is based on best available data, but must be considered estimates because highly detailed engineering analysis were not performed as part of this planning process.

Regarding the physical nature of the flood zone, over 67,670 acres of the total county area in Mercer, Hunterdon Warren and Sussex Counties fall within the 100-year flood zone. In other words, roughly 7% of that land area is vulnerable to a 100-year flood event. These flood zone size estimates were completed using the Q3 digital flood zone maps (see Section 3).

Estimating Potential Losses

Requirement §201.6(c)(2)(ii): *The plan should describe vulnerability in terms of an estimate of the potential dollar losses and the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.*

The loss estimates provided in this section were developed using available data and the methods applied have resulted in an approximation of risk. These estimates should be used to understand relative risk from hazards and potential losses. However, uncertainties are inherent in any loss estimation method, arising in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis (such as abbreviated inventories, demographics or economic parameters).

HAZUS-MH® (FEMA's loss estimation software) applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide damage and loss estimates; these methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards and locations. A conceptual schematic of HAZUS can be seen in Figure 4-1.

As described in Section 2, flood data from the HAZUS-MH software package was supplemented with local data for essential facilities and hazard areas. Inventory data were superimposed over the hazard areas to enable GIS queries to estimate the quantity of assets at risk (population, structures, essential facilities, etc.)

One measure generated by HAZUS-MH is to examine the level of vulnerability using the number of buildings potentially damaged by a 100-year flood. The results of the modeling effort reveal that the county with the most buildings in danger of experiencing a 100-year flood is Mercer (4,941). Hunterdon, Warren and Sussex resulted in damage estimated of 1,904, 1,505 and 1,895 buildings, respectively. The majority of damage to buildings in the four counties would be to residential buildings. Approximately 97% of all the potential damage from the 100-year flood comes from residential buildings.

Another measure generated by HAZUS-MH is to examine the level of vulnerability from flooding using the amount of direct economic losses related to buildings. This measure considers monetary losses from the buildings including structural damage, contents damage, and inventory loss. The result of the HAZUS-MH model for Mercer, Hunterdon, Sussex and Warren shows that $180 million is vulnerable to loss from a 100-year flood. Individually, Mercer - $77M, Hunterdon - $39M, Warren - $23M and Sussex - $41M. Tables 4-1 through 4-4 provide HAZUS generated estimates of general building stock and economic loss by county.

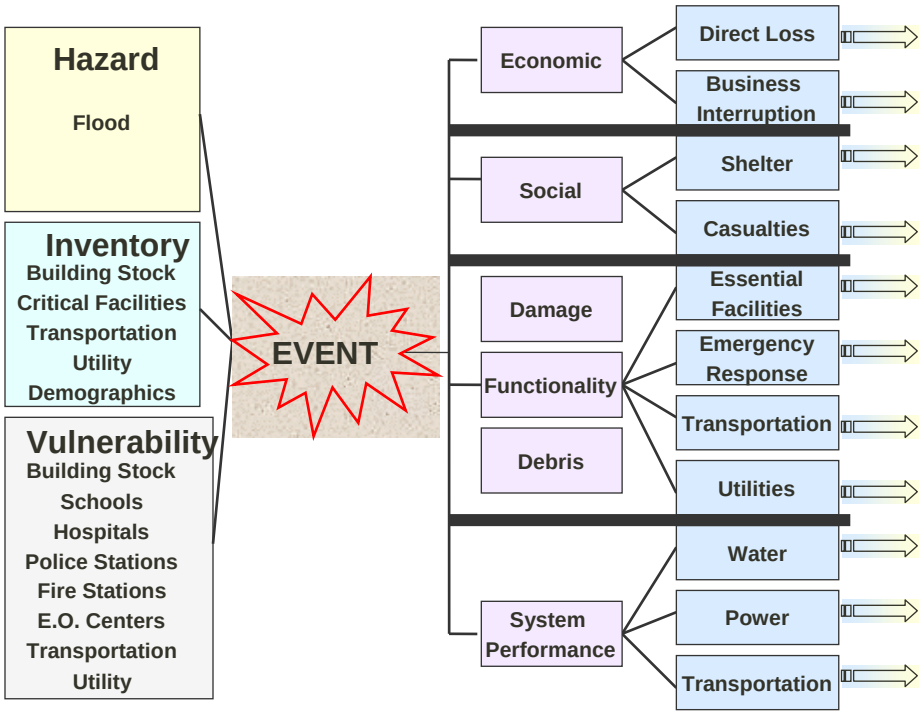

Figure 4-1 Conceptual Schematic of a Vulnerability Assessment (Source, HAZUS-MH, FEMA)

