Bucks County 2016 Hazard Mitigation Plan Update

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with support from PEMA

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Bucks County Hazard Mitigation Plan 2016

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Executive Summary

Background

Hazard mitigation planning helps create safer, more sustainable, and more resilient communities. In 2005, Bucks County recognized the need for a focused hazard mitigation planning effort to identify the areas of risk and vulnerability in their municipalities, and how they could mitigate against those risks and vulnerabilities. The Bucks County Hazard Mitigation Planning Committee (HMPC) led the planning effort to develop a Bucks County Hazard Mitigation Plan (HMP). In 2011, the Pennsylvania Emergency Management Agency (PEMA) contracted the services of Michael Baker International to assist Bucks County in revising and updating its HMP in accordance with requirements set forth by the Disaster Mitigation Act of 2000.

In 2015, PEMA again contracted the services of Michael Baker International to work with the Bucks County HMPC to update the HMP in accordance with the Disaster Mitigation Act of 2000 to ensure all communities in Bucks County are more aware of risks, that they build on the work they have accomplished to reduce losses, and that they are able to bounce back quickly from disasters. Additionally, the 2016 update planning process looks at the identifying historic properties in Bucks County that are vulnerable to the risks identified in the HMP, and identifying ways to mitigate these properties against these hazards.

The product of the plan update is the Bucks County 2016 Hazard Mitigation Plan Update. This document represents the work of citizens, elected and appointed government officials, institutional leaders, and volunteer and non-profit groups to save lives, protect community assets, and preserve the economic viability of the community.

Planning Process

The planning process included three in-person meetings to review the 2011 HMP, identify changing risks, vulnerabilities, and capabilities, and identify mitigation strategies where they achieved success in the past. All municipalities, as well as federal and state governmental entities, non-governmental entities, and members of the public were invited to these meetings and given the chance to review the plan and participate in the planning process. Input from these stakeholders was needed not only to provide valuable content to the plan, but also to ensure success in implementing mitigation actions and projects designed to reduce vulnerability to hazard events. Details about the planning process, the planning meetings, and the participants is included in Section 3.

Hazard Identification and Risk Assessment

The HMPC identified the hazards that impacted Bucks County, and developed hazard profiles in order to the characteristics of each hazard as they apply to Bucks County as well as the areas of Bucks County that are most vulnerable to these hazards. The HMPC reviewed the 18 hazards identified in the 2011 HMP, and after determining that these are still relevant to Bucks County, included three additional hazards: Pandemic, Radon, and Terrorism. Details about the process of updating the hazards and the profiles about the risks of these hazards are included in Sections 4.1, 4.2, and 4.3. Additionally, the HMPC ranked the hazards using a standard risk assessment methodology, which is included in Section 4.4. The following table includes the hazards, ranked by low, moderate, and high, that are profiled in this plan.

Hazards in 2016 Bucks County HMP		
HIGH RANKED HAZARDS	MODERATE RANKED HAZARDS	LOW RANKED HAZARDS
Flood, Flash Flood, Ice Jam;	Pandemic	Structure Collapse (Infrastructure)
Winter Storm	Transportation Accidents	Dam Failure
Environmental Hazards	Urban Fire and Explosion	Earthquake
Utility Interruption	Drought	Landslide
Hurricane, Tropical Storm, Nor'easter	Extreme Temperature	Hailstorm
	Terrorism	Subsidence, Sinkhole
	Wildfire	
	Lightning Strike	
	Radon	
	Tornado, Wind Storm	

The HMPC determined vulnerability in Bucks County by looking at the potential loss estimates based on historic losses and predictive modeling. This information, including full outcomes of an enhanced HAZUS modeling analysis, is included in Section 4.4. Additionally, Section 4.4 includes information about how vulnerability will be affected by future development, as well as how the historic properties in Bucks County add to the vulnerability of the communities.

Capability Assessment

A capability assessment was completed to develop an inventory of existing planning and regulatory tools available throughout the County which have been and may be used to implement proposed mitigation actions, and to analyze the capacity to which those tools are used effectively. This capability assessment, included in Section 5, builds on the assessment in the 2011 HMP by defining in more detail how the 2016 HMP integrates with the identified planning tools and identifying opportunities for future integration.

Mitigation Strategy

The Mitigation Strategy was updated by first reviewing the mitigation successes that Bucks County experienced between 2011 and 2016. This helped the HMPC determine areas where the mitigation goals, objectives, and actions needed to be refined in order to achieve further success in implementing the 2016 HMP Mitigation Strategy. This process, the past successes, and the refined Mitigation Goals and Objectives are included in Section 6.

The HMPC assessed the progress that was made on the actions identified in the 2011 HMP Mitigation Action Plan, and based on the additional hazards, the vulnerabilities identified, and the updated capability assessment, the Mitigation Action Plan was updated and prioritized. The Mitigation Action Plan, which provides the realistic actions for implementation in the next five years to further reduce Bucks County's risk to the identified hazards, is detailed in Section 6.4.

Plan Maintenance and Adoption

The 2016 Bucks County Hazard Mitigation Plan Update is a living document; therefore, continuous monitoring, evaluation, and updating will take place. Plan evaluations will take place annually on or around the anniversary of plan adoption, and will also occur after a major disaster. The plan will be updated every five years, as required by the Disaster Mitigation Act of 2000. Future plan updates will account for any new hazard vulnerabilities, special circumstances, or new information that becomes available.

Certification of Annual Review Meetings

YEAR	DATE OF MEETING	PUBLIC OUTREACH ADDRESSED?*	SIGNATURE
2011	N/A	N/A	To the best knowledge of the Bucks County Hazard Mitigation Planning Committee (HMPC), no HMP meetings were held before the beginning of the HMP update process. See Section 3 of the Bucks County 2016 HMP Update for details regarding the meetings held during this process. The HMPC hereby certifies the review.
2012	N/A	N/A	
2013	N/A	N/A	
2014	N/A	N/A	
2015	See Section 3	See Section 3	
2016			
2017			
2018			
2019			
2020			

**Confirm here annually and describe on record of changes page.*

Record of Changes

DATE	DESCRIPTION OF CHANGE MADE, MITIGATION ACTION COMPLETED, OR PUBLIC OUTREACH PERFORMED	CHANGE MADE BY (PRINT NAME)	CHANGE MADE BY (SIGNATURE)
2011 – 2016	To the best knowledge of the Bucks County HMPC, no HMP progress reports were submitted from municipalities for the period from 2011 – 2016, although mitigation actions were accomplished in this period. Progress on actions is discussed in detail in Section 6.1 of this plan.	N/A	N/A

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List of Acronyms

AFS	Air Facility System
BCEMA	Bucks County Emergency Management Agency
BCPC	Bucks County Planning Commission
BLS	Bureau of Labor Statistics
CDBG	Community Development Block Grants
CFR	Code of Federal Regulations
CIS	FEMA Community Information System
CRGIS	Cultural Resources Geographic Information Systems
CRS	Community Rating System
DCED	Pennsylvania Department of Community and Economic Development
DCNR	Pennsylvania Department of Conservation and Natural Resources
DCNR-BOF	Pennsylvania Department of Conservation and Natural Resources - Bureau of Forestry
DEP	Pennsylvania Department of Environmental Protection
DFIRM	Digital Flood Insurance Rate Map
DHS	U.S. Department of Homeland Security
DMA 2000	Disaster Mitigation Act
EMA	Emergency Management Agency
EMC	Emergency Management Coordinator
EMPG	Emergency Management Performance Grants
EOP	Emergency Operations Plan
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
FBFM	Flood Boundary and Floodway Maps
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
GIS	Geographic Information Systems
HAZUS-MH	Hazards United States Multi-Hazard (FEMA Risk Assessment and Loss Estimation Software)
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HMPC	Hazard Mitigation Planning Committee
HMPT	Hazard Mitigation Planning Team
HVA	Hazard Vulnerability Assessment
ICC	Increased Cost of Compliance
ICIS	Integrated Compliance Information System
LEPCs	Local Emergency Planning Committees
LQG	Large Quantity Generators
mph	Miles per hour
NCDC	National Climatic Data Center

NDMC	National Drought Mitigation Center
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NIDIS	National Integrated Drought Information System
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	Superfund National Priorities List
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
PASDA	Pennsylvania Spatial Data Access
PCS	Permit Compliance System
PDM	Pre-Disaster Mitigation Program
PEIRS	Pennsylvania Emergency Incident Reporting System
PEMA	Pennsylvania Emergency Management Agency
PennDOT	Pennsylvania Department of Transportation
PGA	Peak Ground Acceleration
PHGA	Peak horizontal ground acceleration
PHMC	Pennsylvania Historical and Museum Commission
PSDI	Palmer Severity Drought Index
RF	Risk Factor
RFC	Repetitive Flood Claims Program
RL	Repetitive Loss
SALDOs	Subdivision and land development ordinances
SARA	Superfund Amendments and Reauthorization Act
SFHA	Special Flood Hazard Area
SFIP	Standard Flood Insurance Policy
SOG	Commonwealth of Pennsylvania's All-Hazard Mitigation Planning Standard Operating Guide
SRL	Severe Repetitive Loss
TMDLs	Total Maximum Daily Loads
TRI	Toxic Release Inventory System
UCC	Uniform Code of Construction
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
WYO	Write Your Own Program

1. Introduction

1.1. Background

Bucks County, Pennsylvania recognizes the importance of hazard mitigation and related planning. Bucks County is concerned with planning to address both natural and human-made hazards as it is bordered by the approximately 64 miles of the Delaware River and part of the Greater Philadelphia metropolitan area. Since 1955 there have been twenty-six Presidential Disaster and Emergency Declarations which affected Bucks County. Of the twenty-six Presidential Disaster and Emergency Declarations in Bucks County, seventeen are related to flooding, hurricanes, and tropical storms. The emergency management community, citizens, elected officials and other stakeholders in Bucks County, Pennsylvania recognize the impact of disasters on their community and support proactive efforts needed to reduce the impact of natural and human-caused hazards.

Hazard mitigation describes sustained actions taken to prevent or minimize the long-term risks to life and property from hazards. Pre-disaster mitigation actions are taken in advance of a hazard event and are essential to breaking the disaster cycle of damage, reconstruction, and repeated damage. With careful selection, mitigation actions can be long-term, cost-effective means of reducing the risk of loss.

Hazard mitigation planning has the potential to produce long-term and recurring benefits by breaking the cycle of loss. A core assumption of mitigation is that current dollars invested in mitigation practices will significantly reduce the demand for future dollars by lessening the amount needed for recovery, repair, and reconstruction. These mitigation practices will also enable local residents, businesses, and industries to re-establish themselves in the wake of a disaster, getting the economy back on track sooner and with less interruption. Bucks County has recognized the importance of mitigation and implemented mitigation projects for more than 378 proprieties in Bucks County, making the county a leader in Hazard Mitigation Planning in Pennsylvania.

Accordingly, the Bucks County Hazard Mitigation Planning Team (HMPT) composed of government leaders, community stakeholders, and university representatives from Bucks County, in cooperation with elected officials of the County and its municipalities, have prepared this Hazard Mitigation Plan (HMP). The Plan is the result of work by citizens of the County to develop a pre-disaster, multi-hazard mitigation plan that will not only guide the County towards greater disaster resistance, but will also respect the character and needs of the community.

1.2. Purpose

This Hazard Mitigation Plan was developed for the purpose of:

- Providing a blueprint for reducing property damage and saving lives from the effects of future natural and man-made disasters in Bucks County;
- Qualifying the County for pre-disaster and post-disaster grant funding;
- Complying with state and federal legislative requirements related to local hazard mitigation planning;
- Demonstrating a firm local commitment to hazard mitigation principles; and

- Improving community resiliency following a disaster event.

The Disaster Mitigation Act of 2000 (DMA 2000), Section 322 requires that local governments (communities/counties), as a condition of receiving federal disaster mitigation funds, have a mitigation plan that describes the process for identifying hazards, creating a risk assessment and vulnerability analysis, identifying and prioritizing mitigation strategies, and developing an implementation schedule for the County and each of the municipalities.

Congress authorized the establishment of a Federal grant program to provide financial assistance to States and communities for flood mitigation planning and activities. The Federal Emergency Management Agency (FEMA) has designated this Flood Mitigation Assistance (FMA).

1.3. Scope

The Bucks County 2016 HMP Update has been prepared to meet requirements set forth by the FEMA and the Pennsylvania Emergency Management Agency (PEMA) in order for the County to be eligible for funding and technical assistance from state and federal hazard mitigation programs. The original plan is being updated in order to continually address both natural and human-made hazards determined to be of significant risk to the County and/or its local municipalities. Updates will take place following significant disasters or at a minimum, once a year.

1.4. Authority and References

Authority for this plan originates from the following federal sources:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C., Section 322, as amended;
- Code of Federal Regulations (CFR), Title 44, Parts 201 and 206; and
- Disaster Mitigation Act of 2000, Public Law 106-390, as amended.
- National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 *et seq.*

Authority for this plan originates from the following Commonwealth of Pennsylvania sources:

- Pennsylvania Emergency Management Services Code. Title 35, Pa C.S. Section 101.
- Pennsylvania Municipalities Planning Code of 1968, Act 247 as reenacted and amended by Act 170 of 1988.
- Pennsylvania Stormwater Management Act of October 4, 1978. P.L. 864, No. 167.

The following FEMA guides and reference documents were used to prepare this document:

- FEMA 386-1: Getting Started. September 2002.
- FEMA 386-2: Understanding Your Risks: Identifying Hazards and Estimating Losses. August 2001.
- FEMA 386-3: Developing the Mitigation Plan. April 2003.
- FEMA 386-4: Bringing the Plan to Life. August 2003.
- FEMA 386-5: Using Benefit-Cost Review in Mitigation Planning. May 2007.
- FEMA 386-6: Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning. May 2005.

- FEMA 386-7: Integrating Manmade Hazards into Mitigation Planning. September 2003.
- FEMA 386-8: Multijurisdictional Mitigation Planning. August 2006.
- FEMA 386-9: Using the Hazard Mitigation Plan to Prepare Successful Mitigation Projects. August 2008.
- FEMA. Local Mitigation Planning Handbook. March 2013.
- FEMA. Local Mitigation Plan Review Guide. October 1, 2011.
- FEMA National Fire Incident Reporting System 5.0: Complete Reference Guide. January, 2008.
- FEMA Hazard Mitigation Assistance Unified Guidance. September 11, 2013.
- FEMA. Integrating Hazard Mitigation into Local Planning: Case Studies and Tools for Community Officials. March 1, 2013
- FEMA. Mitigation Ideas. A Resource for Reducing Risk to Natural Hazards. January 2013.

The following PEMA guides and reference documents were used prepare this document:

- PEMA Hazard *Mitigation Planning Made Easy!*
- PEMA Mitigation Ideas: *Potential Mitigation Measures by Hazard Type; A Mitigation Planning Tool for Communities*. March 6, 2009.
- PEMA Pennsylvania's *Hazard Mitigation Planning Standard Operating Guide*. October, 2013.

The following additional guidance document produced by the National Fire Protection Association (NFPA) was used to update this plan:

- NFPA 1600: Standard on Disaster/Emergency Management and Business Continuity Programs. 2007.

2. Community Profile

2.1. Geography and Environment

Bucks County covers 614 square miles and is located in the southeastern portion of the Commonwealth of Pennsylvania. Figure 2.1-1 illustrates the characteristics and geography of Bucks County. The county consists of 54 municipalities – 31 townships and 23 boroughs. It is bounded by Lehigh and Northampton Counties to the north, Montgomery and Philadelphia Counties to the west/south, and the Delaware River (and New Jersey) to the east. The northeastern section of the land consists of rocky terrain and wooded highlands. Major transportation routes include Interstate 95, US Routes 1, 202, 13, the Pennsylvania Turnpike, and State Routes 263, 32, 611, 132, 309, and 413.

Much of Bucks County lies in the Delaware River Basin. The southeastern portion of the County falls in the Neshaminy Creek watershed, as well as the Pennypack Creek and Poquessing Creek. In the north, the water drains into the Tohickon Creek along with the Perkiomen and Saucon creeks, as seen in Figure 2.1-2.

Figure 2.1-1: Base map of Bucks County.

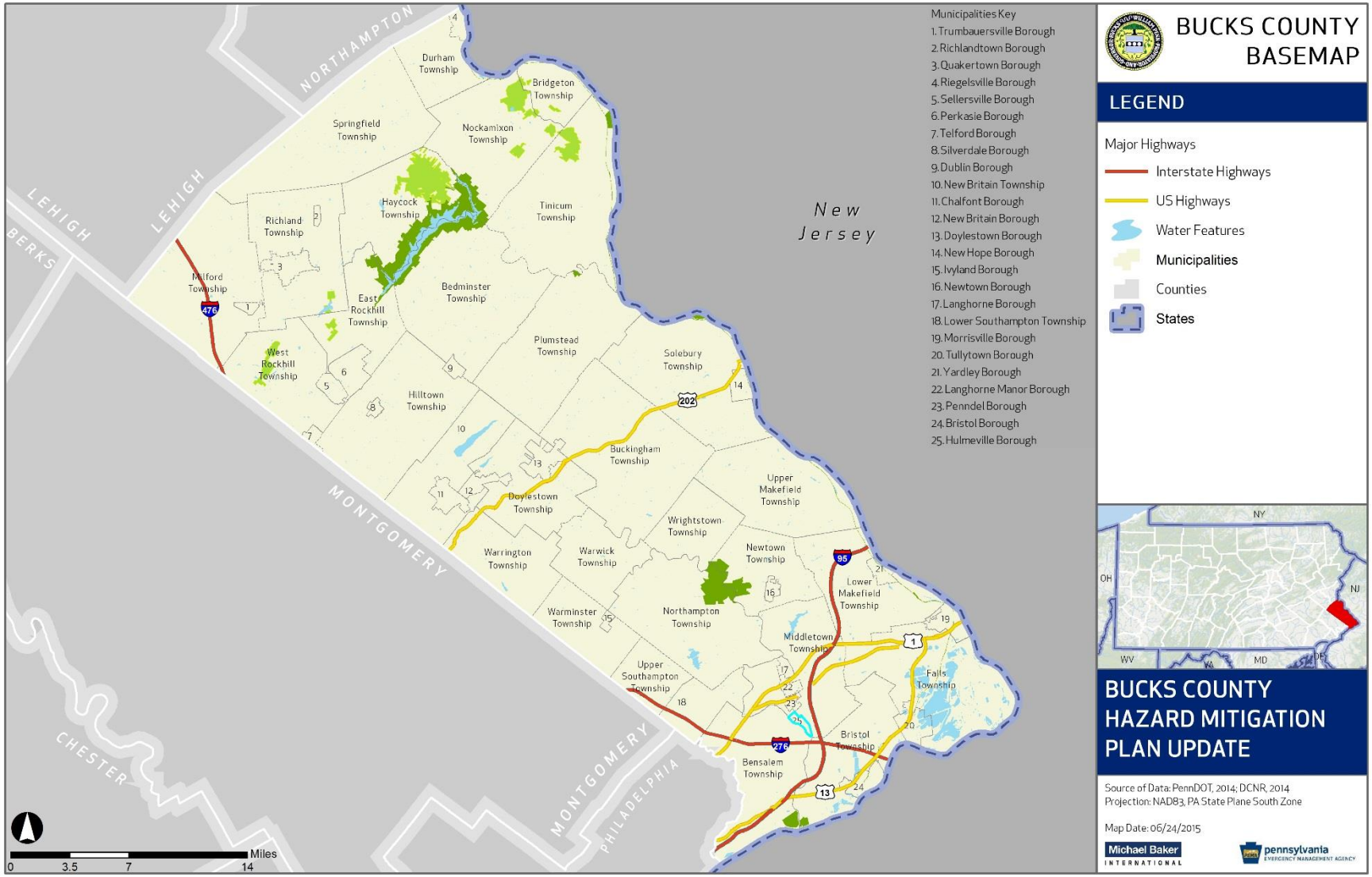
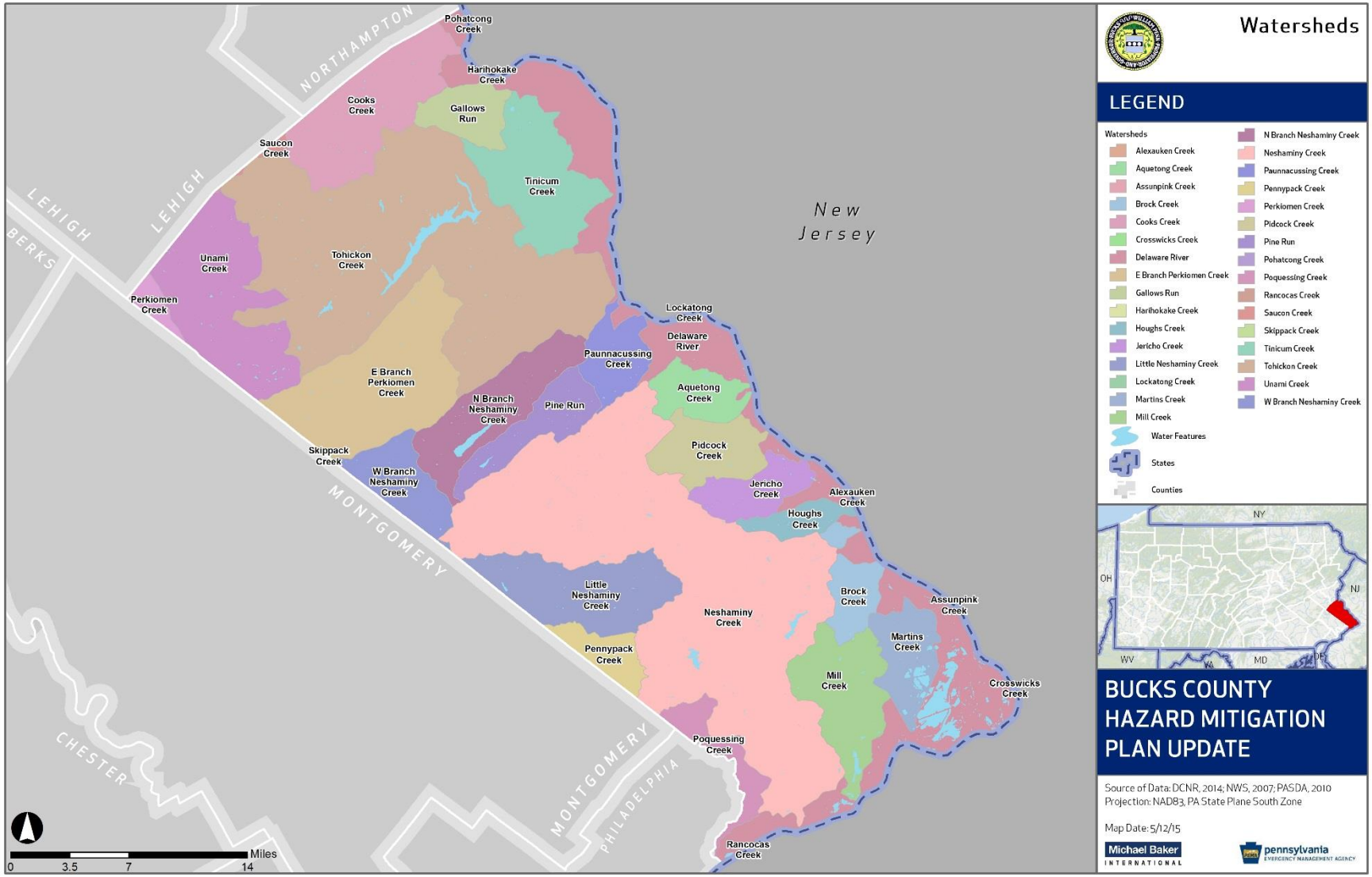


Figure 2.1-2: Bucks County watersheds.