Table 4-1: Mercer County General Building Stock and Economic Loss

General Building Stock in the Floodplain

Building Exposure in the Floodplain (thousands of dollars)

Return Period:	County Name	Population	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education
100 year	Mercer	18400	$1,146,277	$347,232	$46,460	$2,258	$19,552	$4,992	$17,240
500 year	Mercer	23950	$1,466,680	$443,823	$59,076	$2,706	$25,104	$13,535	$20,195
Contents Exposure in the Floodplain (thousands of dollars)									
100 year	Mercer	18400	$573,468	$353,774	$66,160	$2,258	$19,552	$5,215	$21,378
500 year	Mercer	23950	$733,752	$452,449	$84,437	$2,706	$25,104	$13,786	$24,525
Total Exposure in the Floodplain (thousands of dollars)									
100 year	Mercer	18400	$1,719,745	$701,005	$112,620	$4,516	$39,104	$10,206	$38,617
500 year	Mercer	23950	$2,200,432	$896,271	$143,512	$5,413	$50,207	$27,321	$44,720
Building Count (# of buildings) in the floodplain									
100 year	Mercer		4786	129	12	1	7	4	2
500 year	Mercer		6004	166	16	1	8	11	2

Economic Loss (General Building Stock)

Building Loss (thousands of dollars)

Return Period:	County Name	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education
100 year	Mercer	$50,028	$19,169	$1,450	$222	$1,877	$55	$3,023
500 year	Mercer	$71,626	$51,142	$3,098	$255	$4,011	$177	$3,734
Content Loss (thousands of dollars)								
100 year	Mercer	$27,409	$22,442	$2,718	$248	$2,451	$80	$4,304
500 year	Mercer	$39,304	$59,190	$6,634	$286	$5,327	$241	$5,356
Total Loss (thousands of dollars)								
100 year	Mercer	$77,437	$41,611	$4,168	$470	$4,327	$134	$7,326
500 year	Mercer	$110,931	$110,331	$9,731	$540	$9,338	$418	$9,090

Table 4-2: Hunterdon County General Building Stock and Economic Loss

General Building Stock in the Floodplain

Building Exposure in the Floodplain (thousands of dollars)

Return Period:	County Name	Population	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education
100 year	Hunterdon	5400	404,486.30	108,621.90	39,892.90	2,334.40	8,600.10	3,386.50	3,496.30
500 year	Hunterdon	7020	515,785.60	149,951.40	46,905.20	2,879.50	12,819.40	4,202.90	4,359.20
Contents Exposure in the Floodplain (thousands of dollars)									
100 year	Hunterdon	5400	202,435.20	111,954.10	57,492.00	2,334.40	8,600.10	3,983.10	3,496.30
500 year	Hunterdon	7020	258,143.60	154,545.50	67,375.80	2,879.50	12,819.40	4,832.70	4,359.20
Total Exposure in the Floodplain (thousands of dollars)									
100 year	Hunterdon	5400	606,921.50	220,576.00	97,384.90	4,668.80	17,200.20	7,369.60	6,992.60
500 year	Hunterdon	7020	773,929.20	304,496.90	114,281.00	5,759.00	25,638.80	9,035.60	8,718.40
Building Count (# of buildings) in the floodplain									
100 year	Hunterdon		1843	43	10	1	4	3	0
500 year	Hunterdon		2370	58	11	1	5	4	0

Economic Loss (General Building Stock)

Building Loss (thousands of dollars)

Return Period:	County Name	Population	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education
100 year	Hunterdon	25,711.90	12,222.10	3,425.30	199.2	594	269.2	317.2	
500 year	Hunterdon	47,279.70	26,759.20	5,171.70	272.4	1,670.00	474.8	592.3	
Content Loss (thousands of dollars)									
100 year	Hunterdon	13,734.10	15,112.00	7,364.90	227.5	764.00	679.40	391.7	
500 year	Hunterdon	25,358.50	32,570.00	10,773.10	312.1	2,178.30	1,020.60	734.8	
Total Loss (thousands of dollars)									
100 year	Hunterdon	39,446.00	27,334.10	10,790.20	426.7	1,358.00	948.6	708.9	
500 year	Hunterdon	72,638.20	59,329.20	15,944.80	584.5	3,848.30	1,495.40	1,327.10	

Table 4-3: Warren County General Building Stock and Economic Loss

General Building Stock in the Floodplain

Building Exposure in the Floodplain (thousands of dollars)

Return Period:	County Name	Population	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education
100 year	Warren	5010	296,444.90	57,166.70	5,443.10	2,246.60	3,589.60	435.10	3,282.90
500 year	Warren	6600	390,451.60	84,215.10	6,657.10	2,586.90	4,873.70	1,040.60	4,503.10
Contents Exposure in the Floodplain (thousands of dollars)									
100 year	Warren	5010	148,386.10	60,223.30	6,958.80	2,246.60	3,589.60	584.80	3,411.30
500 year	Warren	6600	195,454.90	88,467.60	8,589.10	2,586.90	4,873.70	1,190.30	4,631.60
Total Exposure in the Floodplain (thousands of dollars)									
100 year	Warren	5010	444,831.00	117,390.00	12,401.90	4,493.20	7,179.20	1,019.90	6,694.20
500 year	Warren	6600	585,906.50	172,682.70	15,246.20	5,173.80	9,747.40	2,230.90	9,134.70
Building Count (# of buildings) in the floodplain									
100 year	Warren		1476	22	2	1	2	1	1
500 year	Warren		1966	32	2	1	2	1	1

Economic Loss (General Building Stock)

Building Loss (thousands of dollars)

Return Period:	County Name	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education
100 year	Warren	15,002.40	3,731.70	293.10	271.4	361.00	11.5	231.40
500 year	Warren	26,387.70	7,276.40	475.50	421.3	849.70	32.4	510.00
Content Loss (thousands of dollars)								
100 year	Warren	7,918.80	4,437.60	401.50	313.2	454.00	22.70	281.40
500 year	Warren	14,013.30	8,822.40	693.70	481.8	1,021.20	54.40	631.40
Total Loss (thousands of dollars)								
100 year	Warren	22,921.20	8,169.30	694.60	584.6	815.00	34.2	512.80
500 year	Warren	40,401.00	16,098.80	1,169.20	903.1	1,870.90	86.80	1,141.40

Table 4-4: Sussex County General Building Stock and Economic Loss

General Building Stock in the Floodplain

Building Exposure in the Floodplain (thousands of dollars)

Return Period:	County Name	Population	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education
100 year	Sussex	5390	360,731.10	54,963.80	9,133.70	1,721.30	4,703.10	2,016.70	10,150.70
500 year	Sussex	5890	388,108.20	62,942.50	11,676.40	1,903.80	5,623.80	2,221.00	15,281.50
Contents Exposure in the Floodplain (thousands of dollars)									
100 year	Sussex	5390	180,473.40	57,871.30	11,991.50	1,721.30	4,703.10	2,249.00	13,415.30
500 year	Sussex	5890	194,172.50	66,160.80	15,670.30	1,903.80	5,623.80	2,460.30	21,033.40
Total Exposure in the Floodplain (thousands of dollars)									
100 year	Sussex	5390	541,204.50	112,835.10	21,125.20	3,442.60	9,406.20	4,265.70	23,566.00
500 year	Sussex	5890	582,280.70	129,103.30	27,346.70	3,807.60	11,247.60	4,681.30	36,314.90
Building Count (# of buildings) in the floodplain									
100 year	Sussex		1862	25	2	1	2	1	2
500 year	Sussex		2009	28	3	1	2	1	2

Economic Loss (General Building Stock)

Building Loss (thousands of dollars)