2.2. Community Facts

Bucks County was founded in 1682 by William Penn and named after his family home, Buckinghamshire, in England. The original purpose in establishing Bucks (formerly Buckingham), Philadelphia, and Chester counties was to provide a home for Quakers to practice their religion freely after a long history of persecution in England. The County was formed along the Delaware River; the river has been an integral part of the development of the county starting as a trade route in the 17th century and continued as a gateway for industry in the post-industrial period. U.S. Steel created Fairless Works on riverfront property in Falls Township, attracting housing, businesses, and shopping centers to develop rapidly in both Levittown and Fairless Hills.

The fertile soil along the river is well-suited for agriculture; from its founding to the present day, much of the land in Bucks County is cultivated for farming. Other industry within the county varies from chemical plants to landfills. Recently there's been growth in the biotechnology industry in the Greater Philadelphia area and future development of this industry is expected.

The lower portion of the county is more densely populated, but the upper region near Quakertown has increased in population due to its accessibility to major highways and land availability. The county has a rich heritage of art, culture, and history, and is home to several historic sites including Washington Crossing Historic Park and Pennsbury Manor. The riverfront communities north of Yardley have retained their old-world, small town feel and picturesque scenery, preserving the roots of character and culture of the area.

The health care and social assistance industry sector employs the largest percentage, over 19 percent, of the workforce in Bucks County. Table 2.2-1 details the top ten industries in Bucks County at the end of 2014, with the December employment numbers as reported by the Bureau of Labor Statistics (BLS).

Table 2.2-1: Bucks County Employment by Industry Sector, Fourth Quarter 2014 (BLS, 2015).

INDUSTRY	ESTABLISHMENTS	EMPLOYMENT (DECEMBER 2014)
Health Care & Social Assistance	2,198	44,698
Retail Trade	2,300	37,413
Manufacturing	1,078	27,039
Accommodation & Food Services	1,337	19,821
Construction	2,310	14,688
Professional & Technical Services	2,483	14,658
Administrative & Waste Services	1,257	13,682
Wholesale Trade	1,425	13,613
Other Services (except Public Administration)	1,678	9,748
Finance & Insurance	1,157	7,695

2.3. Population and Demographics

According to the U.S. Census, the population of Bucks County grew by approximately 5 percent between 2000 and 2010, from 597,635 to 625,249. Table 2.3-1 shows details the 2000 population, 2010 population,

and the percent change for each of the municipalities in Bucks County. Bensalem Township is the largest of the 54 municipalities with a population in 2010 of 60,427. Ivyland Borough experienced the greatest change in population, with a growth of 112% from 492 to 1,041, while Langhorne Borough experienced the greatest loss of population, with a decrease of 18 percent from 1,981 to 1,622. Population change, and the effects on the county's and municipalities' vulnerability to hazards, is also addressed in Section 4.4.4.

Table 2.3-1: Population and Population Change by Municipality (U.S. Census, 2000 and 2010).

MUNICIPALITY	2000 POPULATION	2010 POPULATION	PERCENT CHANGE (%)
Bedminster Township	4,804	6,574	37%
Bensalem Township	58,434	60,427	3%
Bridgeton Township	1,408	1,277	-9%
Bristol Borough	9,923	9,726	-2%
Bristol Township	55,521	54,582	-2%
Buckingham Township	16,442	20,075	22%
Chalfont Borough	3,900	4,009	3%
Doylestown Borough	8,227	8,380	2%
Doylestown Township	17,619	17,565	>-1%
Dublin Borough	2,083	2,158	4%
Durham Township	1,313	1,144	-13%
East Rockhill Township	5,199	5,706	10%
Falls Township	34,865	34,300	-2%
Haycock Township	2,191	2,225	2%
Hilltown Township	12,102	15,029	24%
Hulmeville Borough	893	1,003	12%
Ivyland Borough	492	1,041	112%
Langhorne Borough	1,981	1,622	-18%
Langhorne Manor Borough	927	1,442	56%
Lower Makefield Township	32,681	32,559	>-1%
Lower Southampton Township	19,276	18,909	-2%
Middletown Township	44,141	45,436	3%
Milford Township	8,810	9,902	12%
Morrisville Borough	10,023	8,728	-13%
New Britain Borough	3,125	3,152	1%
New Britain Township	10,698	11,070	3%
New Hope Borough	2,252	2,528	12%

Table 2.3-1: Population and Population Change by Municipality (U.S. Census, 2000 and 2010).			
MUNICIPALITY	2000 POPULATION	2010 POPULATION	PERCENT CHANGE (%)
Newtown Borough	2,312	2,248	-3%
Newtown Township	18,206	19,299	6%
Nockamixon Township	3,517	3,441	-2%
Northampton Township	39,384	39,726	1%
Penndel Borough	2,420	2,328	-4%
Perkasie Borough	8,828	8,511	-4%
Plumstead Township	11,409	12,442	9%
Quakertown Borough	8,931	8,979	1%
Richland Township	9,920	13,052	32%
Richlandtown Borough	1,283	1,327	3%
Riegelsville Borough	863	868	1%
Sellersville Borough	4,564	4,249	-7%
Silverdale Borough	1,001	871	-13%
Solebury Township	7,743	8,692	12%
Springfield Township	4,963	5,035	1%
Telford Borough	2,211	2,207	>-1%
Tinicum Township	4,206	3,995	-5%
Trumbauersville Borough	1,059	974	-8%
Tullytown Borough	2,031	1,872	-8%
Upper Makefield Township	7,180	8,190	14%
Upper Southampton Township	15,764	15,152	-4%
Warminster Township	31,383	32,682	4%
Warrington Township	17,580	23,418	33%
Warwick Township	11,977	14,437	21%
West Rockhill Township	4,233	5,256	24%
Wrightstown Township	2,839	2,995	5%
Yardley Borough	2,498	2,434	-3%
TOTAL	**597,635**	**625,249**	**5%**

The median age of Bucks County is 42.2, with about 27 percent of the population under the age of 18 and 16 percent over the age of 65. Table 2.3-2 details the population and housing characteristics in Bucks County as compared to the Commonwealth of Pennsylvania.

Table 2.3-2: Bucks County and Pennsylvania Population and Housing Characteristics (U.S. Census ACS, 2013).		
CHARACTERISTIC	BUCKS COUNTY	PENNSYLVANIA
Persons Under 5 Years (%)	5.1%	5.6%
Persons Under 18 Years (%)	21.8%	21.3%
Persons 65 Years and Over (%)	16.2%	16.4%
Female Persons (%)	51.0%	51.1%
High School Graduate or Higher (% of population over 25)	93.3%	88.7%
Language Other than English Spoken at Home (%)	10.9%	10.3%
White (not Hispanic or Latino) (%)	85.8%	78.4%
Hispanic or Latino (%)	4.7%	6.3%
Black or African American (%)	4.0%	11.5%
American Indian and Alaska Native (%)	0.3%	0.3%
Asian (%)	4.4%	3.1%
Native Hawaiian and Other Pacific Islander (%)	0.1%	0.1%
Two or More Races (%)	1.5%	1.8%
Homeownership Rate (%)	78.0%	69.8%
Housing Units in Multi-Unit Structures (%)	19.3%	20.5%
Median Value of Owner Occupied Housing Units	$309,900	$164,700

The estimated median household income in Bucks County in 2013 was $76,555, about $14,000 greater than the Pennsylvania average and about $13,500 greater than the national average (U.S. Census ACS, 2013). Table 2.3-3 provides details on the income characteristics in Bucks County as compared to the Commonwealth of Pennsylvania.

Table 2.3-3: Bucks County and Pennsylvania Income Characteristics (U.S. Census ACS, 2013).		
CHARACTERISTIC	BUCKS COUNTY	PENNSYLVANIA
Median Household Income	$76,555	$52,548
Per Capita Money Income in Past 12 Months	$37,466	$28,502
Persons Below Poverty Level	5.4%	13.3%

2.4. Land Use and Development

Bucks County is more than 60 percent urban, and over 85 percent of the population lives in urban areas. Though the region has grown and been developed steadily in the recent past, the rate of growth is slowing as the young adult population continues to decline. As the lower portion of the county reaches its development capacity, growth trends have shifted to the central and upper regions of Bucks County. One important factor for growth in Upper Bucks is the region's proximity to both New York and Philadelphia. Population change is also addressed in section 4.4.4.

Table 2.4-1 details the land use in Bucks County, also shown in Figure 2.4-1. Residential land uses are generally low density, single family homes; additionally, over 10 percent of the land use is for rural

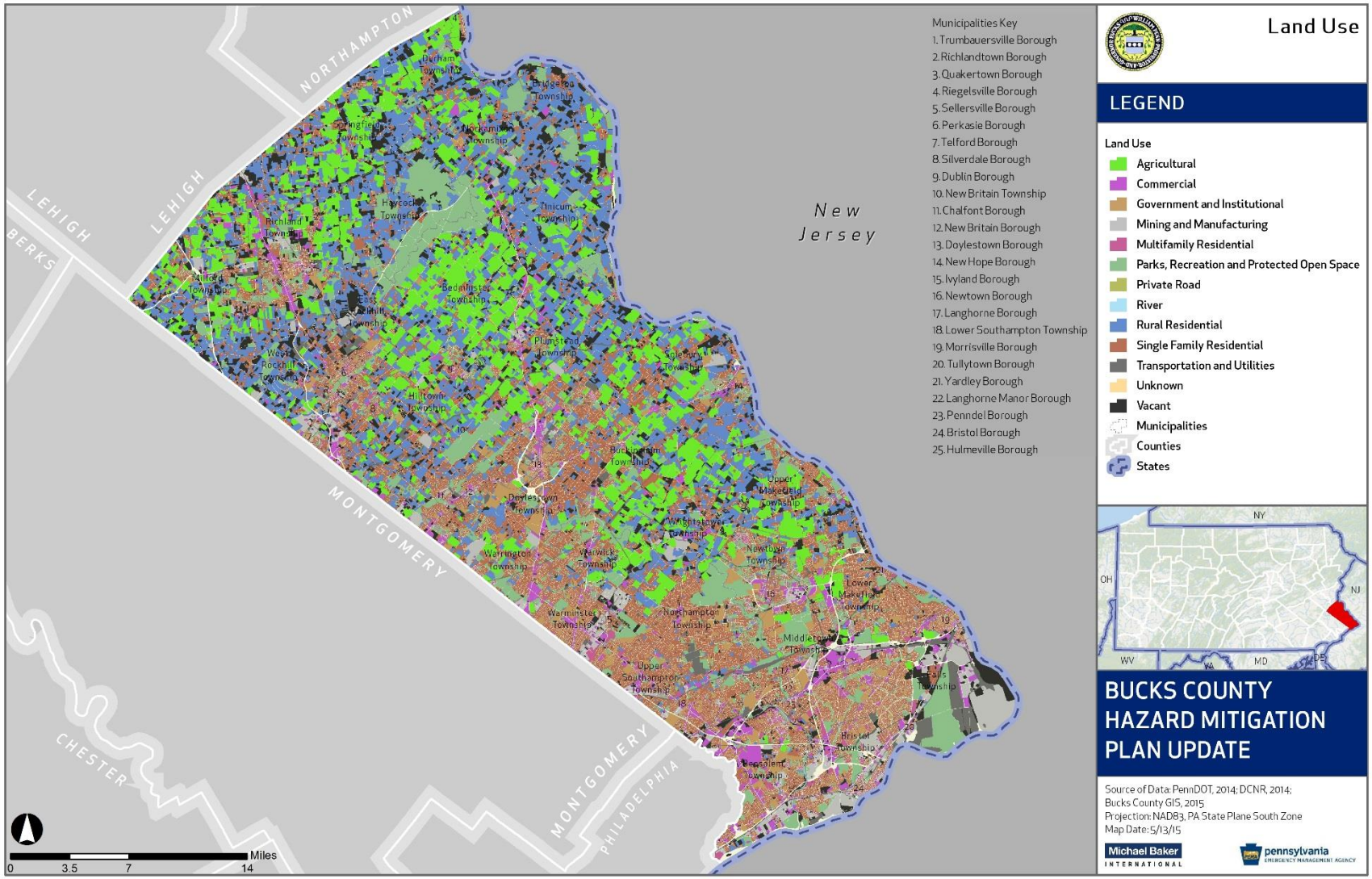
residential purposes, which is lower density. Higher population density is focused around boroughs such as Doylestown and Bristol. Future development, and the impact on the county's and municipalities' vulnerability, is also discussed in Section 4.4.4.

Table 2.4-1: Bucks County Land Use (Bucks County GIS Department, 2015).

LAND USE TYPE	TOTAL ACRES	PERCENT OF BUCKS COUNTY
Agriculture	27.56	3.73%
Commercial	49.68	6.72%
Government and Institutional	19.25	2.60%
Mining and Manufacturing	60.49	8.18%
Multifamily Residential	85.25	11.53%
Parks, Recreation, and Protected Open Space	6.73	0.91%
Rural Residential	75.83	10.25%
Single Family Residential	189.09	25.57%
Unknown	42.84	5.79%
Vacant	182.84	24.72%

Several major highways connect Bucks County with close-by major metropolitan areas as well as with the surrounding counties. The northeast extension of the Pennsylvania Turnpike (I-476) runs north to south from Lehigh to Montgomery County. Interstate 95 links Pennsylvania to New Jersey over the Delaware River via the north-south route. PA route 202 runs east to west across the County through Doylestown.

Figure 2.4-1: Bucks County land use



2.5. Data Sources and Limitations

The Bucks County tax assessment parcel database and the County's building footprints were used as an inventory of properties throughout the County. The building footprints did not include attributes beyond the locations of the structures, including the value of the structure, number of stories, elevation, etc. In order to effectively evaluate the type of structures vulnerable to individual hazards, the consultant team converted the buildings to their centroids and used a spatial join to assign a land use to each structure using the parcel database. Land use categories were then reviewed and consolidated as needed. For example, single family residential, rural residential, and multifamily residential parcel land uses were consolidated to "residential." In addition, since a spatial join was used to derive land use, if a parcel had more than one structure on it, both would be given the same underlying land use. As a result, the structure types used throughout this HMP should be considered estimates. The actual structure and land use may differ than information contained in the database.

The countywide Digital Flood Insurance Rate Map (DFRIM), published on March 16, 2015, was downloaded from the FEMA Map Service Center. This data provides flood frequency and elevation information used in the flood hazard risk assessment. Other GIS datasets including *major streams, land use, water areas,* and *street centerlines* were provided by the Bucks County GIS Department. Additional data for the base map was provided by the Pennsylvania Department of Transportation, Pennsylvania Game Commission, and the Pennsylvania Department of Conservation and Natural Resources.

Additional information used to complete the risk assessment for this plan was taken from various government agency and non-government agency sources. Those sources are cited where appropriate throughout the plan and on each map with full references listed in Appendix A – Bibliography. It should be noted that numerous GIS datasets were obtained from the Pennsylvania Spatial Data Access (PASDA) website (http://www.pasda.psu.edu/). PASDA is the official public access geospatial information clearinghouse for the Commonwealth of Pennsylvania. PASDA was developed by the Pennsylvania State University as a service to the citizens, governments, and businesses of the Commonwealth. PASDA is a cooperative project of the Governor's Office of Administration, Office for Information Technology, Geospatial Technologies Office and the Penn State Institutes of Energy and the Environment of the Pennsylvania State University.

In order to assess the vulnerability of different jurisdictions to the hazards, data on past occurrences of damaging hazard events was gathered. For a number of historic natural-hazard events, the National Climatic Data Center (NCDC) database was utilized. NCDC is a division of the US Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). Information on hazard events is compiled by NCDC from data gathered by the National Weather Service (NWS), another division of NOAA. NCDC then presents it on their website in various formats. The data used for this plan came the US Storm Events database, which "documents the occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce" (NOAA, 2006).

When applicable, Pennsylvania Emergency Incident Reporting System (PEIRS) incident data spanning 1/1/2002 through 6/1/2009 was used in the 2011 plan update and kept in the 2016 update. However,

the Commonwealth of Pennsylvania ceased using PEIRS as its incident reporting system in 2009 and was unable to provide more recent comprehensive incident reports. Although PEIRS data proved valuable, primarily in the human-made hazards section where few records of past occurrences exist, data limitations exist in that the reporting system is not mandatory. As a result, while PEIRS reports provide important information on the frequency of past events, because it is a voluntary reporting system, the number and frequency of events may be under-reported.

Data on the location of historic properties was obtained through the Pennsylvania Historical and Museum Commission from the Cultural Resource GIS database. The data includes all registered and eligible buildings, structures, sites, objects, and districts; however, the initial dataset also included unidentified properties and properties that were marked with an "Insufficient Information to Evaluate" designation. These properties that did not have a type and were marked as having insufficient information were not included in the historic property analysis. Additionally, some properties were included in the dataset multiple times, because they were counted as a building and a district, as multiple districts, and as expansions of original designated places, which affects the tabular data of counts of properties in each municipality.

This HMP evaluates the vulnerability of the County's critical facilities. For the purposes of this plan, critical facilities are those entities that are essential to the health and welfare of the community, transportation infrastructure, and facilities related to the care of children. This includes law enforcement, emergency response, medical services, wastewater plants, correctional facilities, airports, rail stations, municipal buildings, day cares, and schools. The list of critical facilities was developed based on information available from the Bucks County Emergency Management Agency (EMA), the Bucks County Geographic Information Systems (GIS) Department, PEMA, and FEMA. Table 2.5-1 summarizes the critical facilities in Bucks County by type and by. For a complete listing of critical facilities and their vulnerability to individual hazards, please see **Appendix E**.

Throughout the risk and vulnerability assessment included in Section 4, descriptions of limited data indicate some areas in which the County and municipalities can improve their ability to identify vulnerable structures and improve loss estimates. As the County and municipal governments work to increase their overall technical capacity and implement comprehensive planning goals, they will also attempt to improve the ability to identify areas of increased vulnerability.

Table 2.5-1: Summary of Critical Facilities by Type and Municipality.

MUNICIPALITY	AIRPORT	CORRECTIONAL FACILITY	DAY CARE	FIRE DEPART-MENT	HOSPITAL	MUNICI-PAL BUILDING	NURSING / RETIRE-MENT HOME	POLICE STATION	RAILROAD STATION	RESCUE SQUAD	SCHOOL	WASTE-WATER PLANT	GRAND TOTAL
Bedminster Township	0	0	3	1	0	1	0	1	0	0	2	1	9
Bensalem Township	0	0	17	6	1	1	5	1	5	4	19	0	59
Bridgeton Township	0	0	0	1	0	1	0	0	0	0	1	0	3
Bristol Borough	0	0	4	5	0	1	2	1	1	1	5	1	21
Bristol Township	0	0	17	5	1	1	3	1	1	2	23	2	56
Buckingham Township	1	0	7	2	0	1	1	1	0	0	5	1	19
Chalfont Borough	0	0	4	1	0	1	1	1	1	1	1	0	11
Doylestown Borough	0	0	4	1	0	1	4	2	1	1	5	1	20
Doylestown Township	0	3	8	0	1	1	3	1	2	0	2	2	23
Dublin Borough	0	0	0	1	0	1	1	1	0	2	0	0	6
Durham Township	0	0	0	0	0	1	0	0	0	0	0	0	1
East Rockhill Township	1	0	2	0	0	1	1	0	0	0	7	0	12
Falls Township	0	0	10	2	1	1	0	1	0	1	14	0	30
Haycock Township	0	0	0	0	0	1	0	0	0	0	1	0	2
Hilltown Township	0	0	4	0	0	1	1	1	0	0	3	0	10
Hulmeville Borough	0	0	1	0	0	1	0	1	0	0	0	0	3
Ivyland Borough	0	0	0	1	0	1	0	1	0	0	1	0	4
Langhorne Borough	0	0	2	1	0	1	2	2	0	0	0	0	8
Langhorne Manor Borough	0	0	1	0	0	1	2	1	0	0	1	0	6
Lower Makefield Township	0	0	8	0	0	1	5	1	0	1	10	0	26
Lower Southampton Township	0	0	12	3	0	1	0	1	0	4	7	0	28
Middletown Township	0	0	10	1	2	1	8	0	1	2	15	0	40
Milford Township	1	0	4	1	0	1	1	0	0	0	4	1	13
Morrisville Borough	0	0	3	1	0	1	1	1	0	1	4	1	13
New Britain Borough	0	0	3	0	1	1	1	1	0	0	2	0	9
New Britain Township	0	0	9	0	0	1	1	1	0	0	3	0	15
New Hope Borough	0	0	0	1	0	1	1	2	0	0	3	0	8
Newtown Borough	0	0	2	0	0	1	1	1	0	0	2	0	7

Table 2.5-1: Summary of Critical Facilities by Type and Municipality.

MUNICIPALITY	AIRPORT	CORRECTIONAL FACILITY	DAY CARE	FIRE DEPART-MENT	HOSPITAL	MUNICI-PAL BUILDING	NURSING / RETIRE-MENT HOME	POLICE STATION	RAILROAD STATION	RESCUE SQUAD	SCHOOL	WASTE-WATER PLANT	GRAND TOTAL
Newtown Township	0	0	12	1	0	1	7	1	0	1	8	0	31
Nockamixon Township	0	0	1	0	0	1	0	0	0	1	4	0	7
Northampton Township	0	0	8	1	0	1	3	1	0	1	13	0	28
Penndel Borough	0	0	1	0	0	1	0	1	1	0	2	0	6
Perkasie Borough	0	0	6	1	0	1	1	1	0	2	1	0	13
Plumstead Township	0	0	7	1	0	1	0	1	0	2	4	0	16
Quakertown Borough	0	0	5	1	1	1	5	0	0	1	6	0	20
Richland Township	0	0	2	1	0	1	1	2	0	0	3	1	11
Richlandtown Borough	0	0	0	1	0	1	1	0	0	0	0	0	3
Riegelsville Borough	0	0	1	1	0	1	0	0	0	0	0	0	3
Sellersville Borough	0	0	4	1	0	1	1	0	0	0	2	0	9
Silverdale Borough	0	0	0	1	0	1	0	0	0	0	1	0	3
Solebury Township	0	0	7	1	0	1	0	1	0	0	2	0	12
Springfield Township	0	0	3	1	0	1	0	1	0	1	1	0	8
Telford Borough	0	0	1	0	0		1	0	0	0	0	0	2
Tinicum Township	1	0	2	3	0	1	2	1	0	1	1	0	12
Trumbauersville Borough	0	0	1	1	0	1	0	0	0	0	1	0	4
Tullytown Borough	0	0	1	2	0	1	0	1	1	0	3	0	9
Upper Makefield Township	0	0	1	1	0	1	0	1	0	0	1	0	5
Upper Southampton Township	0	0	9	0	0	1	3	1	0	1	5	0	20
Warminster Township	0	0	11	2	0	1	5	1	1	2	12	1	36
Warrington Township	0	0	12	1	0	1	1	1	0	1	6	0	23
Warwick Township	0	0	5	1	0	1	1	1	0	0	4	1	14
West Rockhill Township	0	0	1	0	1	1	3	1	0	1	3	1	12
Wrightstown Township	0	0	3	0	0	1	0	0	0	1	1	0	6
Yardley Borough	0	0	2	2	0	1	0	1	1	0	1	0	8
Grand Total	**4**	**3**	**241**	**59**	**9**	**53**	**80**	**43**	**16**	**36**	**225**	**14**	**783**

3. Planning Process

3.1. Update Process and Participation Summary

To begin the 2016 HMP process, the Hazard Mitigation Planning Committee (HMPC) identified individuals and organizations to invite to be a part of the Hazard Mitigation Planning Tem (HMPT). The Bucks County Planning Commission sent meeting invitations to the Township or Borough Manager and Emergency Management Coordinator (EMC) in each municipality as well as to adjacent county commissioners, watershed associations, and other miscellaneous stakeholders such as agency representatives and non-profit organizations. The HMPT first assembled in March of 2015 to review hazards that affect the County, assess potential damages from those hazard events, select actions to address the County's vulnerability to such hazards, and develop an implementation-strategy action plan in order to mitigate potential losses. The HMPT mailing list was updated based on information provided in the first meeting. Section 3.2 provides a discussion of the HMPT as well as a table of members with their corresponding organization.

Municipal officials, Stakeholders, and Adjacent Counties received written notification regarding all HMP meetings and reminder emails. A brief description of each meeting that was held is available in Section 3.3. In addition, meeting minutes, describing in detail, events of each meeting along are available in **Appendix C** – **Meeting and Other Participation Documentation**.

In order to obtain information from municipalities and other stakeholders, forms and surveys were distributed and collected throughout the planning process. Some forms were completed during planning meetings while others were sent via mail and email and completed and returned in between scheduled meetings. All municipalities were required to have a representative attend at least one meeting and provide pertinent information for the HMP. Table 3.1-1 lists each municipality along with their specific participation and contributions to the planning process. Sign-in sheets for each meeting with individual names are available in **Appendix C** along with all completed forms and surveys.

With funding support from PEMA, Michael Baker International, a full-service engineering firm that provides hazard mitigation planning guidance and technical support, assisted the County through the HMP process. The 2016 Bucks County HMP was submitted for PEMA and FEMA review in August 2015. The 2016 HMP follows an outline mostly recently updated by PEMA in 2013 which provides a standardized format for all local HMPs in the Commonwealth of Pennsylvania.

3.2. The Planning Team

The Hazard Mitigation Planning Committee for the 2016 HMP included:

1) Lynn Bush, Executive Director, Bucks County Planning Commission
2) Scott T. Forster, Director, Bucks County Emergency Management Agency
3) Arthur Feltes, Bucks County Planning Commission
4) Robert Fink, Bucks County Emergency Management Agency
5) Sarah Bowen, Michael Baker International

The HMPC developed a well-diversified list of potential HMPT members which included municipal officials, state and Bucks County government representatives, adjacent county representative, universities, and other stakeholder organizations. These individuals were invited to participate in the HMP process. The HMPC worked throughout the process to plan and hold meetings, collect information and conduct public outreach.

The stakeholders listed in Table 3.2-1 served on the 2016 countywide HMPT and actively participated in the planning process through attendance at meetings, completion of assessment surveys, or submission of comments. The HMPT consisted of state, county, and local officials including municipal supervisors and council members, emergency management coordinators, firefighters, as well as, university and non-profit representatives. Participants representing multiple jurisdictions are listed more than once.

Table 3.2-1: Stakeholders who participated in the planning process.

MUNICIPALITY/ORGANIZATION	PARTICIPANT(S)
Bedminster Township	Richard H. Schilling, Manager / Chief Administrator
Bensalem Township	Robert Race, Deputy EMC; Matt Takita, Director of Building & Planning
Bridgeton Township	Christina Zaveriukha, Deputy EMC
Bristol Borough	Ronald DeAngelis, EMC; Merle Winslow, EMC
Bristol Township	Jim Breslin, Fire Inspector
Buckingham Township	James M. Kettler, EMC
Chalfont Borough	Daniel Jenkins, EMC
Doylestown Borough	Kelli Scarlett, EMC
Doylestown Township	Stephanie J. Mason, Manager / Chief Administrator; Sinclair Salisbury, EMC
Dublin Borough	William Wert, Manager / Chief Administrator; M. Philip Myers, EMC
Durham Township	Joseph Kulick, Township Administrator and EMC
East Rockhill Township	Marianne K. Morano, Manager / Chief Administrator; David R. Nyman, Planning Commission Secretary
Falls Township	Richard Dippolito, EMC
Haycock Township	Henry DePue, EMC
Hilltown Township	Ray Fegley, EMC
Hulmeville Borough	David M. Harris, Mayor / Executive; William Wheeler, EMC
Ivyland Borough	Daniel Jenkins, EM
Langhorne Borough	Scott Mitchell, Manager; Christine Schoell, Municipal Clerk
Langhorne Manor Borough	William R. McTigue Jr., Administrative Officer for Public Affairs
Lower Makefield Township	Tom Roche, Captain
Lower Southampton Township	William Oettinger, EMC
Middletown Township	Wilford K. Richards, FMO
Milford Township	Josh Mallery, EMC; Jeffrey A. Vey, Manager
Morrisville Borough	Robert A. Seward, EMC; Lorraine Robson, Code Secretary
New Britain Borough	Daniel Jenkins, EM
New Britain Township	Eileen M. Bradley, Manager / Chief Administrator
New Hope Borough	Michael V. Cummings, EMC; John Goss, Deputy EMC
Newtown Borough	Glenn Forsyth, EMC; Matt Zimmerman, Police Department
Newtown Township	Glenn Forsyth, EMC
Nockamixon Township	Daniel Jenkins, EM
Northampton Township	Frank Fenton, EMC
Penndel Borough	Robert Winkler, Mayor and EMC
Perkasie Borough	Steven Reichman, EMC; Joe Bernardi, Manager

Table 3.2-1: Stakeholders who participated in the planning process.	
MUNICIPALITY/ORGANIZATION	**PARTICIPANT(S)**
Plumstead Township	Scott Fleischer, EMC; Daniel Jenkins, EM; Carolyn McCreary, Township Manager
Quakertown Borough	Doug Wilhelm, Zoning Officer
Richland Township	Stephen Sechriest, Township Manager
Richlandtown Borough	Daniel Jenkins, EM
Riegelsville Borough	Daniel Jenkins, EM
Sellersville Borough	David J. Rivet, Manager / Chief Administrator; Craig A. Wilhelm, EMC
Silverdale Borough	Clair Black, EMC; Lisa Herman, Administrative Assistant
Solebury Township	James J. Kuhn, EMC; Kevin Edwards, Sergeant; Jean Weiss, Administrative Assistant
Springfield Township	Michael Brown, Township Manager
Telford Borough	Megan McShane, Administrative Secretary
Tinicum Township	Linda McNeill, Manager / Chief Administrator; William Cahill, EMC
Trumbauersville Borough	Marilyn J. Bobb, EMC
Tullytown Borough	Alison Smith, Borough Coordinator; Ed Wallace, Police Officer
Upper Makefield Township	David Nyman, Manager; Robert Kay, EMC
Upper Southampton Township	Mark Showmaker, EMC
Warminster Township	Joseph Velter, EMC
Warrington Township	Lee Greenberg, EMC
Warwick Township	Kyle Seckinger, Assistant Township Manager
West Rockhill Township	Greg Lippincott, Township Manager/Zoning Officer
Wrightstown Township	Joseph F. Pantano, Manager / Chief Administrator; Ted Middleman, Fire Marshall
Yardley Borough	Mike Mueller, Planner; Wes Foraker, EMC
Bucks County Planning Commission	Lynn Bush, Director; Art Feltes, Planner/County Recycling Coordinator; Rea Monaghan, Environmental Planner
Bucks County Emergency Management Agency	Scott T. Forster, Director; Robert Fink, Emergency Management Specialist; Steven Reichman, Supt. Training
Bucks County Conservation District	Meghan Rogalus, Watershed Specialist
Bucks County Community College	Dennis McCay, Director of Security
Cairn University	Chris Lloyd, Director-Security
County of Burlington, NJ	Kevin Tuno, County OEM Coordinator
County of Northampton, PA	Nick Tylenda, Emergency Management Coordinator
Federal Emergency Management Agency	Therese (Tess) Grubb, Community Planner Lead
Fresh H2O	Su Fanok
North Branch Watershed Association	Meghan Rogalus, Watershed Specialist
Pennsylvania Department of Environmental Protection	Walt Bair, Emergency Response Coordinator
Pennsylvania Department of Conservation and Natural Resources	Richard Deppen
Pennsylvania Emergency Management Agency	Ernie Szabo, State Hazard Mitigation Planner
Pennsylvania Historical & Museum Commission	Jeremy Young, Project Manager

3.3. Meetings and Documentation

The following meetings were held during the planning process. Invitations, agendas, presentations, sign-in sheets, and minutes for these meetings are included in **Appendix C**.

January 14, 2015 – Hazard Mitigation Planning Committee Kickoff call to discuss participation, meeting schedule, data collections and priorities for 2016 update.

March 3, 2015 – Community Kick-Off Meeting held at Bucks County Public Safety Training Center in Doylestown to introduce the project to the HMPT, inform representatives of the HMP process and schedule, and make a formal request for response to Hazards in Your Community, Capability Assessment and NFIP Surveys.

May 5, 2015 – Mitigation Strategy Workshop M**eeting** held at Bucks County Public Safety Training Center in Doylestown to review preliminary risk assessment results. The meeting was used to review mitigation goals, objectives, and actions for 2016 update. Participants asked to complete a Risk Assessment, Goals and Objective, Mitigation Action, and Historical Property Mitigation worksheets.

June 23, 2015 – Final Public Meeting – Public Meeting held at the Bucks County Public Safety Training Center in Doylestown to update the attendees about the HMP process and findings. Several verbal comments were noted in the meeting minutes and attendees were informed about the timeline and their opportunity to review the entire plan on the County's website and provide written comments.

July 2015 – Additional Planning Team Conference Calls and Webinars – A series of calls were held with webinar components to gain participation of the municipalities who were not able to attend the previous meetings in-person. Table 3.3-1 provides details of the dates of the calls and the municipalities which attended them. The HMP update process and forms were reviewed, as well as the draft plan, so that the call attendees were able to be aware of the contents of the plan, make comments, and be aware of how to further participate in the planning process. Minutes for the meetings are in Appendix C.

Table 3.3-1: Planning Team Conference Calls/Webinars

DATE	PARTICIPATING MUNICIPLITY (IES)
July 7, 2015	Silverdale Borough
July 14, 2015	Richland Township, Springfield Township
July 21, 2015	Falls Township
July 22, 2015	Haycock Township
February 3, 2016	Langhorne Borough
February 4, 2016	Langhorne Manor Borough, Milford Township, Quakertown Borough, Tullytown Borough, and West Rockhill Township

November 2015 to February 2016 – Additional Planning Team Conference Calls and Webinars and Form Collection – Bucks County prioritized 100% participation in the plan and worked to collect forms, confirm meeting participation and encourage attendance at a conference. Art Feltes reached out to municipalities and confirmed that Joseph Kulick of Durham attended May 5, 2015 meeting, which is why we had form

from Township. Art gathered forms to complete participation from Falls Township, Ivyland Borough, Newtown Borough, Newtown Township, Nockamixon Township, and Warrington Township. Then Langhorne Borough attended a call February 3, 2016 and the following day Langhorne Manor Borough, Milford Township, Quakertown Borough, Tullytown Borough, and West Rockhill Township attended a February 4, 2016 call. All six of the communities that needed to attend call also submitted forms

Additionally, the Final Meeting for the Bucks County DFIRM update on June 30, 2015 was announced at the June 23rd HMP meeting. Since the DFIRM and HMP update processes were happening simultaneously Baker staff attended to Final Meeting to briefly explain the HMP update process and to distribute a flier to announce the HMP finalization and public comment period. This was an important step to build on the momentum of the DFIRM update and not confuse stakeholders with different invites and planning processes.

Figure 3.3-1: Attendees and Presentation at Kickoff Meeting on March 3, 2015.

Figure 3.3-2: Attendees and Presentation at Mitigation Solutions Meeting on May 5, 2015.

3.4. Public & Stakeholder Participation

Each municipality was given multiple opportunities to participate in the HMP process through invitation to meetings, review of risk assessment results and mitigation actions, and an opportunity to comment on the draft HMP. The five tools listed below were distributed with meeting invitations or at meetings to solicit data, information, and comments from local municipalities in Bucks County. Responses to these worksheets and surveys are included in **Appendix C**:

Figure 3.3-3: Public notices of HMP process and website were posted to engage people from the beginning of the planning process on March 1, 2015 in the Bucks County Courier Times and the Intelligencer.

NOTICE

Bucks County is starting the process of updating its All-Hazard Mitigation Plan. The Plan is a blueprint for reducing property damage and saving lives from the effects of future natural and human-made disasters in Bucks County. Interested persons may visit www.pennsylvaniahmp.com/bucks-hmp throughout the planning process to sign up for alerts and view draft documents and meeting dates. A kick-off meeting for the project is being held Tuesday March 3rd from 2:30 PM to 3:30 PM at the Bucks County Public Safety Training Center, Room 201, 1760 South Easton Road, Doylestown, PA 18901. Please plan to participate in the planning process between now and June 15, 2015!
1t M 1

1) ***Hazards in Your Community***: Bucks County had a robust risk assessment in its 2011 plan with 18 hazards. For the 2016 update, participants were asked to analyze the spatial extent, impact, probability, and significance of hazards to add to the analysis of existing hazards. They were also asked to identify new hazards impacting the county.

2) ***Capability Assessment Survey***: Collects information on local planning, regulatory, administrative, technical, fiscal, political, and resiliency capabilities that can be included in the countywide mitigation strategy.

3) ***NFIP Worksheet:*** This form collects information on the nation's largest mitigation program. Information that can be filled in from FEMA databases is provided to each community for review and so that participants may focus on providing locally nuisance information.

4) ***Risk Assessment Exercise:*** This form provides an opportunity for municipalities and stakeholders to review and comment on hazard ranking and local impact.

5) ***Historical Property Mitigation:*** This form provides a map of historic properties and sites in Bucks County and is used to gather ideas and interest in specialized mitigation projects.

6) ***Goals and Objectives Review:*** Provides municipalities and stakeholders the opportunity to review the existing goals and objectives, recommend changes, and not progress.

7) ***Mitigation Action Progress Report Form:*** This action form was tailored to each community to review existing actions, note progress, and elect new actions.

Community participation and comment was encouraged throughout the planning process. Newspaper notices were published in the *Bucks County Courier Times* and *The Intelligencer* on March 1, 2015 to notify the citizens of Bucks County of the public meeting held on March 3, 2015 and the opportunity to

participate throughout the planning process www.pennsylvaniahmp.com/bucks. The Bucks County HMP was posted on the website beginning June 26, 2015 and comments were accepted through July 27, 2015. HMPT members were also emailed regarding the availability of the plan for review. Comments were to be submitted in writing to Sarah Bowen of the Michael Baker International. Copies of all comments received are located in **Appendix C**. A copy of the public notice is shown in Figure 3.4-1.

Several comment forms were received at the Final Public Meeting and after the meeting via emails and the Comment Form at www.pennsylvaniahmp.com/bucks. Most of the comments at the public meeting were from municipalities that wanted to sign up for additional actions. Communities were signed up for additional actions as requested. All comments received were addressed.

3.5. Multi-Jurisdictional Planning

This HMP was developed using a multi-jurisdictional approach. Though County level departments have resources such as technical expertise and data which local jurisdictions may lack; involvement from local municipalities is critical to the collection of local knowledge related to hazard events. Local municipalities also have the legal authority to enforce compliance with land use planning and development issues. The County undertook an intensive effort to involve all 31 townships and 23 boroughs in the planning process.

Note: A portion of Telford Borough is in Montgomery County; this plan only addresses the risks to Bucks County residents. Telford Borough residents will need to adopt both the Bucks County and Montgomery County hazard mitigation plans.

Table 3.5-1 documents jurisdictional presence at the meetings described in Section 3.3 and other involvement from each jurisdiction throughout the planning process. Each municipality was emailed or mailed invitations to all meetings and if email addresses were available, received email reminders prior to each meeting. Surveys and forms were mailed or emailed to jurisdictions along with letters requesting that local information be provided. All 100 percent of the municipalities, 54 of 54 total municipalities, attended at least one meeting and completed at least one form. All 54 municipalities also participated in the 2011 and 2006 HMP planning processes.

Table 3.5-1: Summary of participation from local municipalities during the 2016 Hazard Mitigation Planning Process.

	MEETING				WORKSHEETS/SURVEYS/FORMS					
MUNICIPALITY	KICK-OFF MARCH 4, 2015	MITIGATION STRATEGY WORKSHOP MAY 5, 2015	PUBLIC MEETING JUNE 23, 2015	PLANNING TEAM CONFERENCE CALLS	HAZARDS IN YOUR COMMUNITY	CAPABILITY ASSESSMENT	NFIP	RISK ASSESSMENT	HISTORIC PROPERTY MITIGATION	MITIGATION STRATEGY RELATED FORMS
Bedminster Township	Y							Y		
Bensalem Township	Y	Y	Y		Y	Y	Y	Y	Y	Y
Bridgeton Township			Y							Y
Bristol Borough	Y		Y		Y	Y	Y			
Bristol Township	Y		Y					Y		
Buckingham Township	Y				Y					
Chalfont Borough	Y	Y	Y		Y			Y	Y	Y
Doylestown Borough	Y	Y			Y	Y	Y			
Doylestown Township	Y	Y	Y			Y	Y	Y	Y	Y
Dublin Borough	Y		Y		Y		Y			Y
Durham Township		Y						Y		
East Rockhill Township		Y	Y		Y	Y	Y	Y	Y	Y
Falls Township				Y				Y		
Haycock Township				Y				Y		
Hilltown Township	Y				Y					
Hulmeville Borough	Y	Y			Y					
Ivyland Borough			Y					Y		
Langhorne Borough				Y				Y		
Langhorne Manor Borough				Y				Y		
Lower Makefield Township	Y							Y		Y
Lower Southampton Township	Y	Y			Y	Y	Y	Y	Y	Y
Middletown Township	Y							Y		
Milford Township				Y				Y		
Morrisville Borough	Y	Y	Y		Y	Y	Y			Y
New Britain Borough	Y	Y	Y		Y			Y	Y	Y
New Britain Township	Y		Y		Y					Y
New Hope Borough	Y	Y	Y		Y	Y	Y			
Newtown Borough	Y					Y		Y		

Table 3.5-1: Summary of participation from local municipalities during the 2016 Hazard Mitigation Planning Process.