Return Period:	County Name	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education
100 year	Sussex	26,596.20	9,014.40	769.60	226.4	1,024.60	205.8	328.10
500 year	Sussex	30,323.20	10,580.20	945.10	305	1,237.50	260.2	485.00
Content Loss (thousands of dollars)								
100 year	Sussex	14,154.60	11,563.10	1,207.10	247.5	1,298.00	318.90	398.40
500 year	Sussex	16,126.70	13,470.30	1,491.50	334.1	1,568.90	405.90	598.90
Total Loss (thousands of dollars)								
100 year	Sussex	40,750.80	20,577.50	1,976.70	473.9	2,322.60	524.7	726.50
500 year	Sussex	46,449.90	24,050.50	2,436.60	639.1	2,806.40	666.10	1,083.90

Flood Risk - Repetitive Loss Properties

The fourth risk assessment method is based on an analysis of National Flood Insurance Program (NFIP) data on repetitive flood loss properties. The NFIP defines repetitive loss properties as those that have submitted at least two (2) insurance claims of more than $1,000 in a ten-year period. Table 4-5 provides a summary of residential repetitive loss claims for building and contents damages by municipality. Note that these figures are as of January 31, 2008.

Residential flood risk is calculated by a simple methodology that uses the FEMA default present-value coefficients from the benefit-cost analysis software modules. To perform this calculation, the repetitive loss data was reviewed to determine an approximate period over which the claims occurred. There is not an exact method of doing this, because there are numerous properties in the database, and insurance policies come into force at different times, and are cancelled and reinstated periodically; these variables are not part of the query output. The majority of the flood claims range from 1996 through the present, a period of about 11 years with most of the flood claims occurring in 2004, 2005 and 2006.

The results of this analysis reveal that Harmony Township, Warren County has the highest projected 100-year flood risk. As shown in Table 4-5, Harmony Township has had 205 claims for 66 properties in the 11-year period, for an average number of claims per year of 18.6. Based on a 100-year horizon and a present value coefficient of 14.27 (the coefficient for 100 years using the mandatory OMB discount rate of 7.0 percent), the projected flood risk over 100 years is $10.3 million.

Following Harmony Township is Trenton, Mercer County with a projected 100-year flood risk of $6.9M, Kingwood Township, Hunterdon County with a projected 100-year flood risk of $4.9M, Lambertville, Hunterdon County with a projected 100-year flood risk of $4.3M, and Knowlton, Warren County with a projected 100-year flood risk of $4.0M. Table 4-6 presents each municipality's vulnerability to flooding based on the repetitive risk analysis and the data presented by each municipality in this report. A raking of High was given to those municipalities with a projected 100-year flood risk of over $1M.

It must be understood that this analysis is based on repetitive loss properties, which requires individuals to have a flood insurance policy. This projection is simply an estimate of potential damages. Many factors including the ability of individuals to cancel flood insurance policies, and future variables, including the weather exist. This projection is simply an estimate of potential damages. Nevertheless, it offers a useful metric that can be used in assessing the potential cost effectiveness of mitigation actions.