	MEETING				WORKSHEETS/SURVEYS/FORMS					
MUNICIPALITY	KICK-OFF MARCH 4, 2015	MITIGATION STRATEGY WORKSHOP MAY 5, 2015	PUBLIC MEETING JUNE 23, 2015	PLANNING TEAM CONFERENCE CALLS	HAZARDS IN YOUR COMMUNITY	CAPABILITY ASSESSMENT	NFIP	RISK ASSESSMENT	HISTORIC PROPERTY MITIGATION	MITIGATION STRATEGY RELATED FORMS
Newtown Township	Y					Y		Y		
Nockamixon Township			Y					Y		
Northampton Township	Y	Y	Y		Y		Y			Y
Penndel Borough	Y	Y	Y		Y	Y	Y	Y	Y	Y
Perkasie Borough	Y	Y	Y		Y					
Plumstead Township			Y					Y		Y
Quakertown Borough				Y				Y		
Richland Township				Y						Y
Richlandtown Borough			Y							Y
Riegelsville Borough			Y					Y		Y
Sellersville Borough	Y	Y	Y		Y	Y	Y			
Silverdale Borough				Y	Y		Y			
Solebury Township	Y	Y	Y		Y	Y	Y			Y
Springfield Township				Y						
Telford Borough	Y	Y			Y	Y	Y			
Tinicum Township	Y	Y	Y		Y	Y	Y			
Trumbauersville Borough	Y				Y	Y	Y			
Tullytown Borough				Y				Y		
Upper Makefield Township	Y	Y	Y		Y	Y	Y			Y
Upper Southampton Township	Y	Y	Y		Y	Y	Y			Y
Warminster Township	Y	Y	Y		Y	Y	Y			Y
Warrington Township	Y							Y		
Warwick Township	Y				Y	Y	Y			
West Rockhill Township				Y				Y		
Wrightstown Township	Y	Y	Y		Y	Y	Y			
Yardley Borough	Y	Y	Y		Y	Y	Y	Y	Y	Y

4. Risk Assessment

4.1. Update Process Summary

This risk assessment provides a factual basis for activities proposed by the County in their mitigation strategy. Hazards that may affect Bucks County are identified and defined in terms of location and geographic extent, magnitude of impact, previous events, and likelihood of future occurrence. The Risk Assessment section of the Bucks County HMP update utilizes existing data and analysis from the previous FEMA-approved HMP, as well as more recent data and analysis on hazards occurring during the last five years.

The HMPT identified natural and human-made hazards which have the potential to impact Bucks County. The occurrence of a past hazard event in the County provided an indication of future possible incidence, but the fact that a hazard event has not previously occurred did not exclude the hazard from further investigation. Similarly, limited past occurrences of hazard events did not solely warrant a hazard's inclusion in the plan.

The HMPT reviewed all 34 hazards listed in PEMA's Standard List of Hazards from the Commonwealth of Pennsylvania's All-Hazard Mitigation Planning Standard Operating Guide (SOG) that might affect Bucks County in a PowerPoint presentation during the first planning meeting. HMPT members were asked to complete Hazards in Your Community form to review the impact of hazards currently addressed in the plan and to select new hazards found to have an impact on Bucks County. Based on the results of this survey, information from the 2013 Pennsylvania State HMP update, and past disaster declarations, the HMPC determined that the 18 hazards identified in the current plan were valid for the update, and determined the need to include the following three additional hazards: Pandemic, Radon, and Terrorism. Preliminary analysis on these hazards was reviewed at the Risk Assessment and Mitigation Solutions Workshop, were attends confirmed that these 21 hazards were the proper focus for the 2016 HMP update.

Hazard profiles were then developed in order to define the characteristics of each hazard as they apply to Bucks County. Each municipality and the other stakeholders participating in the planning process then evaluated the impact of hazard profiled in their jurisdiction or organization using the Risk Assessment Exercise (see Appendix C). This evaluation, together with the research and analysis of each hazard, allowed for an assessment of jurisdictional risk, discussed in Section 4.4.2.

Following hazard identification and profiling, a vulnerability assessment was conducted for each hazard to identify the impact of both natural and human-made hazard events on people, buildings, infrastructure, and the community, as appropriate. Each hazard is discussed in terms of its potential impact on individual communities, including the types of structures that may be at risk. This assessment allows the County and its municipalities to focus on and prioritize local mitigation efforts on areas that are most likely to be damaged or require early response to a hazard event. A vulnerability analysis was performed which identifies structures, critical facilities, and/or populations that may be impacted during hazard events and

describes what events can do to physical, social, and economic assets. This information and analysis is captured in Sections 4.3 Hazard Profiles and Vulnerability Analysis and 4.4 Hazard Vulnerability Summary.

4.2. Hazard Identification

4.2.1. Table of Presidential Disaster Declarations

Presidential Disaster and Emergency Declarations are issued when it has been determined that state and local governments need assistance in responding to a disaster event. Table 4.2-1 identifies Presidential Major Disaster and Emergency Declarations issued between 1955 through 2016 that have affected Bucks County. Additional declarations beyond 2016 can be found on the FEMA website at: http://www.fema.gov/news/disasters_state.fema?id=42.

Table 4.2-1: Presidential Disaster and Emergency Declarations affecting Bucks County (FEMA, 2016c).

DECLARATION NUMBER	DATE	EVENT
3367	February 6, 2014	Severe Winter Storm
4099	January 10, 2013	Hurricane Sandy
3356	October 29, 2012	Hurricane Sandy
4030	September 12, 2011	Tropical Storm Lee
3340	September 8, 2011	Remnants of Tropical Storm Lee
4025	September 3, 2011	Hurricane Irene
3339	August 29, 2011	Hurricane Irene
1649	June, 2006	Severe Storms, Flooding, and Mudslides
1587	April, 2005	Severe Storms and Flooding
3235	September, 2005	Proclamation of Emergency - Hurricane Katrina
1557	September, 2004	Tropical Depression Ivan
1383	June, 2001	Flash Flood (Tropical Storm Allison)
1294	September, 1999	Hurricane Floyd
1120	June, 1996	Flooding
1085	January, 1996	Severe Winter Storms
1093	January, 1996	Flooding
1015	January, 1994	Severe Winter Storms
3105	March, 1993	Blizzard
400	July, 1973	Severe Storms and Flood
340	June, 1972	Flood (Tropical Storm Agnes)
312	September, 1971	Flood
206	August, 1965	Water Shortage (Drought)

Since 1955, declarations have been issued for a variety of hazard events, including hurricanes, tornadoes, severe winter storms, and flooding. A unique Presidential Emergency Declaration was issued in September 2005 declaring that a state of emergency existed in the Commonwealth of Pennsylvania and ordered federal aid to supplement Commonwealth and local response efforts to help people evacuated

from their homes due to Hurricane Katrina. All counties within Pennsylvania, including Bucks County, were indirectly affected by Hurricane Katrina as a result of evacuee assistance.

4.2.2. Summary of Hazards

As described in Section 4.1, the HMPC was provided the Pennsylvania Standard List of Hazards to evaluate new and changing hazards in Bucks County. Following a review of the hazards considered in the 2011 HMP, the 2013 Standard State All-Hazard Mitigation Plan, and the Standard List of Hazards, the HMPT decided that the 2016 plan update should identify, profile, and analyze 21 hazards. Table 4.2-2 contains a complete list of the 21 hazards that have the potential to impact Bucks County. Hazard profiles are included in Section 4.3 for each of these hazards.

Table 4.2-2: Hazards identified in the 2016 Bucks County Hazard Mitigation Plan and their respective definitions.

HAZARD NAME	HAZARD DESCRIPTION
NATURAL HAZARDS	
Drought	Drought is a natural climatic condition which occurs in virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a long period of time, usually a season or more in length. High temperatures, prolonged winds, and low relative humidity can exacerbate the severity of drought. This hazard is of particular concern in Pennsylvania due to the presence of farms as well as water-dependent industries and recreation areas across the Commonwealth. A prolonged drought could severely impact these sectors of the local economy, as well as residents who depend on wells for drinking water and other personal uses. (National Drought Mitigation Center, 2006).
Earthquake	An earthquake is the motion or trembling of the ground produced by sudden displacement of rock usually within the upper 10-20 miles of the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of underground caverns. Earthquakes can affect hundreds of thousands of square miles, cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of persons, and disrupt the social and economic functioning of the affected area. Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking which is dependent upon amplitude and duration of the earthquake. (FEMA, 1997).
Extreme Temperature	Extreme cold temperatures drop well below what is considered normal for an area during the winter months and often accompany winter storm events. Combined with increases in wind speed, such temperatures in Pennsylvania can be life threatening to those exposed for extended periods of time. Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined (Lawrence County, PA HMP, 2004).

Table 4.2-2: Hazards identified in the 2016 Bucks County Hazard Mitigation Plan and their respective definitions.	
HAZARD NAME	**HAZARD DESCRIPTION**
Flood, Flash Flood, Ice Jam	Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding is typically experienced when precipitation occurs over a given river basin for an extended period of time. Flash flooding is usually a result of heavy localized precipitation falling in a short time period over a given location, often along mountain streams and in urban areas where much of the ground is covered by impervious surfaces. The severity of a flood event is dependent upon a combination of stream and river basin topography and physiography, hydrology, precipitation and weather patterns, present soil moisture conditions, the degree of vegetative clearing as well as the presence of impervious surfaces in and around flood-prone areas (NOAA, 2009). Winter flooding can include ice jams which occur when warm temperatures and heavy rain cause snow to melt rapidly. Snow melt combined with heavy rains can cause frozen rivers to swell, which breaks the ice layer on top of a river. The ice layer often breaks into large chunks, which float downstream, piling up in narrow passages and near other obstructions such as bridges and dams. All forms of flooding can damage infrastructure (USACE, 2007).
Hailstorm	In addition to flooding and severe winds, hail is another potential damaging product of severe thunderstorms. Hailstorms occur when ice crystals form within a low pressure front due to the rapid rise of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until, having developed sufficient weight, they fall as precipitation in the form of balls or irregularly shaped masses of ice greater than 0.75 inches in diameter (FEMA, 1997). The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Damage to crops and vehicles are typically the most significant impacts of hailstorms. Areas in eastern and central Pennsylvania typically experience less than 2 hailstorms per year while areas in western Pennsylvania experience 2-3 annually.
Hurricane, Tropical Storm, Nor'easter	Hurricanes, tropical storms, and nor'easters are classified as cyclones and are any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise (in the Northern Hemisphere) and whose diameter averages 10-30 miles across. While most of Pennsylvania is not directly affected by the devastating impacts cyclonic systems can have on coastal regions, many areas in the state are subject to the primary damaging forces associated with these storms including high-level sustained winds, heavy precipitation, and tornadoes. Areas in southeastern Pennsylvania could be susceptible to storm surge and tidal flooding. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico during the official Atlantic hurricane season (June through November) (FEMA, 1997).

Table 4.2-2: Hazards identified in the 2016 Bucks County Hazard Mitigation Plan and their respective definitions.	
HAZARD NAME	**HAZARD DESCRIPTION**
Landslide	A landslide is the downward and outward movement of slope-forming soil, rock, and vegetation reacting to the force of gravity. Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes due to construction or erosion, earthquakes, and changes in groundwater levels. Mudflows, mudslides, rockfalls, rockslides, and rock topples are all forms of a landslide. Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, developed hillsides, and areas recently burned by forest and brush fires (Delano & Wilshusen, 2001).
Lightning Strike	Lightning is a discharge of electrical energy resulting from the build-up of positive and negative charges within a thunderstorm. The flash or "bolt" of light usually occurs within clouds or between clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000°F. On average, 89 people are killed each year by lightning strikes in the United States. Within Pennsylvania, the annual average number of thunder and lightning events a given area can expect ranges between 40-70 events per year (FEMA, 1997).
Pandemic	A pandemic occurs when infection from of a new strain of a certain disease, to which most humans have no immunity, substantially exceeds the number of expected cases over a given period of time. Such a disease may or may not be transferable between humans and animals (Martin & Martin-Granel, 2006).
Radon Exposure	Radon is a cancer-causing natural radioactive gas that you can't see, smell, or taste. It is a large component of the natural radiation that humans are exposed to and can pose a serious threat to public health when it accumulates in poorly ventilated residential and occupation settings. According to the EPA, radon is estimated to cause about 21,000 lung cancer deaths per year, second only to smoking as the leading cause of lung cancer (EPA 402-R-03-003: EPA Assessment, 2003). An estimated 40% of the homes in Pennsylvania are believed to have elevated radon levels (Pennsylvania Department of Environmental Protection, 2009).
Subsidence, Sinkhole	Subsidence is a natural geologic process that commonly occurs in areas with underlying limestone bedrock and other rock types that are soluble in water. Water passing through naturally occurring fractures dissolves these materials leaving underground voids. Eventually, overburden on top of the voids causes a collapse which can damage structures with low strain tolerances. This collapse can take place slowly over time or quickly in a single event, but in either case. Karst topography describes a landscape that contains characteristic structures such as sinkholes, linear depressions, and caves. In addition to natural processes, human activity such as water, natural gas, and oil extraction can cause subsidence and sinkhole formations. (FEMA, 1997).

Table 4.2-2: Hazards identified in the 2016 Bucks County Hazard Mitigation Plan and their respective definitions.	
HAZARD NAME	**HAZARD DESCRIPTION**
Tornado, Windstorm	A wind storm can occur during severe thunderstorms, winter storms, coastal storms, or tornadoes. Straight-line winds such as a downburst have the potential to cause wind gusts that exceed 100 miles per hour. Based on 40 years of tornado history and over 100 years of hurricane history, FEMA identifies western and central Pennsylvania as being more susceptible to higher winds than eastern Pennsylvania. (FEMA, 1997). A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes or tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of high wind velocities and wind-blown debris. According to the National Weather Service, tornado wind speeds can range between 30 to more than 300 miles per hour. They are more likely to occur during the spring and early summer months of March through June and are most likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small, short-lived tornadoes can inflict tremendous damage. Destruction ranges from minor to catastrophic depending on the intensity, size, and duration of the storm. Structures made of light materials such as mobile homes are most susceptible to damage. Waterspouts are weak tornadoes that form over warm water and are relatively uncommon in Pennsylvania. Each year, an average of over 800 tornadoes is reported nationwide, resulting in an average of 80 deaths and 1,500 injuries (NOAA, 2002). Based on NOAA Storm Prediction Center Statistics, the number of recorded F3, F4, & F5 tornadoes between 1950-1998 ranges from <1 to 15 per 3,700 square mile area across Pennsylvania (FEMA, 2009b). A water spout is a tornado over a body of water (American Meteorological Society, 2009).
Wildfire	A wildfire is a raging, uncontrolled fire that spreads rapidly through vegetative fuels, exposing and possibly consuming structures. Wildfires often begin unnoticed and can spread quickly, creating dense smoke that can be seen for miles. Wildfires can occur at any time of the year, but mostly occur during long, dry hot spells. Any small fire in a wooded area, if not quickly detected and suppressed, can get out of control. Most wildfires are caused by human carelessness, negligence, and ignorance. However, some are precipitated by lightning strikes and in rare instances, spontaneous combustion. Wildfires in Pennsylvania can occur in fields, grass, brush, and forests. 98% of wildfires in Pennsylvania are a direct result of people, often caused by debris burns (DCNR-BOF, 2009).
Winter Storm	Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. A winter storm can range from a moderate snowfall or ice event over a period of a few hours to blizzard conditions with wind-driven snow that lasts for several days. Many winter storms are accompanied by low temperatures and heavy and/or blowing snow, which can severely impair visibility and disrupt transportation. The Commonwealth of Pennsylvania has a long history of severe winter weather (NOAA, 2009).

Table 4.2-2: Hazards identified in the 2016 Bucks County Hazard Mitigation Plan and their respective definitions.	
HAZARD NAME	**HAZARD DESCRIPTION**
HUMAN-MADE HAZARDS	
Structure Collapse (Infrastructure)	Collapse of a building or structure refers to the loss of the load-carrying capacity of a component of the structure or the entire structure itself. The loss of a structure's load carrying capacity occurs when the loads applied to the structure exceed the structure's load-carrying capacity. This can be a result of improper design, lack of maintenance, events from a structure's load history that have gradually reduced its load-carrying capacity, or sudden and severe hazard events such as severe weather or terrorism (Ratay, 2000).
Dam Failure	A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but immense damage and loss of life is possible in downstream communities when such events occur. Aging infrastructure, hydrologic, hydraulic, and geologic characteristics, population growth, and design and maintenance practices should be considered when assessing dam failure hazards. The failure of the South Fork Dam, located in Johnstown, PA, was the deadliest dam failure ever experienced in the United States. It took place in 1889 and resulted in the Johnstown Flood which claimed 2,209 lives (FEMA, 1997). Today there are approximately 3,200 dams and reservoirs throughout Pennsylvania (Pennsylvania Department of Environmental Protection, 2009).
Environmental Hazards	Environmental hazards are hazards that pose threats to the natural environment, the built environment, and public safety through the diffusion of harmful substances, materials, or products. For the purposes of the Bucks County HMP, environmental hazards focuses on Hazardous material releases at fixed facilities or in transit; including toxic chemicals, infectious substances, biohazardous waste, and any materials that are explosive, corrosive, flammable, or radioactive (PL 1990-165, § 207(e)).
Terrorism	Terrorism is use of force or violence against persons or property with the intent to intimidate or coerce. Acts of terrorism include threats of terrorism; assassinations; kidnappings; hijackings; bomb scares and bombings; cyber-attacks (computer-based); and the use of chemical, biological, nuclear, and radiological weapons (FEMA, 2009a). Active shooter incidents are considered acts of terrorism, as the physical and emotional effect on a community is analogous to that of another type of terrorist attack. Increasingly, cyber-attacks and active shooter events have become more pressing concerns for governments across America.
Transportation Accident	Transportation accidents can result from any form of air, rail, water, or road travel. It is unlikely that small accidents would significantly impact the larger community. However, certain accidents could have secondary regional impacts such as a hazardous materials release or disruption in critical supply/access routes, especially if vital transportation corridors or junctions are present (US DOT, 2009). Traffic congestion in certain circumstances can also be hazardous. Traffic congestion is a condition that occurs when traffic demand approaches or exceeds the available capacity of the road network. This hazard should be carefully evaluated during emergency planning since it is a key factor in timely disaster or hazard response, especially in areas with high population density (Federal Highway Administration, 2009).

Table 4.2-2: Hazards identified in the 2016 Bucks County Hazard Mitigation Plan and their respective definitions.	
HAZARD NAME	**HAZARD DESCRIPTION**
Urban Fire and Explosion	An urban fire involves a structure or property within an urban or developed area. For hazard mitigation purposes, major urban fires involving large buildings and/or multiple properties are of primary concern. The effects of a major urban fire include minor to significant property damage, loss of life, and residential or business displacement. Explosions are extremely rapid releases of energy that usually generate high temperatures and often lead to fires. The risk of severe explosions can be reduced through careful management of flammable and explosive hazardous materials. (FEMA, 1997).
Utility Interruption	Utility interruption hazards are hazards that impair the functioning of important utilities in the energy, telecommunications, public works, and information network sectors. Utility interruption hazards include the following: • **Geomagnetic Storms**; including temporary disturbances of the Earth's magnetic field resulting in disruptions of communication, navigation, and satellite systems (National Research Council et al., 1986). • **Fuel or Resource Shortage**; resulting from supply chain breaks or secondary to other hazard events. • **Electromagnetic Pulse**; originating from an explosion or fluctuating magnetic field and causing damaging current surges in electrical and electronic systems (Institute for Telecommunications Sciences, 1996). • **Information Technology Failure**; due to software bugs, viruses, or improper use (Rainer Jr., et al, 1991). • **Ancillary Support Equipment**; electrical generating, transmission, system-control, and distribution-system equipment for the energy industry (Hirst & Kirby, 1996). • **Public Works Failure**; damage to or failure of highways, flood control systems, deepwater ports and harbors, public buildings, bridges, dams, for example (United States Senate Committee on Environment and Public Works, 2009). • **Telecommunications System Failure**; Damage to data transfer, communications, and processing equipment, for example (FEMA, 1997) • **Transmission Facility or Linear Utility Accident**; liquefied natural gas leakages, explosions, facility problems, for example (United States Department of Energy, 2005) • **Major Energy, Power, Utility Failure**; interruptions of generation and distribution, power outages, for example (United States Department of Energy, 2000).

4.3. Hazard Profiles and Vulnerability Analysis

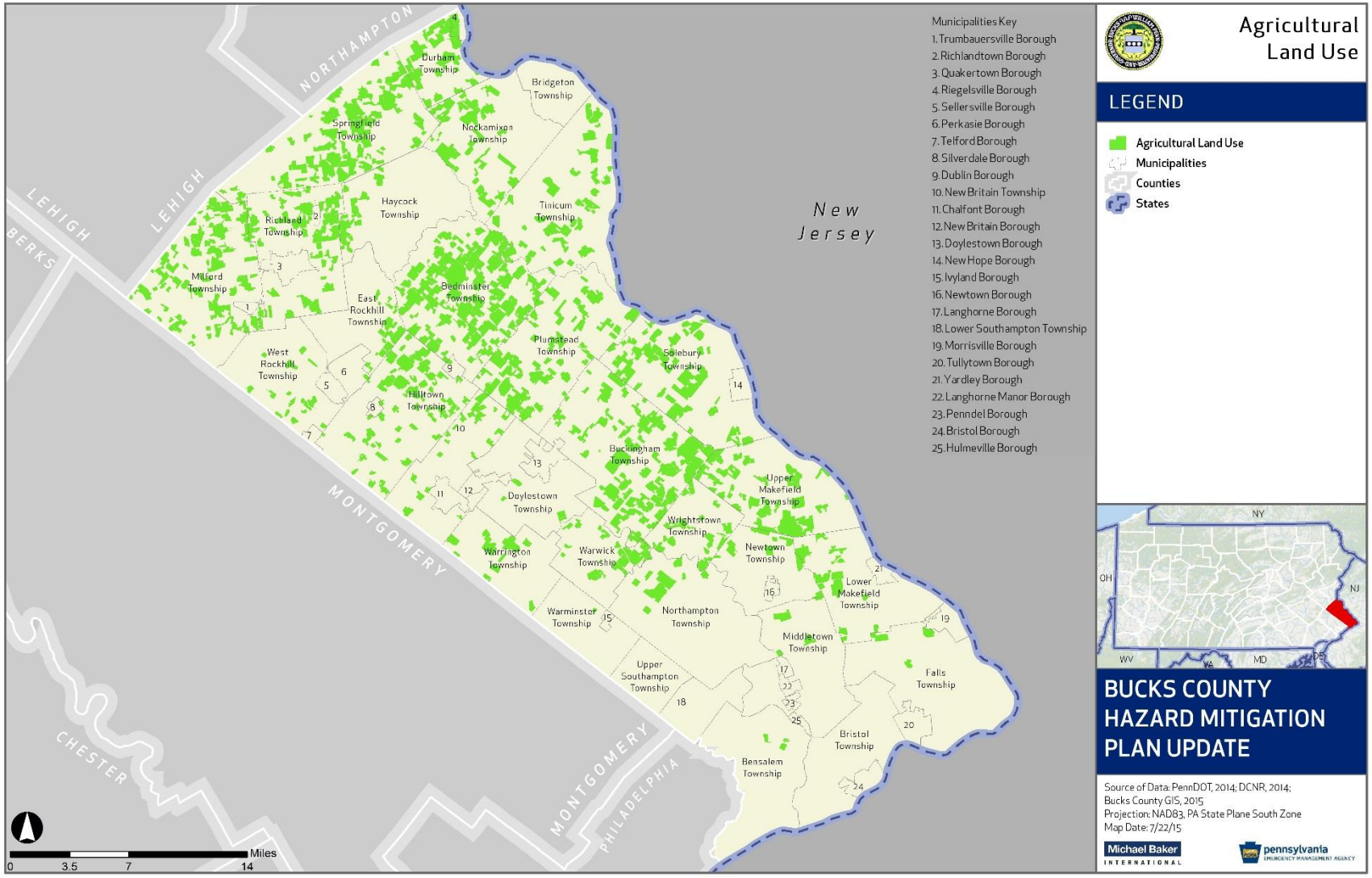
NATURAL HAZARDS

4.3.1. Drought

4.3.1.1. Location and Extent

Droughts are regional climatic events, so when these events occur in Bucks County, impacts are felt across the County as well as in areas outside the County boundaries. The spatial extent for areas of impact can range from localized areas in Pennsylvania to the entire Mid-Atlantic region. Areas with extensive agricultural land uses are most vulnerable to drought; as shown in Figure 4.3.1-1, these uses are largely found in the northern and central portions of the County.

Figure 4.3.1-1: Agricultural land use in Bucks County.



4.3.1.2. Range of Magnitude

Drought is a normal part of virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a long period of time, usually a season or more in length. High temperatures, prolonged winds, and low relative humidity can exacerbate the severity of drought. Hydrologic drought events result in a reduction of stream flows, reduction of lake/reservoir storage, and a lowering of groundwater levels. These events have adverse impacts on public water supplies for human consumption, rural water supplies for livestock consumption and agricultural operations, water quality, natural soil water or irrigation water for agriculture, soil moisture, conditions conducive to wildfire events, and water for navigation and recreation.

The Commonwealth uses five parameters to assess drought conditions:

1. Stream flows (compared to benchmark records)
2. Precipitation (measured as the departure from normal, 30 year average precipitation)
3. Reservoir storage levels in a variety of locations (especially three New York City reservoirs in upper Delaware River Basin)
4. Groundwater elevations in a number of counties (comparing to past month, past year and historic record)
5. The Palmer Drought Severity Index – a soil moisture algorithm calibrated for relatively homogeneous regions which measures dryness based on recent precipitation and temperature (see Table 4.3.1-1).

Table 4.3.1-1: Palmer Drought Severity Index (PSDI) classifications (NDMC, 2009).

SEVERITY CATEGORY	PSDI VALUE
Extremely wet	4.0 or more
Very wet	3.0 to 3.99
Moderately wet	2.0 to 2.99
Slightly wet	1.0 to 1.99
Incipient wet spell	0.5 to 0.99
Near normal	0.49 to -0.49
Incipient dry spell	-0.5 to -0.99
Mild drought	-1.0 to -1.99
Moderate drought	-2.0 to -2.99
Severe drought	-3.0 to -3.99
Extreme drought	-4.0 or less

Phases of drought preparedness in Pennsylvania in order of increasing severity are:

- Drought Watch: A period to alert government agencies, public water suppliers, water users and the public regarding the potential for future drought-related problems. The focus is on increased monitoring, awareness and preparation for response if conditions worsen. A request for voluntary water conservation is made. The objective of voluntary water conservation measures during a drought watch is to reduce water uses by 5 percent in the affected areas. Due to varying

conditions, individual water suppliers or municipalities may be asking for more stringent conservation actions.

- Drought Warning: This phase involves a coordinated response to imminent drought conditions and potential water supply shortages through concerted voluntary conservation measures to avoid or reduce shortages, relieve stressed sources, develop new sources, and if possible forestall the need to impose mandatory water use restrictions. The objective of voluntary water conservation measures during a drought warning is to reduce overall water uses by 10-15 percent in the affected areas. Due to varying conditions, individual water suppliers or municipalities may be asking for more stringent conservation actions.
- Drought Emergency: This stage is a phase of concerted management operations to marshal all available resources to respond to actual emergency conditions, to avoid depletion of water sources, to assure at least minimum water supplies to protect public health and safety, to support essential and high priority water uses and to avoid unnecessary economic dislocations. It is possible during this phase to impose mandatory restrictions on non-essential water uses that are provided in the Pennsylvania Code (Chapter 119), if deemed necessary and if ordered by the Governor of Pennsylvania. The objective of water use restrictions (mandatory or voluntary) and other conservation measures during this phase is to reduce consumptive water use in the affected area by fifteen percent, and to reduce total use to the extent necessary to preserve public water system supplies, to avoid or mitigate local or area shortages, and to assure equitable sharing of limited supplies.
- Local Water Rationing: Although not a drought phase, local municipalities may, with the approval of the PA Emergency Management Council, implement local water rationing to share a rapidly dwindling or severely depleted water supply in designated water supply service areas. These individual water rationing plans, authorized through provisions of the Pennsylvania Code (Chapter 120), will require specific limits on individual water consumption to achieve significant reductions in use. Under both mandatory restrictions imposed by the Commonwealth and local water rationing, procedures are provided for granting of variances to consider individual hardships and economic dislocations.

Environmental impacts of drought include:

- Hydrologic effects – lower water levels in reservoirs, lakes, and ponds; reduced streamflow; loss of wetlands; estuarine impacts; groundwater depletion and land subsidence; effects on water quality such as increases in salt concentration and water temperature
- Damage to animal species – lack of feed and drinking water; disease; loss of biodiversity; migration or concentration; and reduction and degradation of fish and wildlife habitat
- Damage to plant communities – loss of biodiversity; loss of trees from urban landscapes and wooded conservation areas
- Increased number and severity of fires
- Reduced soil quality
- Air quality effects – dust and pollutants
- Loss of quality in landscape

The worst case drought event in Bucks County occurred in July of 1999. The County only received about seventy-five percent of the expected rainfall between April and September (Penn State College of Agricultural Sciences, October 2, 2010). A drought warning was issued and residents were encouraged to conserve water due to low level of ground and surface water, reducing the overall water supply (ABCNews, September 17, 2010). Both the Governor's Proclamation and the President's Declaration of Major Disaster were announced due to the severity of the drought. Many staple crops such as corn, hay, and soybeans were reduced to ten percent of the normal yield. Fruits, vegetables, and pasture land were hit hard, along with dairy farmers, who had to purchase water to survive the drought. This not only affected Bucks County but the whole of Pennsylvania (Pennridge School District, 2011).

4.3.1.3. Past Occurrence

Between 1930 and 1994, the Commonwealth of Pennsylvania experienced five significant droughts: 1930-1934, 1939-1942, 1953-1955, 1961-1967, and 1991-1992. From 1999 through early 2003, the area experienced a severe drought (per the PA Department of Environmental Protection (DEP)). The DEP maintains the most comprehensive data on drought occurrences across Pennsylvania. Declared drought status for Bucks County from 1980 to Present is shown in Table 4.3.1-2. Descriptions for drought status categories (i.e. watch, warning, and emergency) are included in Section 4.3.1.1.

Table 4.3.1-2: Past Drought Events in Bucks County (PADEP, 2015)

DATE	DROUGHT STATUS	DATE	DROUGHT STATUS
Nov 6, 1980 - Nov 7, 1980	Normal	Jan 15, 1999 - Mar 15, 1999	Warning
Nov 7, 1980 - Nov 14, 1980	Normal	Mar 15, 1999 - Jun 10, 1999	Watch
Nov 14, 1980 - Nov 18, 1980	Normal	Jun 10, 1999 - Jun 18, 1999	Warning
Nov 18, 1980 - Apr 20, 1982	Emergency	Jun 18, 1999 - Jul 20, 1999	Warning
Nov 8, 1982 - Nov 10, 1982	Normal	Jul 20, 1999 - Sep 30,1999	Emergency
Nov 10, 1982 - Feb 8, 1983	Warning	Sep 30, 1999 - Dec 16, 1999	Watch
Feb 8, 1983 - March 28, 1983	Warning	Dec 16, 1999 - Feb 25,2000	Watch
Jan 23, 1985 - Apr 26, 1985	Warning	Feb 25, 2000 - May 5, 2000	Watch
Apr 26, 1985 - Jul 29, 1985	Emergency	Aug 8, 2001 - Aug 24, 2001	Normal
Jul 29, 1985 - Oct 22, 1985	Emergency	Aug 24, 2001 - Nov 6, 2001	Normal
Oct 22, 1985 - Oct 29, 1985	Emergency	Nov 6, 2001 - Dec 5, 2001	Watch
Oct 29, 1985 - Dec 19, 1985	Emergency	Dec 5, 2001 - Feb 12, 2002	Warning
Jul 7, 1988 - Aug 24, 1988	Watch	Feb 12, 2002 - May 13, 2002	Emergency
Aug 24, 1988 - Dec 12, 1988	Watch	May 13, 2002 - Jun 14, 2002	Emergency
Mar 3, 1989 - May 15, 1989	Warning	Jun 14, 2002 - Aug 9, 2002	Warning
Jun 28, 1991 - Jul 24, 1991	Normal	Aug 9, 2002 - Sep 5, 2002	Warning
Jul 24, 1991 - Aug 16, 1991	Normal	Sep 5, 2002 - Nov 7, 2002	Emergency
Aug 16, 1991 - Sep 13, 1991	Normal	Nov 7, 2002 - Dec 19, 2002	Warning
Sep 13, 1991 - Oct 21, 1991	Warning	Dec 19, 2002 - Jan 8, 2003	Normal
Oct 21, 1991 - Jan 16, 1992	Warning	Jan 8, 2003 - Jun 18, 2003	Normal
Jan 17, 1992 - Apr 20, 1992	Warning	Apr 11, 2006 - Jun 30, 2006	Watch

Table 4.3.1-2: Past Drought Events in Bucks County (PADEP, 2015)			
DATE	DROUGHT STATUS	DATE	DROUGHT STATUS
Apr 20, 1992 - Jun 23, 1992	Warning	Aug 8, 2007 - Sep 5, 2007	Normal
Jun 23, 1992 - Sep 11, 1992	Warning	Sep 5, 2007 - Oct 5, 2007	Normal
Sep 11, 1992 - Jan 15, 1993	Watch	Oct 5, 2007 - Jan 11, 2008	Watch
Sep 1, 1995 - Sep 20, 1995	Warning	Jan 11, 2008 - Feb 15, 2008	Watch
Sep 20, 1995 - Nov 8, 1995	Emergency	Nov 7, 2008 - Jan 26, 2009	Normal
Nov 8, 1995 - Dec 18, 1995	Warning	Jan 26, 2009 - Sept 16, 2010	Normal
Jul 17, 1997 - Oct 27, 1997	Normal	Sept 16, 2010 - Nov 10 2010	Warning
Oct 27, 1997 - Nov 13, 1997	Watch	Nov 10, 2010 - Dec 17, 2010	Normal
Nov 13, 1997 - Jan 16, 1998	Warning	Dec 17, 2010 - Aug 5, 2011	Normal
Jan 16, 1998 - Feb 19, 1998	Normal	Aug 5, 2011 - Sept 2, 2011	Watch
Feb 19, 1998 - Spring 1998	Normal	Sept 2, 2011 - Oct 13, 2011	Normal
Dec 3, 1998 - Dec 8, 1998	Watch	Oct 13, 2011 - July 19, 2012	Normal
Dec 8, 1998 - Dec 14, 1998	Watch	July 19, 2012 - Aug 31, 2012	Normal
Dec 14, 1998 - Dec 16, 1998	Warning	Aug 31, 2012 - March 24, 2015	Normal
Dec 16, 1998 - Jan 15, 1999	Warning	March 24, 2015 - Present (6/2015)	Normal

According to DEP's Watershed Management Drought Information Center, the County has had four drought watches and two drought warnings in the period since the last drought emergency ending in November of 2002. As can be seen from Table 4.3.1-2 above, Bucks County has not had a declared drought since Fall 2010; however, some of the agricultural lands have experienced loss due to drought conditions. The USDA Risk Management Agency operates and manages the Federal Crop Insurance Corporation program. Since Bucks County farms are eligible for crop insurance, it is possible to determine agricultural losses due to drought in the county. Table 4.3.1-3 displays the crop loss insurance payments by year due to drought (including even mild drought occurrences) since 1980.

Table 4.3.1-3: Crop loss insurance compensation due to drought (U.S. Dept. RMA, 2015).	
CROP YEAR	INDEMNITY AMOUNT ($)
2014	33,268
2013	3,102
2012	93,408
2011	64,040
2010	224,411
2007	5,779
2006	10,778
2005	26,618
2004	6,320
2002	60,295

Table 4.3.1-3: Crop loss insurance compensation due to drought (U.S. Dept. RMA, 2015).	
CROP YEAR	**INDEMNITY AMOUNT ($)**
2001	1,693
1999	37,260
Total	**566,971**

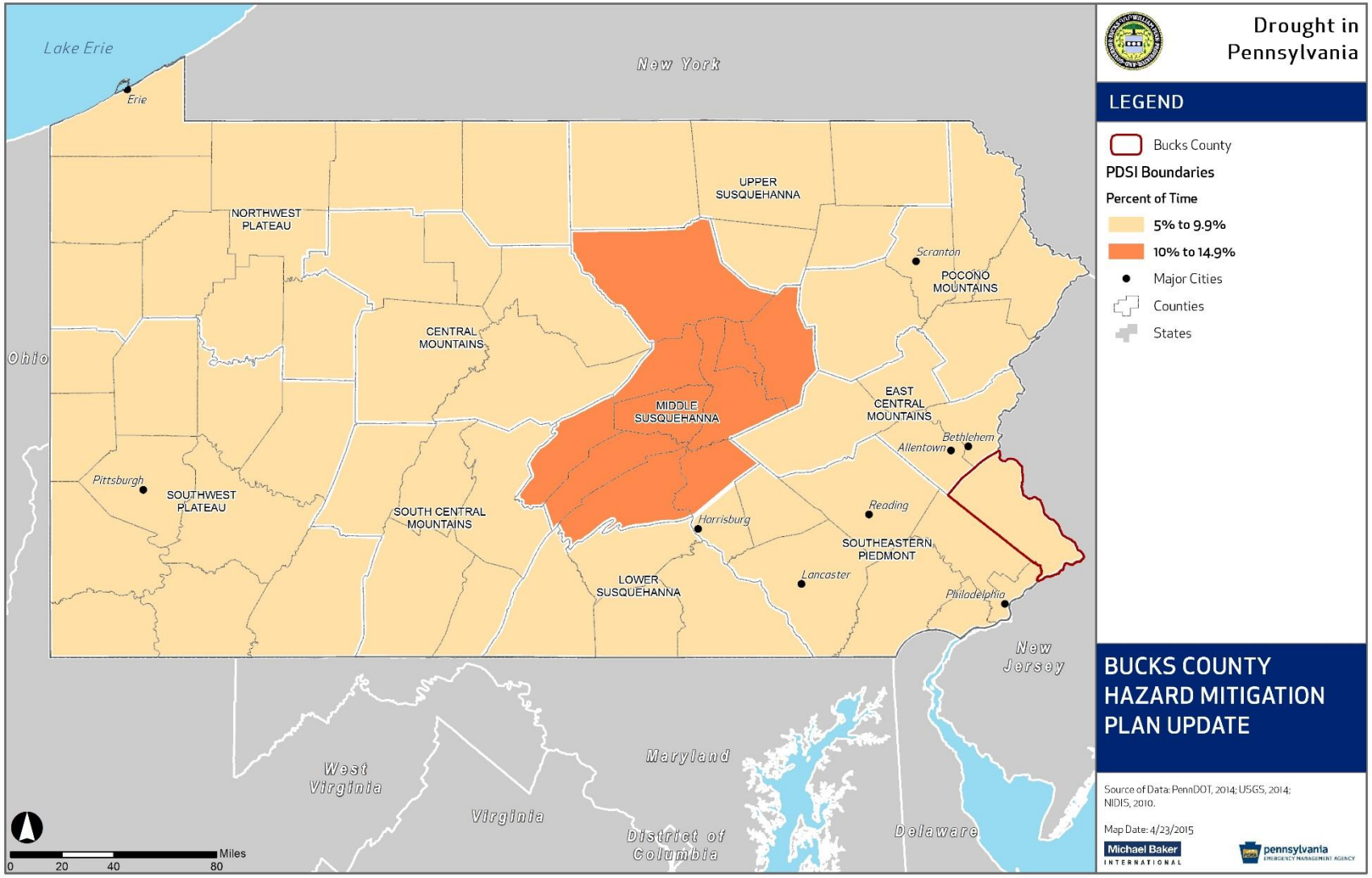
Of the crop losses summarized in Table 4.3.1-3, the crop that suffered the most substantial losses (as defined by indemnity amount) was corn. Table 4.3.1-4 provides the total indemnity amount by crop type for crop years 1952 through 2014.

Table 4.3.1-4: Crop loss insurance compensation by crop type (U.S. Dept. RMA, 2015)	
CROP	**INDEMNITY AMOUNT ($)**
CORN	240,963
FRESH MARKET SWEET CORN	83,852
GRAIN SORGHUM	2,337
NURSERY (FG&C)	21,256
OATS	21
SOYBEANS	168,670
WHEAT	6,237
WINTER SQUASH	43,635
Total	**566,971**

One way to measure the magnitude of a drought is through the Palmer Drought Severity Index. This index is based on several meteorological and hydrological factors, including temperature and soil moisture levels, and is computed weekly by the National Weather Service's Climate Prediction Center. The index compares precipitation received against the average amount expected during that period. Droughts are expressed as negative numbers. Palmer values of -2.00 to -2.99 indicate a watch status; values of -3.00 to -3.99 indicate a warning; and values of -4.00 and less indicate an emergency.

According to the Palmer Drought Severity Index and seen in Figure 4.3.1-2 below, Bucks County spent 5% to 9.9% of the time between 1895 and 1995 in a severe and extreme drought (i.e., Palmer values less than or equal to -3). The following figure displays these findings and Bucks County in relation to other areas in Pennsylvania.

Figure 4.3.1-2: Pennsylvania Palmer Drought Severity Index for Bucks County (PDSI, NIDIS, 2010)



4.3.1.4. Future Occurrence

It is difficult to forecast the exact severity and frequency of future drought events in Bucks County, but the County Hazards and Vulnerability Analysis (HVA) reports that droughts have become more frequent in recent years, and the demand for water is ever increasing (BCEMA, 2011). Based on national data from 1895 to 1995, Bucks County is in severe or extreme drought approximately 5 to 9.9 percent of the time, which is represented by the cream color in Figure 4.3.1-2. This is equivalent to a PDSI value less than or equal to -3. Figure 4.3.1-2 illustrates that Bucks County, highlighted with a red border, is in the zone of the Commonwealth with lower drought prevalence; the only area of the Commonwealth with higher drought prevalence is highlighted orange along the Middle Susquehanna. Therefore, the future occurrence of drought for Bucks County can be considered *possible* as defined by the Risk Factor methodology probability criteria (see Table 4.4-1).

4.3.1.5. Vulnerability Assessment

Drought is a concern for Bucks County residents because of the presence of farms and other water-dependent industry and recreation in the area. A prolonged drought could negatively impact these sectors of the local economy, as well as residents who depend on wells for drinking and other personal uses. The most significant losses resulting from drought events are typically found in the agriculture sector of the County's economy. For example, the drought in 1999 resulted in a Gubernatorial Proclamation of Emergency in part because of significant crop damage. Preliminary damage estimates by the US Department of Agriculture (USDA) indicated possible crop losses across Pennsylvania in excess of $500 million. This figure did not include a 20 percent decrease in dairy milk production statewide, which also resulted in million dollar losses (NCDC, 2015).