Table 4-5: Projected 100-Year Flood Risk in Repetitive Loss Areas

Municipality	County	Number of RLPs	Total Value of Claims	Total Number of Claims	Avg Claims/ year	Average value of claims per year	Projected risk, 100-year horizon
TRENTON CITY	MERCER	155	$5,300,600	433	39.4	$481,873	$6,876,323
EWING TWP	MERCER	22	$483,969	60	5.5	$43,997	$627,839
HOPEWELL TWP	MERCER	6	$410,244	18	1.6	$37,295	$532,199
LAWRENCE TWP	MERCER	4	$241,634	8	0.7	$21,967	$313,466
HAMILTON TWP	MERCER	5	$75,396	10	0.9	$6,854	$97,809
KINGWOOD TWP	HUNTERDON	24	$3,779,650	76	6.9	$343,605	$4,903,237
LAMBERTVILLE CITY	HUNTERDON	64	$3,323,384	172	15.6	$302,126	$4,311,336
STOCKTON BORO	HUNTERDON	32	$1,888,816	68	6.2	$171,711	$2,450,309
FRENCHTOWN BORO	HUNTERDON	20	$1,268,951	52	4.7	$115,359	$1,646,175
DELAWARE TWP	HUNTERDON	6	$425,271	16	1.5	$38,661	$551,693
RARITAN TWP	HUNTERDON	3	$112,425	7	0.6	$10,220	$145,846
WEST AMWELL TWP	HUNTERDON	2	$41,049	5	0.5	$3,732	$53,252
LEBANON TWP	HUNTERDON	1	$7,010	2	0.2	$637	$9,094
HARMONY TWP	WARREN	66	$7,905,076	205	18.6	$718,643	$10,255,039
KNOWLTON TWP	WARREN	32	$3,058,188	85	7.7	$278,017	$3,967,303
POHATCONG TWP	WARREN	27	$2,389,689	74	6.7	$217,244	$3,100,079
BELVIDERE TOWN	WARREN	36	$1,797,571	93	8.5	$163,416	$2,331,939
PHILLIPSBURG TOWN	WARREN	12	$1,255,298	34	3.1	$114,118	$1,628,464
BLAIRSTOWN TWP	WARREN	11	$928,624	26	2.4	$84,420	$1,204,678
LOPATCONG TWP	WARREN	2	$132,815	5	0.5	$12,074	$172,297
WHITE TWP	WARREN	2	$60,031	6	0.5	$5,457	$77,877
HACKETTSTOWN	WARREN	1	$55,423	4	0.4	$5,038	$71,899
FRANKLIN TWP	WARREN	1	$7,416	2	0.2	$674	$9,620
SANDYSTON TWP	SUSSEX	1	$133,492	2	0.2	$12,136	$173,175
MONTAGUE TWP	SUSSEX	2	$127,635	5	0.5	$11,603	$165,577
FRANKFORD TWP	SUSSEX	1	$13,371	2	0.2	$1,216	$17,345

Table 4-6. Summary of Flood Vulnerability by Jurisdiction

MERCER	
EWING TWP	Medium
HAMILTON TWP	Medium
HOPEWELL TWP	Medium
LAWRENCE TWP	Medium
PENNINGTON BOROUGH	Low
TRENTON CITY	High
HUNTERDON	
DELAWARE TWP	Medium
EAST AMWELL TWP	Low
FRANKLIN TWP	Low
FRENCHTOWN BOROUGH	High
HAMPTON BOROUGH	Low
KINGWOOD TWP	High
LAMBERTVILLE CITY	High
LEBANON TWP	Low
MILFORD BOROUGH	Low
RARITAN TWP	Medium
STOCKTON BOROUGH	High
WEST AMWELL TWP	Low

WARREN	
BELVIDERE TWP	High
BLAIRSTOWN TWP	High
FRANKLIN TWP	Low
FRELINGHUYSEN TWP	Low
HACKETTSTOWN TOWN	Low
HARDWICK TWP	Low
HARMONY TWP	High
INDEPENDENCE TWP	Low
KNOWLTON TWP	High
LOPATCONG TWP	Medium
MANSFIELD TWP	Low
OXFORD TWP	Low
PHILLIPSBURG TOWN	High
POHATCONG TWP	High
WHITE TWP	Medium
SUSSEX	
ANDOVER BOROUGH	Low
BRANCHVILLE	Low
BYRAM TWP	Low
FRANKFORD TWP	Low
FREDON TWP	Low
MONTAGUE TWP	Medium
NEWTON TOWN	Low
SANDYSTON TWP	Low
SPARTA TWP	Low
STILLWATER TWP	Low

Economic Impacts of Flooding

Economic impacts of flooding affect households, businesses and communities. The losses to households include personal items, household goods, vehicles, homes, and in some cases, lost wages or even lost jobs. Local businesses experience lost inventory, lost sales, and lost productivity and profits. Even firms not directly affected by flooding might lose sales if they were suppliers of goods and services to affected businesses or households. All aspects of public service delivery are affected. In some communities, wastewater and water facilities are compromised and must be restored. Affected municipalities need to repair roads and bridges, public lighting, public parks, and public buildings.

The community fiscal effects of infrastructure losses depend primarily on the amount of federal and state disaster assistance they obtain. Federal and state disaster assistance programs take the form of direct payments, grants, and no-interest or low-interest loans to individuals, businesses and communities. Under the Public Assistance Grant Program, FEMA awards grants to assist state and local governments and certain private nonprofit organizations with the response to and recovery from disasters. The program provides funding for debris removal, implementation of emergency protective measures and permanent restoration of infrastructure. The Individuals and Households Program can assist those affected flooding by providing temporary help with alternative housing and/or financial assistance with other disaster-related needs. Individual assistance can also be in the form of low-interest disaster loans from the U.S. Small Business Administration for homeowners, renters, businesses of all sizes, and non-profit organizations. Future studies may be able to begin to evaluate the economic impacts of past flood events to municipalities by tracking and comparing awarded Public Assistance, Individual Assistance and Small Business Loans by municipality.

In considering economic impacts of flooding, it would be remiss not to mention the impact to a community's tax base. Local property tax revenues decline if properties remain vacant, property values decline or affected properties are mitigated through acquisition.

Vulnerable Essential Facilities

For the purposes of this risk assessment, the label "essential facility" may refer to any of the following: hospitals and other medical facilities, police and fire stations, emergency operations centers, government and public buildings, water treatment facilities and institutions with vulnerable populations such as colleges, schools, hospitals and nursing homes.

Through the planning process of this Flood Mitigation Plan, the following essential facilities were found to be vulnerable to flooding. For many of these facilities, mitigation actions targeting the vulnerability of these facilities are included in each respective municipality's mitigation action plan.

Mercer

Trenton: Trenton Water Filtration Plant
Ewing: Ewing Sewage Pump Station, Villa Victoria Academy
Hopewell: Mercer County Correction Center

Hunterdon
Frenchtown: Frenchtown Sewer Plant
Stockton: Stockton Sewer Pump Station, Stockton Fire Department, Stockton Borough Hall

Warren
Phillipsburg: Phillipsburg WWTP, Lift Station

Sussex
Fredon Civic Center

Analyzing Land Use and Development Trends

Although this plan focuses on evaluating the vulnerability flooding to the current built environment, it is worthwhile to briefly discuss the importance of land use planning, zoning and sound development in order to limit the vulnerability to any future development. Planning tools such as a Natural Resource Inventory, zoning ordinance and Master Plan, environmental resource protection ordinances, and compact development patterns are all important tools for sustainable local land use planning. Communities can set polices or goals in their Master Plan that articulate how their community plans to manage/minimize the impacts of flooding. Municipalities can also enable ordinances to help mitigate both existing and potential impacts of flooding (e.g. Land Use/Zoning, Stream Corridor or other Buffer Ordinance, Woodland Conservation, Steep Slopes, Stormwater Management).

A build-out analysis can be used as a tool to predict what a community will look like in the future should development based on existing zoning, master plan, and implementation measures be completed at their full potential. New Jersey's state agencies employ multiple build-out analysis methodologies for varying purposes. The Department of Environmental Protection identifies build-out methodologies in its regulation of Water Quality Management Plans, including Wastewater Management and Stormwater planning. The Office of Smart Growth also utilizes a build-out analysis to help guide municipalities toward a community-supported vision. At either a community level or during a future study, this type of analysis may prove useful in defining the vulnerability of future development and buildings to flooding. In turn, such an analysis may encourage municipalities to strengthen their current land use and zoning ordinances.

In addition to vulnerability of the built environment to flooding, development can negatively impact flooding conditions downstream. Impervious surfaces are mainly constructed features such as rooftops, sidewalks, roads and parking lots covered by impenetrable materials such as asphalt, concrete, brick and stone. These materials repel water and act as a local barrier to infiltration which may affect groundwater recharge. Soils compacted by development and agricultural practices are also highly impervious. An increase in impervious surfaces decreases the amount of land through which precipitation can recharge groundwater aquifers. Water that cannot infiltrate into the ground increases the amount of overland flow, with the potential for an increase in soil erosion and flooding.

Impervious surface is expressed as a percentage of the total land area. In rural areas, the impervious surface may be only one or two percent, but increases to about 10% in low-density

developed areas to over 50% in higher-density communities. In industrial and commercial areas coverage can be a high as 70% and in regional shopping centers and dense downtown areas it is over 90%.