While these were statewide impacts, they illustrate the potential for droughts to severely impair the local economy in more agricultural communities. Bucks County ranks 31st out of the 67 counties in Pennsylvania, with agricultural production totaling $62.4 million (USDA, 2012). About 75 percent of this total is the production of crops, including nursery and greenhouse crops ($46.8 million); the remaining agricultural production is made up of livestock, poultry, and their products (USDA, 2012). The county ranks 6th in nursery, greenhouse, floriculture, and sod in Pennsylvania by sales value. Other important crops include fruits, tree nuts, and berries; vegetables, melons, potatoes, and sweet potatoes; and the sale of livestock, such as horses, ponies, mules, burros, and donkeys (USDA, 2012). Table 4.3.1-5 lists the top livestock inventory items in Bucks County. With these agricultural assets, drought events can severely impair the local economy with prolonged drought negatively impacting the livelihood of residents within agricultural communities particularly.

Table 4.3.1-5: Top Livestock Inventory Items in Bucks County (USDA, 2012).

LIVESTOCK	COUNT
Layers	11,449
Cattle and calves	6,968
Horses and ponies	3,232
Chukars	2,040
Sheep and lambs	1,907

Wildfire is the most severe secondary effect associated with drought. Wildfires can devastate wooded and agricultural areas, threatening natural resources and farm production facilities. Prolonged drought conditions can cause major ecological changes, such as increases in scrub growth, flash flooding, and soil erosion.

Water supplies are also vulnerable to the effects of drought. Water supply vulnerability can stem from two primary factors, quantity and quality, both which may be impacted by drought. While the impact of drought is concerning, Bucks County has the support of many agencies that administer programs to mitigate hazards associated with water supply sources and systems. These agencies represent a supportive network that protects Bucks County's water from the negative impacts of drought and other hazards. The *Bucks County Comprehensive Plan* outlines county-wide capability and assets that are potentially vulnerable to drought; assets are addressed in the following paragraphs.

According to the *Bucks County Comprehensive Plan*, the county is serviced by the following types of water suppliers: 3 private; 12 municipal; and 17 municipal, joint municipal or county water authorities. Table 4.3.1-6 outlines the major community water suppliers in the County and the municipalities served.

Table 4.3.1-6: Major Community Water Suppliers in Bucks County and Municipalities Served (BCPC, 2011)

COMPANY	MUNICIPALITIES SERVED
Aqua PA	Bristol, Chalfont, New Britain boroughs, Bensalem, Bristol, New Britain, Solebury townships
Newtown Artesian Water Company	Newtown Borough, Middletown, Newtown townships
PA American Water Company	Yardley Borough, Falls, Lower Makefield townships
MUNICIPAL WATER DEPARTMENTS	
Bristol Township Water Department	Bristol Township
Buckingham Township Water & Wastewater Department	Buckingham Township
Doylestown Borough Water Department	Doylestown Borough, Buckingham, Doylestown townships
Dublin Borough Water Department	Dublin Borough
Falls Township Water & Sewer Department	Bristol, Falls, Middletown townships
Plumstead Township	Plumstead Township
Quakertown Water Department	Quakertown Borough, Milford, Richland townships
Richland Township Water & Sewer Department	Milford and Richland townships
Richlandtown Municipal Waterworks	Richlandtown Borough
Riegelsville Waterworks	Riegelsville Borough
Trumbauersville Borough Municipal Waterworks	Milford Township, Trumbauersville Borough
Warrington Township Water & Sewer Department	Warrington, Warwick townships
MUNICIPAL, JOINT MUNICIPAL, AND COUNTY AUTHORITIES	
Bedminster Municipal Authority	Bedminster Township

Table 4.3.1-6: Major Community Water Suppliers in Bucks County and Municipalities Served (BCPC, 2011)	
COMPANY	**MUNICIPALITIES SERVED**
Bucks County Water & Sewer Authority	Hulmeville, Langhorne, Langhorne Manor, New Hope, Penndel boroughs, Lower Southampton, Middletown, Solebury, Springfield townships
Doylestown Township Municipal Authority	New Britain Borough, Buckingham, Doylestown, New Britain, Plumstead, Warrington townships
Hilltown Township Water & Sewer Authority	Hilltown Township, Silverdale Borough
Hulmeville Municipal Authority	Hulmeville Borough
Lower Bucks County Joint Municipal Authority	Tullytown Borough, Bristol, Falls, Middletown townships
Milford Township Water Authority	Milford Township
Morrisville Municipal Authority	Morrisville Borough, Falls, Lower Makefield townships
North Penn Water Authority	Sellersville Borough, East Rockhill, Hilltown, New Britain, West Rockhill townships
North Wales Water Authority	New Britain Township
Northampton Bucks County Municipal Authority	Northampton Township
Perkasie Borough Authority	Perkasie Borough, East Rockhill, Hilltown, West Rockhill townships
Springfield Water Authority	Springfield Township
Telford Borough Authority	Telford Borough, Hilltown and West Rockhill townships
Upper Southampton Authority	Northampton, Upper Southampton, Warminster townships
Warminster Township Municipal Authority	Ivyland Borough, Warminster, Warwick townships
Warwick Township Water & Sewer Authority	Warwick Township

Bucks County residents that use private domestic wells are more vulnerable to droughts. Table 4.3.1-7 displays the number of domestic wells per municipality. It is important to note that the well data was obtained from the Pennsylvania Groundwater Information System (PaGWIS). PaGWIS relies on voluntary submissions of well record data by well drillers; as a result, it is not a complete database of all domestic wells in the County. This is the most complete dataset of domestic wells available. As seen in Table 4.3.1-7, the municipalities with the highest number of domestic wells are Buckingham, Solebury, Upper Makefield, and Plumstead Townships.

Table 4.3.1-7: PaGWIS Data for Bucks County (DCNR, 2015).			
MUNICIPALITY	**NUMBER OF REPORTED DOMESTIC WELLS**	**MUNICIPALITY**	**NUMBER OF REPORTED DOMESTIC WELLS**
Bedminster Township	746	Newtown Township	126
Bensalem Township	470	Nockamixon Township	899
Bridgeton Township	388	Northampton Township	764

Table 4.3.1-7: PaGWIS Data for Bucks County (DCNR, 2015).

MUNICIPALITY	NUMBER OF REPORTED DOMESTIC WELLS	MUNICIPALITY	NUMBER OF REPORTED DOMESTIC WELLS
Bristol Borough	207	Penndel Borough	23
Bristol Township	352	Perkasie Borough	119
Buckingham Township	1,568	Plumstead Township	1,313
Chalfont Boroughs	66	Quakertown Borough	124
Doylestown Borough	76	Richland Township	716
Doylestown Township	930	Richlandtown Borough	16
Dublin Borough	95	Riegelsville Borough	7
Durham Township	208	Sellersville Borough	18
East Rockhill Township	591	Silverdale Borough	9
Falls Township	264	Solebury Township	1,388
Haycock Township	475	Springfield Township	886
Hilltown Township	910	Telford Borough	3
Hulmeville Borough	30	Tinicum Township	802
Ivyland Borough	21	Trumbauersville Borough	23
Langhorne Borough	33	Tullytown Borough	20
Langhorne Manor Borough	38	Upper Makefield Township	1,385
Lower Makefield Township	198	Upper Southampton Township	248
Lower Southampton Township	179	Warminster Township	514
Middletown Township	312	Warrington Township	472
Milford Township	992	Warwick Township	484
Morrisville Borough	60	West Rockhill Township	475
New Britain Borough	36	Wrightstown Township	627
New Britain Township	450	Yardley Borough	25
New Hope Borough	128	Unknown	464
Newtown Borough	64	**Total**	**21,837**

Although the greatest amount of groundwater obtained in Bucks County is from wells, springs are a significant source of water supply in a few instances (e.g. Riegelsville Borough and Springfield Township) (BCPC, 2011). In addition, many of the Bucks County water suppliers obtaining water from surface sources also use wells to augment available water supplies or have wells available for emergency backup.

The number of county residents dependent on groundwater supplies (both public and private) for their household water supply needs has been steadily declining. The decrease is a result of additional development occurring in areas served by public water supplies which withdraw mainly from surface water sources (e.g., rivers and streams). The construction and expansion of the Forest Park Treatment Plant and the construction of the Point Pleasant Pumping Station have increased surface water withdrawals further. Great strides have been taken towards the improvement of water quality in Bucks County. Many of the municipal wastewater treatment plants within the county have been upgraded to provide advanced secondary treatment and many municipalities now have industrial pretreatment ordinances requiring industries to treat wastewater before releasing into a public wastewater treatment system. Thus, the cleanup of industrial and municipal wastewater has helped ensure the integrity of surface water supply systems.

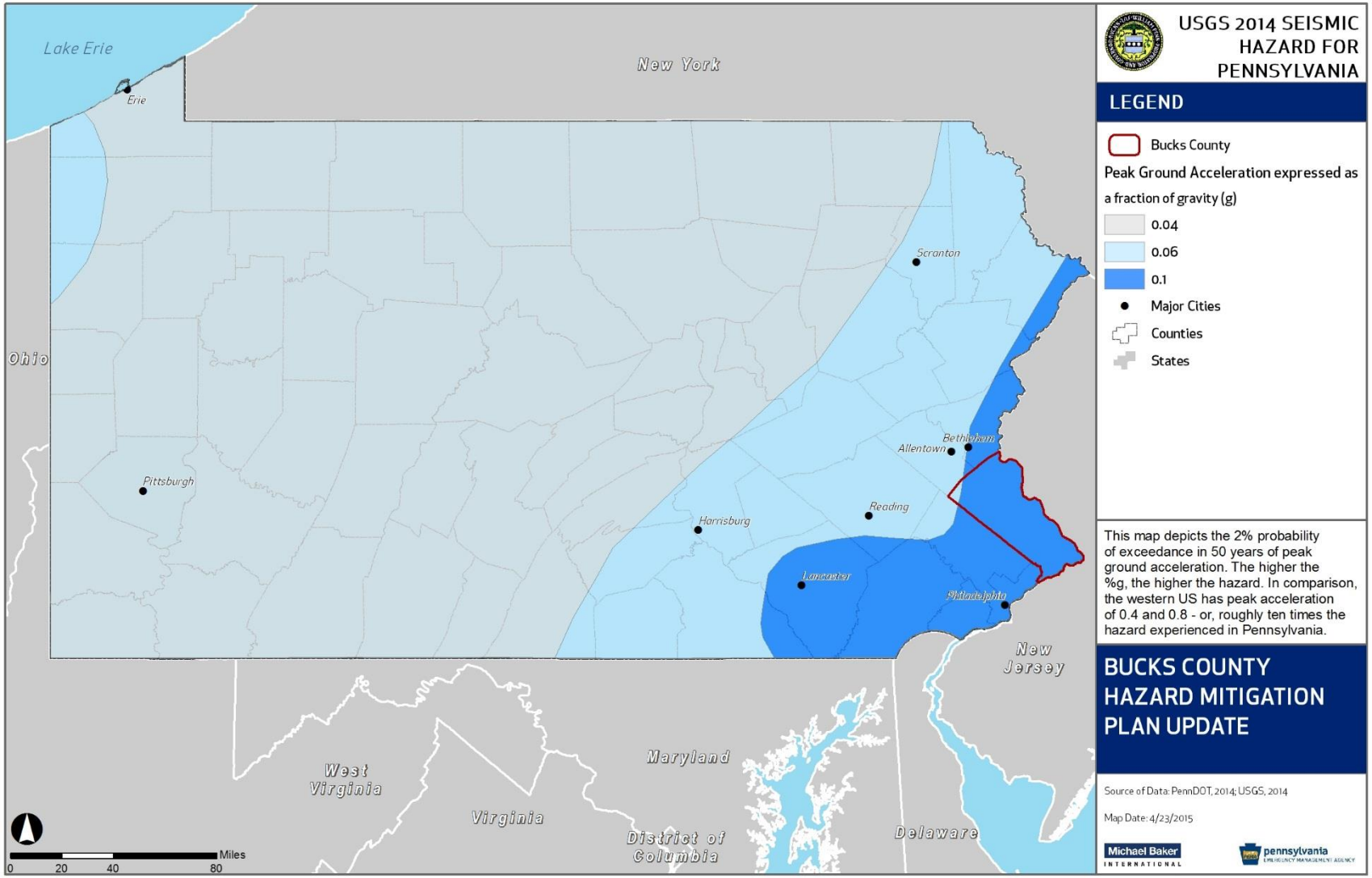
Surface water sources include the Delaware River, North Branch Neshaminy Creek, Pine Run, and man-made impoundments on some of the smaller streams in the county. Other sources of surface water in the county include the Ironworks Reservoir on Ironworks Creek in Northampton Township and the Smoketown Creek catch basin which is located on a tributary to Three Mile Run in West Rockhill Township.

4.3.2. Earthquake

4.3.2.1. Location and Extent

Earthquake events in Pennsylvania typically do not impact areas greater than 100 km from the epicenter, and earthquake epicenters in Bucks County are not common. The area does not have a significant history of seismicity, and USGS downgraded the probabilistic seismic hazard for much of Pennsylvania in 2014. Figure 4.3.2-1 shows the 2014 earthquake hazard in Pennsylvania and Bucks County, expressed as the two-percent probability of exceedance in 50 years of peak ground acceleration (g). This map was digitized from the 2014 National Seismic Hazard report. Bucks County lies in the 0.1 zone, indicating that the hazard is slightly greater than the rest of Pennsylvania. Earthquakes originating from outside Pennsylvania can also impact the Commonwealth, as was the case with a magnitude 5.8 earthquake in Virginia in August 2011 (see Section 4.3.2.3).

Figure 4.3.2-1: Earthquake hazard zones for Pennsylvania, highlighting Bucks County.



4.3.2.2. Range of Magnitude

Earthquake magnitude is often measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake. Table 4.3.2-1 summarizes Richter Scale magnitudes as they relate to the spatial extent of impacted areas. A historical survey of earthquakes occurring within Bucks County indicates that earthquakes have generally had magnitudes of up to 3.3 with most magnitudes between 2 and 3. Pennsylvania has not experienced any earthquakes with a magnitude greater than 6.0.

Table 4.3.2-1: Richter scale magnitudes and associated earthquake size effects.

RICHTER MAGNITUDES	EARTHQUAKE EFFECTS
Less than 3.5	Generally not felt, but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most, slight damage to well-designed buildings; can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive up to about 100 kilometers from epicenter.
7.0-7.9	Major earthquake; can cause serious damage over large areas.
8.0 or greater	Great earthquake; can cause serious damage in areas several hundred kilometers across.

The Richter Scale does not give any indication of the impact or damage of an earthquake, although it can be inferred that higher magnitude events cause more damage. Instead, the impact of an earthquake event is measured in terms of earthquake intensity, usually measured using the Modified Mercalli Intensity Scale, shown in Table 4.3.2-2. Based on historical data of earthquakes with a recorded Intensity, little damage is expected from earthquake events. Only two epicenters in Bucks County have intensity recorded. The strongest occurred near Croyden Heights on December 27th, 1961 with a recorded magnitude of 3.3 and an intensity of V. The second was a 2.4 magnitude earthquake with an intensity of II that occurred near Penndel on May 12th, 1982.

Table 4.3.2-2: Modified Mercalli Intensity Scale with associated impacts.

SCALE	INTENSITY	DESCRIPTION OF EFFECTS	CORRESPONDING RICHTER SCALE MAGNITUDE
I	**Instrumental**	Usually detected only on seismographs.	<4.2
II	**Feeble**	Felt only by a few persons at rest, especially on upper floors of buildings.	
III	**Slight**	Felt quite noticeably indoors, especially on upper floors. Most people don't recognize it as an earthquake (i.e. a truck rumbling).	
IV	**Moderate**	Can be felt by people walking; dishes, windows, and doors are disturbed.	
V	**Slightly Strong**	Sleepers are awoken; unstable objects are overturned.	<4.8
VI	**Strong**	Trees sway; suspended objects swing; objects fall off shelves; damage is slight.	<5.4

Table 4.3.2-2: Modified Mercalli Intensity Scale with associated impacts.

SCALE	INTENSITY	DESCRIPTION OF EFFECTS	CORRESPONDING RICHTER SCALE MAGNITUDE
VII	Very Strong	Damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built or badly designed structures; some chimneys are broken.	<6.1
VIII	Destructive	Damage is slight in specially designed structures; considerable in ordinary, substantial buildings. Moving cars become uncontrollable; masonry fractures, poorly constructed buildings damaged.	<6.9
IX	Ruinous	Some houses collapse, ground cracks, pipes break open; damage is considerable in specially designed structures; buildings are shifted off foundations.	
X	Disastrous	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed along with foundations. Ground cracks profusely; liquefaction and landslides widespread.	<7.3
XI	Very Disastrous	Most buildings and bridges collapse, roads, railways, pipes and cables destroyed.	<8.1
XII	Catastrophic	Total destruction; trees fall; lines of sight and level are distorted; ground rises and falls in waves; objects are thrown upward into the air.	>8.1

Since the worst earthquake recorded in Pennsylvania was a magnitude 5.2, a worst-case scenario for this hazard would be an earthquake even of similar magnitude with an epicenter in Bucks County or near the border in an adjacent county, causing mild damage and disruption in populated areas.

Environmental impacts of earthquakes can be numerous, widespread, and devastating, particularly if indirect impacts like economic impacts are considered. Some examples of these impacts are listed below, although the geography of Bucks County makes most of these impacts unlikely:

- Induced tsunamis and flooding or landslides and avalanches;
- Poor water quality;
- Damage to vegetation; and
- Breakage in sewage or toxic material containments.

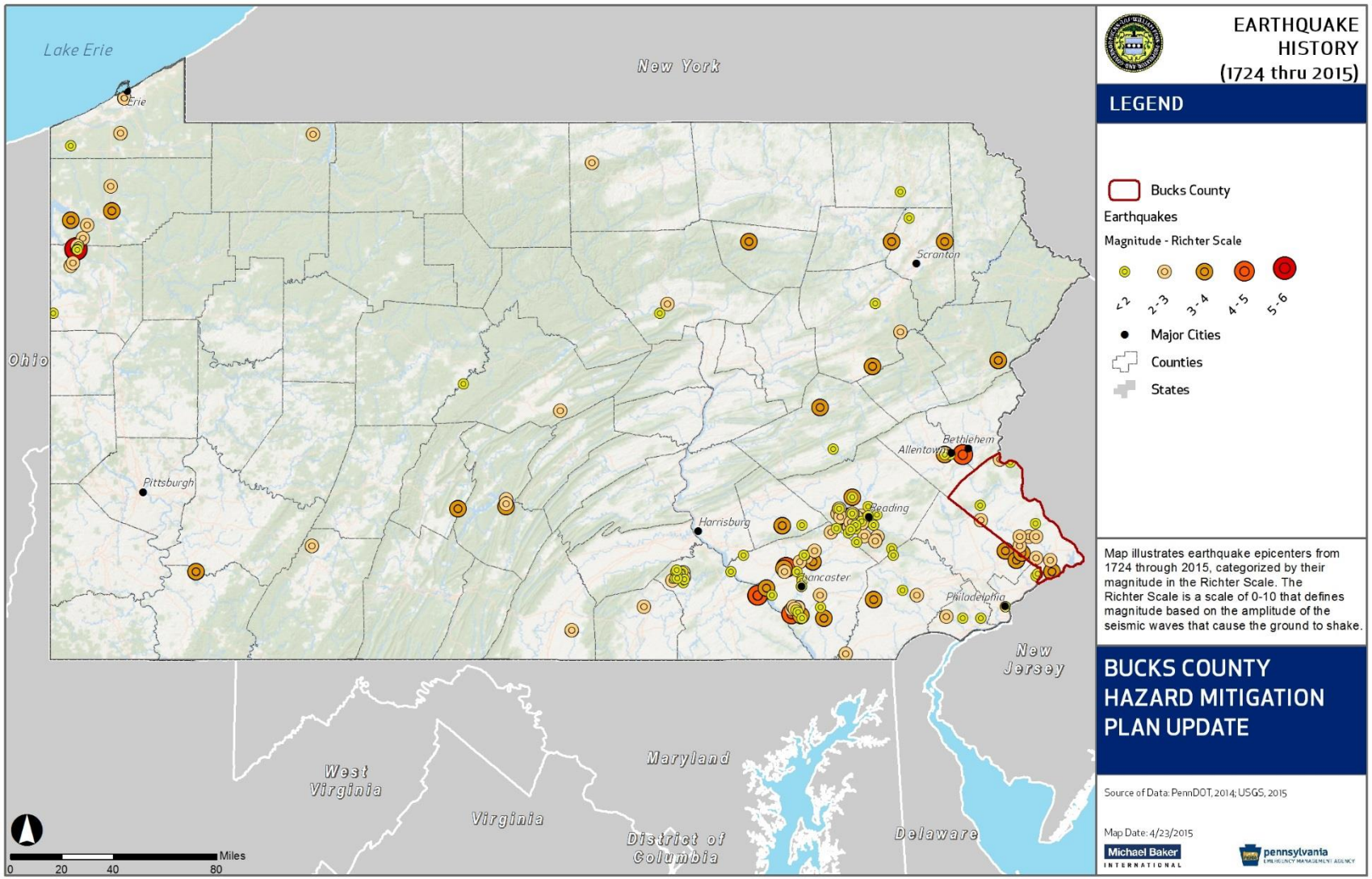
4.3.2.3. Past Occurrence

There has been 12 earthquake epicenters recorded in Bucks County up to the present. Most were minor with magnitudes below 3 on the Richter scale. As a result, their impacts were unlikely to be felt by county residents. However, earthquakes from well outside the county boundaries can have a significant impact as well. In 2011, a magnitude 5.8 earthquake with an epicenter in rural Louisa County, VA was felt throughout Pennsylvania, triggering evacuations, emergency bridge and tunnel inspections, and minor damage to buildings. This shallow earthquake occurring along the Spotsylvania Fault was felt as far north

as Ontario, Canada and as far south as Alabama. While earthquake epicenters have been concentrated in Lower Bucks, there are also concentrations in nearby Berks and Lancaster Counties.

Figure 4.3.2-2 shows earthquake epicenters from 1724 through 2015 in Bucks County and the Commonwealth of Pennsylvania as a whole.

Figure 4.3.2-2: Bucks County earthquake history (USGS, 2015).



4.3.2.4. Future Occurrence

One way to express an earthquake's severity is to compare its acceleration to the normal acceleration due to gravity. Peak ground acceleration (PGA) measures the strength of ground movements in this manner. PGA represents the rate in change of motion of the earth's surface during an earthquake as a ratio of the established rate of acceleration due to gravity. As shown in Figure 4.3.2-1, Bucks County has a low PGA ratio of 0.1. Overall, the future likelihood of an earthquake is *unlikely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

4.3.2.5. Vulnerability Assessment

Earthquakes of the magnitude seen in Pennsylvania are small and shallow. Based on the past history of earthquake events in and near Bucks County, the County's vulnerability to this hazard is expected to be low. In the event of an earthquake, unanchored objects may be upset, but few damages are expected.

4.3.3. Extreme Temperature

4.3.3.1. Location and Extent

Bucks County is subject to extreme temperatures in the summer and winter seasons. Temperature extremes are a concern in Bucks County because of the effect they can have on agricultural products as well as the human health issues they can cause. The elderly, the very young, and those with low or no income are more vulnerable to the effects of extreme temperatures, so the demographics of each of the municipalities in Bucks County effect their vulnerability to this hazard. Areas most susceptible to extreme heat include urban environments, which tend to retain the heat well into the night, leaving little opportunity for dwellings to cool.

Figure 4.3.3-1 and Figure 4.3.3-2 show annual mean maximum and minimum temperatures throughout Pennsylvania and highlight Bucks County. These maps present the year-round average minimum temperature (40-45°F) and average maximum temperature (60-65°F). However, during July, the warmest month, the average high temperature is 85° F and the average low is 63° F in Bucks County. In January, the coldest month, the average high in Bucks County is 37° F and the average low is 20° F (Weather For You, 2015).

Figure 4.3.3-1: Average Minimum Temperature for Pennsylvania and Bucks County

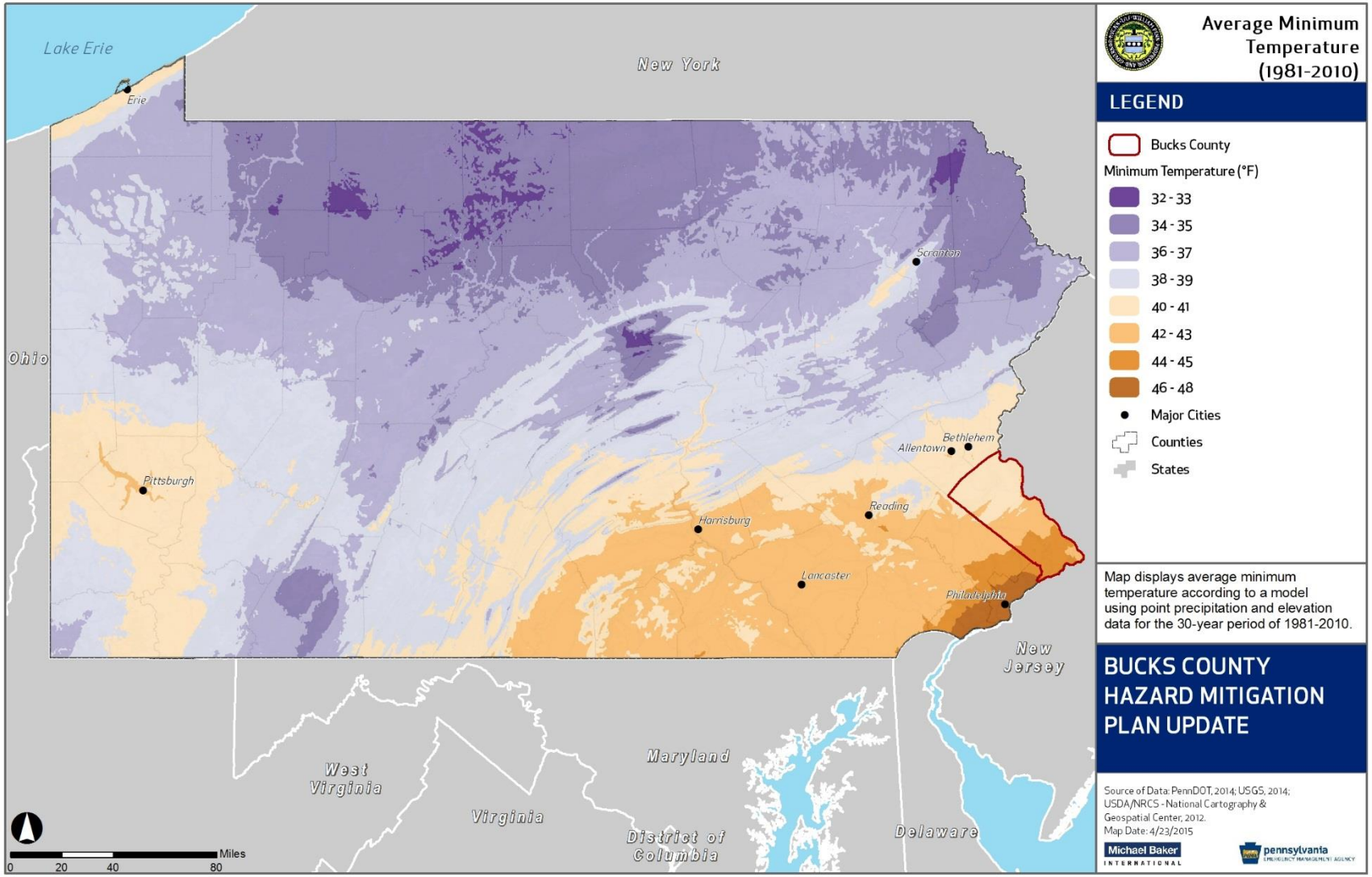
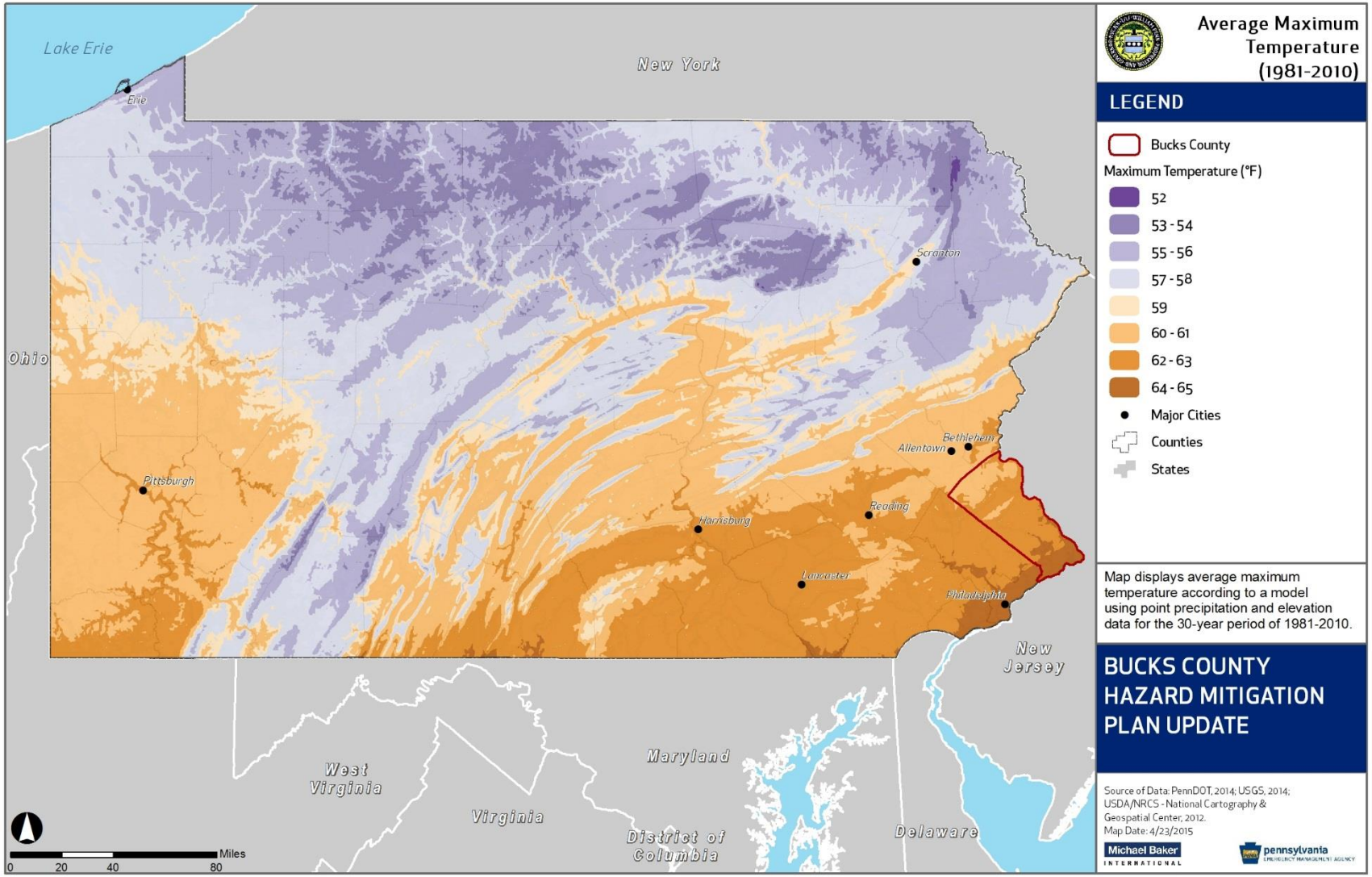


Figure 4.3.3-2: Average Maximum Temperature for Pennsylvania and Bucks County.



4.3.3.2. Range of Magnitude

Extreme temperatures can cause a range of impacts to communities, including:

- **Health Impacts** – The health impacts of extreme cold are greater in terms of mortality in humans, but often after more prolonged exposure versus a cold snap. Extreme heat waves, however, can prove more deadly over a shorter duration. At greatest risk of death in heat waves are the urban-dwelling elderly without access to an air-conditioned environment for at least part of the day.
- **Transportation** – Cold weather can impact automotive engines, possibly stranding motorists, and stress metal bridge structures. Highways and railroad tracks can become distorted in high heat. Disruptions to the transportation network and accidents due to extreme temperatures represent an additional risk.
- **Agriculture** – Absolute temperature and duration of extreme cold can have devastating effects on trees and winter crops. Livestock is especially vulnerable to heat, and crop yields can be impacted by heat waves that occur during key development stages.
- **Energy** – Energy consumption rises significantly during extreme cold weather. Residents are placed in extreme danger when any fuel shortages or utility failures prevent the heating of a dwelling. Extreme heat also can result in utility interruptions, and sagging transmission lines due to the heat can lead to shorting out.

The range of these impacts, especially health effects, can be mitigated through improved forecasts, warnings, community preparedness, and appropriate community-based response.

Temperature advisories, watches, and warnings are issued by the National Weather Service relating the above impacts to the range of temperatures typically experienced in Pennsylvania. Exact thresholds vary across the Commonwealth, but in general Heat Advisories are issued when the heat index will be equal to or greater than 100°F, but less than 105°F, Excessive Heat Warnings are issued when heat indices will attain or exceed 105°F, and Excessive Heat Watches, are issued when there is a possibility that excessive heat warning criteria may be experienced within twelve to forty-eight hours (NOAA NWS, 2014). In terms of human health concerns, extremely high temperatures cause heat stress which can be divided into four categories. Each category is defined by apparent temperature which is associated with a heat index value that captures the combined effects of dry air temperature and relative humidity on humans and animals. Major human risks for these temperatures include heat cramps, heat syncope, heat exhaustion, heatstroke, and death. Note that while the temperatures in Figure 4.3.3-3 serves as a guide for various danger categories, the impacts of high temperatures will vary from person to person based on individual age, health, and other factors. The elderly, the very young, and those with low or no income are most vulnerable to health-related impacts of extreme temperatures.

Cold temperatures can be extremely dangerous to humans and animals exposed to the elements. Without heat and shelter, cold temperatures can cause hypothermia, frost bite, and death. Wind chill temperatures are often used in place of raw temperature values due to the effect of wind can have in drawing heat from the body under cold temperatures. These values represent what temperatures

actually feel like to humans and animals under cold, windy conditions. Similarly to high temperatures, the effect of cold temperatures will vary by individual.

Figure 4.3.3-3 shows the effects of wind speed on extreme cold events and humidity on extreme heat events. These compounding factors can increase the risk experienced by vulnerable populations and the general public.

Figure 4.3.3-3: Wind Chill and Heat Index

EXTREME COLD AND WIND CHILL

WIND SPEED (mph)	AIR TEMPERATURE (F) 50	45	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40
5	48	42	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57
10	46	40	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66
15	45	38	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71
20	44	37	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74
25	43	36	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78
30	42	35	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80
35	41	35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82
40	41	34	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84
45	40	33	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86
50	40	33	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88
55	40	32	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89
60	39	32	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91
65	39	32	24	17	10	2	-5	-12	-19	-27	-34	-41	-49	-56	-63	-70	-78	-85	-92
70	38	31	24	16	9	2	-6	-13	-20	-27	-35	-42	-49	-57	-64	-71	-79	-86	-93
75	38	31	23	16	9	1	-6	-13	-21	-28	-36	-43	-50	-58	-65	-72	-80	-87	-95
80	38	30	23	16	8	1	-7	-14	-21	-29	-36	-44	-51	-59	-66	-73	-81	-88	-96
85	38	30	23	15	8	0	-7	-15	-22	-30	-37	-44	-52	-59	-67	-74	-82	-89	-97
90	37	30	22	15	7	0	-8	-15	-23	-30	-38	-45	-53	-60	-68	-75	-83	-90	-98
95	37	29	22	14	7	-1	-8	-16	-23	-31	-38	-46	-53	-61	-68	-76	-84	-91	-99
100	37	29	22	14	6	-1	-9	-16	-24	-31	-39	-47	-54	-62	-69	-77	-84	-92	-100

Approx frostbite times: 30 min | 10 min | 5 min

EXTREME HEAT AND HEAT INDEX

RELATIVE HUMIDITY (%)	AIR TEMPERATURE (F) 80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	116
5	78	80	81	83	85	86	88	89	91	93	94	96	97	99	101	102	104	105	107
10	78	80	81	83	84	86	88	89	91	93	95	97	99	101	103	105	107	109	111
15	78	80	81	83	84	86	88	90	92	94	96	98	100	103	105	108	111	113	116
20	79	80	81	83	85	86	88	90	93	95	97	100	103	106	109	112	115	119	122
25	79	80	82	83	85	87	89	91	94	97	100	103	106	109	113	117	121	125	129
30	79	80	82	84	86	88	90	93	96	99	102	106	110	114	118	122	127	132	137
35	80	81	83	85	87	89	92	95	98	102	106	110	114	119	123	129	134	140	146
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136	142	148	
45	80	82	84	87	89	92	96	100	104	109	114	119	124	130	137	143			
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137					
55	81	84	86	89	93	97	101	106	112	117	124	130	137						
60	82	84	88	91	95	100	105	110	116	123	129								
65	82	85	89	93	98	103	108	114	121	128	136								
70	83	86	90	95	100	106	112	119	126										
75	84	88	92	97	103	109	116	124											
80	84	89	94	100	106	113	121												
85	85	90	96	102	110	117													
90	86	91	98	105	113														
95	86	93	100	108															
100	87	95	103																

Blank area is where dewpoint > 85F

Heat disorder risk: CAUTION | EXTREME CAUTION | DANGER | EXTREME DANGER

A worst-case scenario of extreme high temperatures occurred on July 15, 1995 where high temperatures near and above the 100-degree mark were some of the hottest reported in Eastern Pennsylvania in 29 years. There were 67 heat-related deaths in the region. Most were elderly, shut-ins, or people in otherwise poor health with no ventilation or air conditioning (Bucks County, 2011). A worst case for

extreme cold temperatures would include injuries resulting from direct exposure (as a result of an interruption of energy supplies) and from being cut off from medical care due to associated snow or ice impacting travel. This scenario is estimated to require medical care for 1 percent of Bucks County's population over 65 years of age, and cause 10 percent mortality of those impacted. With an approximate population of 101,543 persons who are 65 and older (Census, 2013), this results in 1,015 injuries and 102 deaths from a potential worst case scenario. Medical afflictions would be a result of direct influence on the coronary circulation system and via the respiratory system. Influenza and other infectious diseases would be secondary impacts.

4.3.3.3. Past Occurrence

Table 4.3.3-1 describes events related to extreme heat and cold in Bucks County between 1994 and February 2015 as reported to the National Climatic Data Center. While each of these events affected Bucks County, the temperatures, deaths, injuries, and damage indicated in the table were not necessarily in Bucks County itself; data for these events is regional in nature.

Table 4.3.3-1: Recorded Temperature Extremes in Bucks County and surrounding region (NCDC, 2015)

DATE	EVENT	TEMPERATURE (WIND CHILL)	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
06/13/1994	Heat Waves	97°F	5	0	0	0
07/06/1994	Heat Wave	98°F	10	0	0	0
11/01/1994	Unseasonably Warm	48°F	0	0	0	0
12/01/1994	Unseasonably Warm	37.6°F	0	0	0	0
01/01/1995	Unseasonably Warm	Unknown	0	0	0	0
01/14/1995	Record Warmth	69°F	0	0	0	0
02/06/1995	Extreme Cold	5°F	1	0	0	0
05/01/1995	Unseasonably Warm	55.4°F	0	0	0	0
07/01/1995	Excessive Heat	>100°F	67	0	0	0
07/13/1995	Heat Wave	Unknown	3	0	0	0
07/23/1995	Heat Wave	Unknown	2	0	0	0
08/01/1995	Unseasonably Warm & Dry	79.5°F	29	0	0	0
08/12/1995	Heat Wave	Unknown	0	0	0	0
08/23/1995	Heat Wave	Unknown	9	0	0	0
12/09/1995	Unseasonably Cold	10°F (-10°)	2	0	0	0
02/04/1996	Extreme Cold	-10°F	0	0	0	0

Table 4.3.3-1: Recorded Temperature Extremes in Bucks County and surrounding region (NCDC, 2015)						
DATE	EVENT	TEMPERATURE (WIND CHILL)	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
05/19/1996	Excessive Heat	98°F	1	4	0	0
01/03/1997	Unseasonably Warm	64°F	0	0	0	0
01/17/1997	Extreme Cold	0°F	3	0	0	0
02/19/1997	Unseasonably Warm	69°F	0	0	0	0
02/26/1997	Unseasonably Warm	74°F	0	0	0	0
02/28/1997	Unseasonably Warm	35.6°F	0	0	0	0
03/01/1997	Unseasonably Warm	73°F	0	0	0	0
04/09/1997	Unseasonably Cold	28°F	0	0	0	25.0M
06/24/1997	Excessive Heat	95°F	1	0	0	0
07/12/1997	Excessive Heat	100°F	24	60	0	0
08/17/1997	Excessive Heat	98°F	2	0	0	0
01/04/1998	Unseasonably Warm	69°F	0	0	0	0
01/31/1998	Unseasonably Warm	36.5°F	0	0	0	0
02/28/1998	Unseasonably Warm	40.4°F	0	0	0	0
03/27/1998	Unseasonably Warm	88°F	0	0	0	0
06/25/1998	Excessive Heat	95°F	3	0	0	0
07/23/1998	Excessive Heat	93°F	11	75	0	0
08/22/1998	Heat Wave	92°F	0	0	0	0
09/27/1998	Unseasonably Hot	91°F	0	0	0	0
09/30/1998	Unseasonably Warm & Dry	71.8°F	0	0	0	0
11/28/1998	Unseasonably Warm	66°F	0	0	0	0
12/01/1998	Unseasonably Warm	76°F	0	0	0	0
12/31/1998	Unseasonably Warm & Dry	37.5°F	0	0	0	0
12/31/1998	Unseasonably Warm Year	58.1°F (mean)	0	0	0	0
06/07/1999	Excessive Heat	96°F	2	1	0	0

Table 4.3.3-1: Recorded Temperature Extremes in Bucks County and surrounding region (NCDC, 2015)						
DATE	EVENT	TEMPERATURE (WIND CHILL)	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
07/04/1999	Excessive Heat	101°F	74	135	0	0
07/16/1999	Excessive Heat	100°F	0	0	0	0
07/23/1999	Excessive Heat	101°F	4	0	0	0
07/37/1999	Unseasonably Warm & Dry	78°F	0	0	0	0
08/07/1999	Excessive Heat	98°F	5	0	0	0
08/31/1999	Unseasonably Warm	77.1°F	0	0	0	0
11/30/1999	Unseasonably Warm	50.9°F	0	0	0	0
01/02/2000	Unseasonably Warm	63°F	0	0	0	0
02/08/2000	Unseasonably Warm	79°F	0	0	0	0
02/31/2000	Unseasonably Warm &Wet	44.2°F	0	0	0	0
05/02/2001	Unseasonably Hot	92°F	0	0	0	0
06/26/2001	Excessive Heat	96°F	2	0	0	0
07/01/2001	Excessive Heat	91°F	1	0	0	0
07/24/2001	Excessive Heat	94°F	2	0	0	0
08/26/2001	Excessive Heat	99°F	22	0	0	0
11/30/2001	Unseasonably Warm	47.0°F	0	0	0	0
12/01/2001	Unseasonably Warm	72°F	0	0	0	0
12/31/2001	Unseasonably Warm	38.2°F	0	0	0	0
01/27/2002	Unseasonably Warm	69°F	0	0	0	0
02/28/2002	Unseasonably Warm	37.2°F	0	0	0	0
06/24/2002	Excessive Heat	95°F	4	0	0	0
07/01/2002	Excessive Heat	98°F	15	0	0	0
07/15/2002	Excessive Heat	96°F	2	0	0	0
07/28/2002	Excessive Heat	95°F	3	0	0	0
08/01/2002	Excessive Heat	102°F	9	0	0	0