Some municipalities regulate and track of the amount of impervious surface in their communities, others do not. As a means to help municipalities identify the amount of impervious cover change in their municipalities due to development practices, a simple analysis of impervious surface change was performed for municipalities in Mercer, Hunterdon, Warren and Sussex. The results of this analysis are available in Figure 4.2. The data source for this analysis was the "NJDEP 2002 Land Use/Land Cover (LU/LC)". This data set includes impervious surface coverage information for both 1995 and 2002. The results of the analysis generate a comparison of impervious surface change, in terms of percentages, for the time period from 1995 to 2002.

As another means of identifying increased development by municipality, Figure 4.3 displays population change by municipality. This map displays population change in terms of percentage, for the time period from 1990 to 2000, based on data from the U.S. Census.

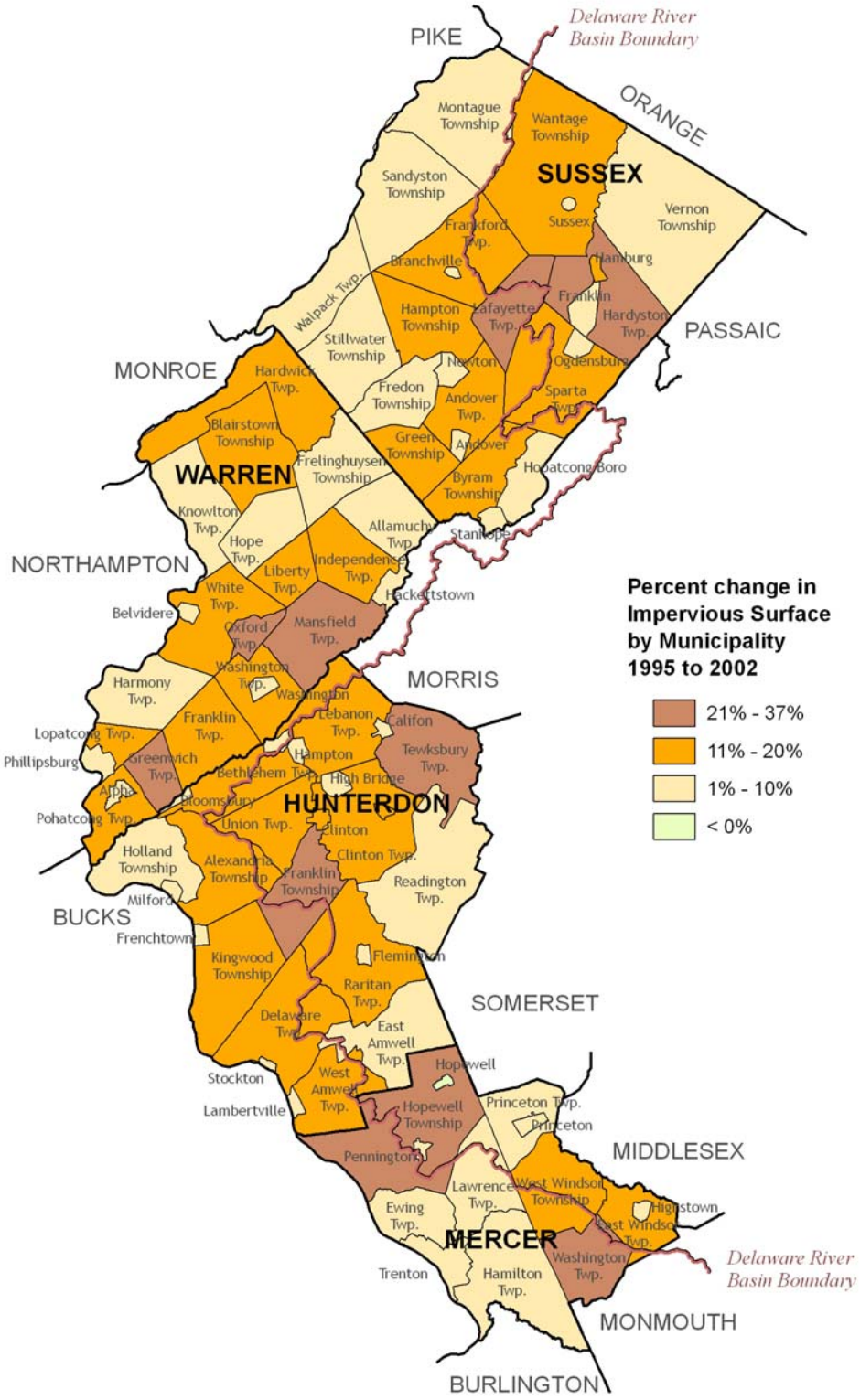

Figure 4-2: Percent Change in Impervious Surface

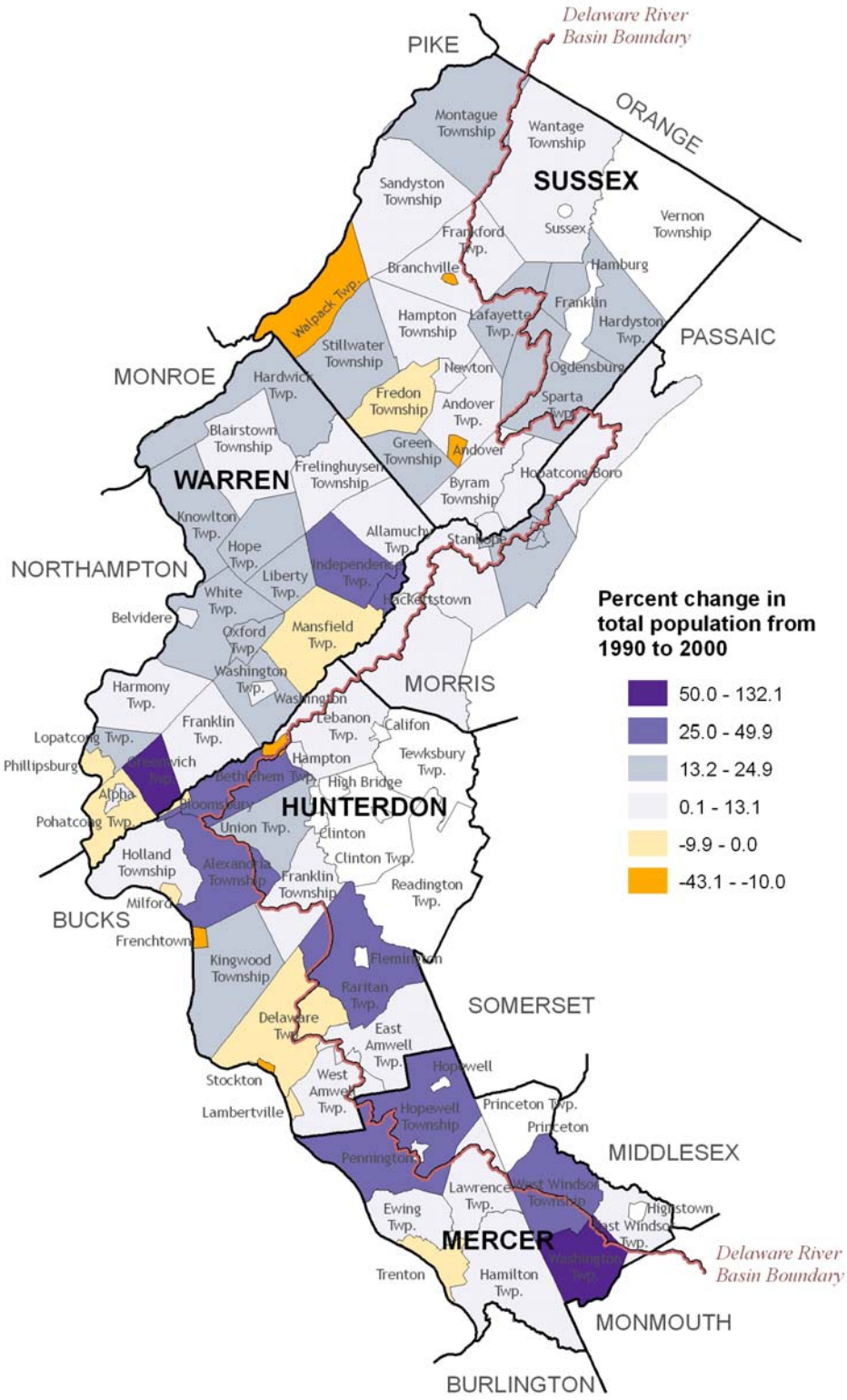

Figure 4-3: Percent Population Change