Table 4.3.3-1: Recorded Temperature Extremes in Bucks County and surrounding region (NCDC, 2015)

DATE	EVENT	TEMPERATURE (WIND CHILL)	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
08/11/2002	Excessive Heat	98°F	8	0	0	0
01/14/2003	Extreme Cold/wind chill	6°F	4	0	0	0
06/23/2003	Excessive Heat	93°F	3	0	0	0
07/04/2003	Excessive Heat	92°F	4	0	0	0
01/09/2004	Extreme Cold/wind chill	-2°F	2	0	0	0
01/15/2004	Extreme Cold/wind chill	1°F	1	0	0	0
12/20/2004	Extreme Cold/wind chill	3°F	0	0	0	0
01/18/2005	Extreme Cold/wind chill	-10°F	2	1	0	0
01/23/2005	Extreme Cold/wind chill	-3°F	10	0	0	0
01/28/2005	Extreme Cold/wind chill	-6°F	0	0	0	0
06/13/2005	Excessive Heat	92°F	3	0	0	0
07/18/2005	Excessive Heat	92°F	6	0	0	0
07/25/2005	Excessive Heat	96°F	7	0	0	0
08/02/2005	Excessive Heat	95°F	5	0	0	0
08/11/2005	Excessive Heat	96°F	2	0	0	0
07/16/2006	Excessive Heat	98°F	3	0	0	0
08/01/2006	Excessive Heat	105°F	24	40	0	0
02/15/2007	Cold/wind chill	4°F	0	0	0	0
02/16/2007	Cold/wind chill	4°F	0	0	0	0
02/19/2007	Cold/wind chill	6°F	0	0	0	0
07/08/2007	Excessive Heat	95°F	0	0	0	0
08/07/2007	Excessive Heat	96°F	0	0	0	0
04/25/2009	Heat	93°F	0	0	0	0
07/01/2009	Heat	86°F	1	0	0	0
08/10/2009	Excessive Heat	103°F	0	0	0	0
08/16/2009	Heat	95°F	0	0	0	0

Table 4.3.3-1: Recorded Temperature Extremes in Bucks County and surrounding region (NCDC, 2015)						
DATE	EVENT	TEMPERATURE (WIND CHILL)	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
06/23/2010	Excessive Heat	94°F	0	0	0	0
07/16/2010	Excessive Heat	90°F	0	0	0	0
7/6/2013	Excessive Heat	95°F	0	0	0	0
7/15/2013	Excessive Heat	95°F	0	0	0	0
7/18/2013	Excessive Heat	95°F	0	0	0	0
9/11/2013	Heat	91°F	0	0	0	0
1/4/2014	Extreme Cold/Wind Chill	-2°F	0	0	0	0
1/7/2014	Cold/Wind Chill	-22°F (with wind chill)	0	0	0	0
1/22/2014	Cold/Wind Chill	-15°F (with wind chill)	0	0	0	0
6/17/2014	Heat	94°F	0	0	0	0
7/2/2014	Heat	96°F	0	0	0	0
1/7/2015	Cold/Wind Chill	-11°F (with wind chill)	0	0	0	0
2/13/2015	Cold/Wind Chill	4°F	0	0	0	0
2/15/2015	Cold/Wind Chill	-20°F (with wind chill)	0	0	0	0
2/19/2015	Cold/Wind Chill	-23°F (with wind chill)	0	0	0	0
2/24/2015	Cold/Wind Chill	-5°F	0	0	0	0

4.3.3.4. Future Occurrence

The future occurrence of extreme temperature can be considered possible as defined by the Risk Factor methodology probability criteria (see Table 4.4-1). Due to its location and geography, the County is more likely to encounter excessive heat than extreme cold weather. Topography and vegetation can impact temperature differentials across the County (NCDC, 2015).

It is important to note that frequency estimates may not be an accurate representation of future conditions due to the unknown impacts of climate change. Significant, broad evidence supports human influence to a long-term trend of global warming. It has been difficult to predict how much, how fast, or how long the warming will occur, due to the large number of variables involved. According to the Pennsylvania Climate Impacts Assessment Report (2009), annual and seasonal average temperatures are expected to increase; with one scenario predicting almost a 7°F increase in annual average temperature

by the end of the 21st century. Some areas of the world may experience greater temperature changes than others. Predictions for smaller areas and shorter time periods become more uncertain.

4.3.3.5. Vulnerability Assessment

The potential for extreme heat and cold always exists in and around the summer and winter months. In terms of human and social vulnerabilities, weather forecasters can normally predict the temperature with excellent accuracy and they, along with local emergency management personnel and social services agencies, are instrumental in reducing extreme temperature vulnerabilities through public education and attention to the issue. Adhering to extreme temperature warnings can significantly reduce the risk of temperature-related deaths.

Those hardest hit by both heat and cold waves include the elderly, the very young, and those with low or no income, and others who are already physically vulnerable. Excessive heat exposure also affects people with certain pre-existing medical conditions, including cardiovascular disease, respiratory illnesses, and obesity. All 54 jurisdictions are considered to be vulnerable to the effects of extreme temperatures, but these vulnerabilities are individualized among the general population and will continue to be extremely difficult to address from a countywide or even local emergency response to such events.

4.3.4. Flood, Flash Flood, Ice Jam

4.3.4.1. Location and Extent

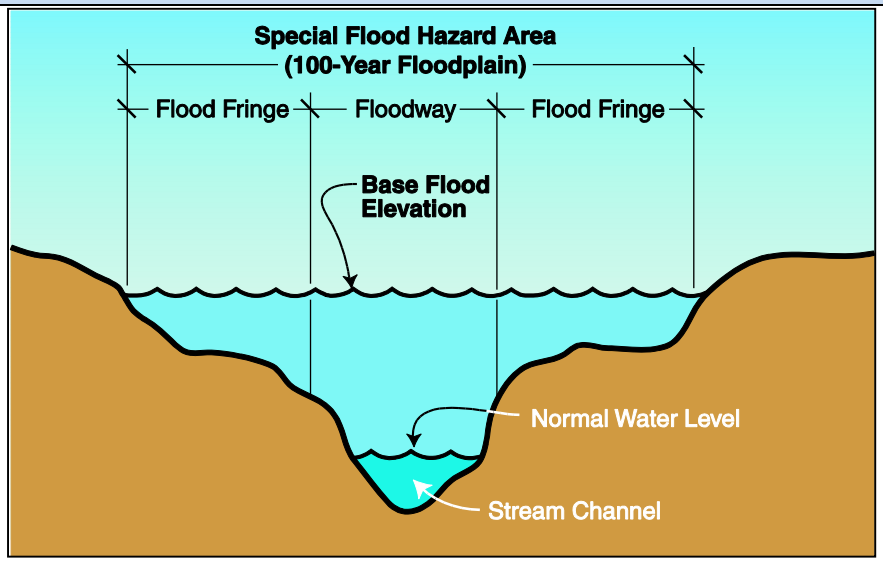
Bucks County is located largely in the Central Delaware River sub-basin, though some of the southern and western areas are located in the Lower Delaware River sub-basin. This area has a typical piedmont geography with low rolling hills flattening out to the Atlantic Coastal Plain along the Delaware River. Excess water from rainfall or snowmelt can accumulate in this area and drain into the streams and rivers, which can then overflow onto stream banks and adjacent floodplains. Bucks County, like many other areas in Pennsylvania, is flood prone due to the terrain and because most of the communities are located in the floodplains along streams and valleys.

Flooding has the potential to impact soil stability and exacerbate other hazards. Flooding can contribute to slope failure when precipitation, runoff, or floodwaters combine with soil on a slope or natural incline to cause a collapse or slide. The municipalities along Bucks County's southeastern border are moderately susceptible to slope failure or landslides while the rest of the county has a low susceptibility; more information on Landslides is available in Section 4.3.7. Flooding can also undermine soil stability and contribute to Subsidence and Sinkholes addressed in Section 4.3.11 and Structure Collapse discussed in Section 4.3.15.

Floodplains are lowlands adjacent to rivers, streams, and creeks that are subject to recurring floods. The size of the floodplain is described by the recurrence interval of a given flood. Flood recurrence intervals are explained in more detail in Section 4.3.4.4. However, in assessing the potential spatial extent of flooding it is important to know that a floodplain associated with a flood that has a 10 percent chance of occurring in a given year is smaller than the floodplain associated with a flood that has a 0.2% annual chance of occurring.

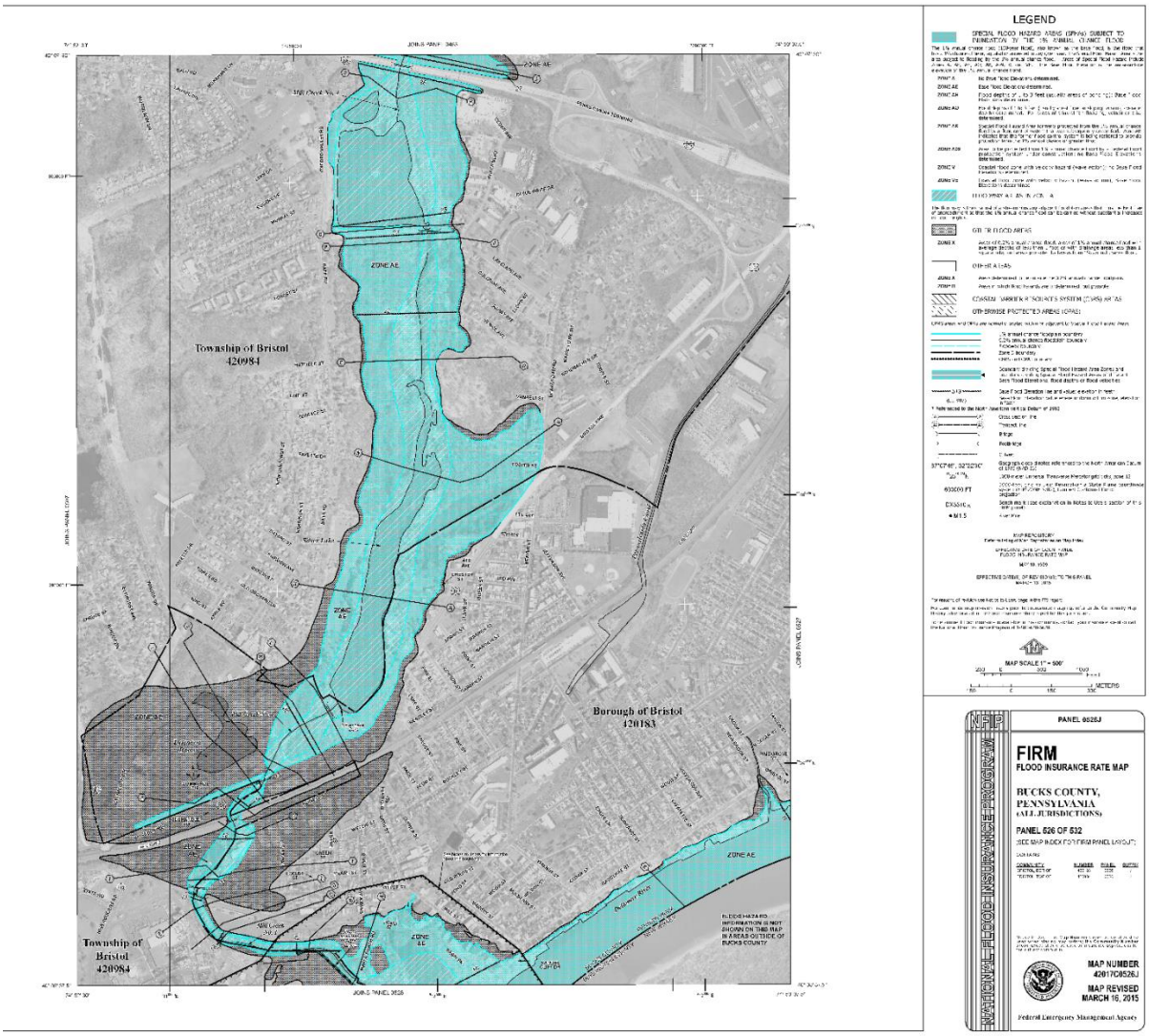
The National Flood Insurance Program (NFIP), for which FIRMs are published, identifies the 1% annual chance flood. This 1% annual chance flood event is used to delineate the Special Flood Hazard Area (SFHA) and identify Base Flood Elevations. Figure 4.3.4-1 illustrates these terms. The SFHA serves as the primary regulatory boundary used by FEMA, the Commonwealth of Pennsylvania and Bucks County local governments.

Figure 4.3.4-1: Diagram identifying Special Flood Hazard Area, 1% annual chance (100-Year) floodplain, floodway and flood fringe.



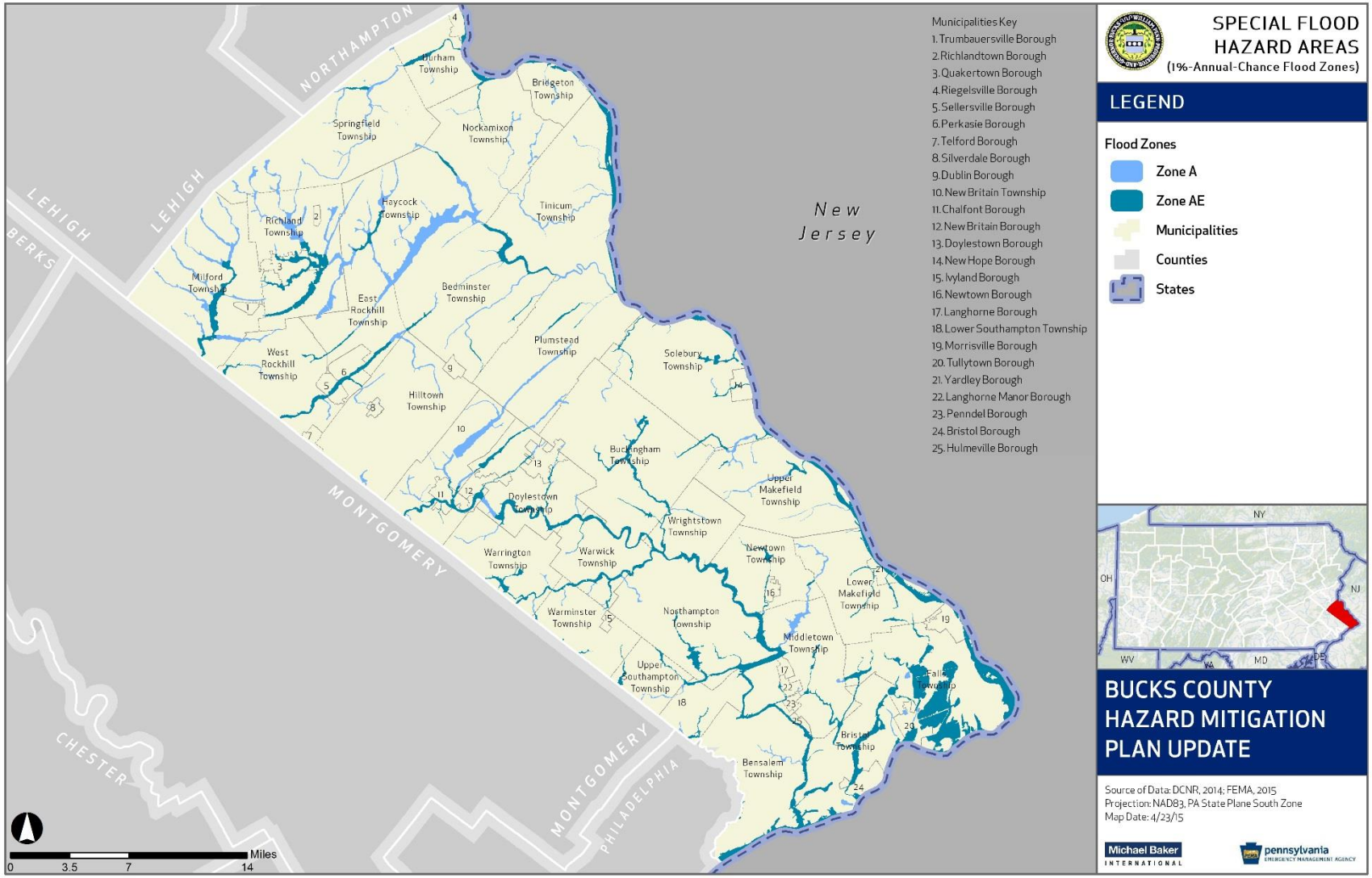
Countywide Digital Flood Insurance Rate Maps (FIRMs) and a Countywide Flood Insurance study were released for Bucks County on March 16, 2015. All communities within the County are shown on a single set of countywide FIRMs. Previous FIRMs and Flood Boundary and Floodway Maps (FBFM) were digitized to produce a DFIRM that is compatible with GIS. Prior to the publication of this digital data, flood hazard information from FEMA was available through paper FIRMs and Q3 data. The maps can be obtained from the FEMA Map Service Center (http://www.msc.fema.gov). These maps can be used to identify the expected spatial extent and elevation of flooding from a 1% and 0.2% annual chance event. For example, Figure 4.3.4-2 displays the areas of expected flooding from a 1% and 0.2% annual chance flood event. Almost all of the municipalities in the County, with the exception of the boroughs of Dublin, Ivyland, and Richlandtown, were determined to have SFHA.

Figure 4.3.4-2: FIRM Panel 42017C0526 J, effective 3/16/2015, showing flood zones in Bristol Borough.



Bucks County identifies the Delaware River and the Neshaminy Creek as the two main contributors to flood hazards in the County, although flooding can and will happen on smaller streams and tributaries. Continued development in the floodplain countywide also exacerbates flooding issues. Figure 4.3.4-3 shows the location of watercourses and flood zones in Bucks County. The location of approximate and detailed (including Base Flood Elevations) Special Flood Hazard Areas (1% annual-chance-zones) are shown.

Figure 4.3.4-3: Map showing the location of watercourses and flood zones throughout Bucks County.



4.3.4.2. Range of Magnitude

Floods are considered hazards when people and property are affected. Most injuries and deaths from flooding happen when people are swept away by flood currents and most property damage results from inundation by sediment-filled water. A large amount of rainfall over a short time span can result in flash flood conditions. Small amounts of rain can result in floods in locations where the soil is frozen or saturated from a previous wet period or if the rain is concentrated in an area of impermeable surfaces such as large parking lots, paved roadways, or other impervious developed areas. Flooding can impact the foundation of buildings and compromise the structure or even lead to building collapse.

Several factors determine the severity of floods, including rainfall intensity and duration, topography, ground cover and rate of snowmelt. Water runoff is greater in areas with steep slopes and little to no vegetative ground cover. Additionally, urbanization typically results in the replacement of vegetative ground cover with asphalt and concrete, increasing the volume of surface runoff and stormwater, particularly in areas with poorly planned stormwater drainage systems.

Winter floods have resulted from runoff of intense rainfall on frozen ground, and, on rare occasions, local flooding has been exacerbated by ice jams in rivers. Ice jam floods occur on rivers that are totally or partially frozen. A rise in stream stage will break up a totally frozen river and create ice flows that can pile up on channel obstructions such as shallow riffles, log jams, or bridge piers. The jammed ice creates a dam across the channel over which the water and ice mixture continues to flow, allowing for more jamming to occur. The County Hazard Vulnerability Analysis (HVA) reports that ice jams are typically limited to the Neshaminy Creek, and there have only been ice jam-related damages once in 1993.

Summer floods have occurred from intense rainfall on previously saturated soils. Summer thunderstorms deposit large quantities of rainfall over a short period of time that can result in flash flood events. In addition, the County occasionally experiences intense rainfall from tropical storms in late summer and early fall.

The magnitude of a flood ranges from a small event in which water enters basements and covers low-lying roads to regional flooding events where swollen creeks and rivers destroy homes, businesses, and infrastructure. According to the County, the worst case flood event occurred in Bucks County in August 1955, when Hurricanes Connie and Diane struck a week apart and caused the worst damage ever in the history of the watershed (HVA, 2011). Hurricane Connie hit the Mid-Atlantic August 12-13, dropping significant rainfall across eastern Pennsylvania and flooding along the Delaware River, Neshaminy Creek, and Perkiomen Creek. Then, just five days later, Hurricane Diane brought heavy rains to an already soaked region. Damages from this flood were estimated at $10.6 million, in July 1961 prices (Gelber, 2002).

The impact on Bucks County from the August 1955 flooding was severe. Both the Delaware River and Neshaminy Creek reached record flood heights and all watersheds within the county were impacted by flooding (HVA, 2011). The storms disrupted power and utilities, damaged and destroyed bridges and roads, and water flooded homes from rivers, creeks, and a break in the Delaware Canal (Martin). Though data on deaths is not specifically available for Bucks County, 184-200 lives were lost on the east coast from the combination of these two storms including 70 campers who were impacted by flash flooding

upstream of Bucks County in the Poconos (Smith). These storms prompted active flood mitigation in Bucks County that has made residents safer, particularly along the Delaware River and Neshaminy Creek (HVA, 2011). Figures 4.3.4-4, 4.3.4-5, 4.3.4-6, and 4.3.4-7 show photos taken by the USACE to document the 1955 flooding in Bucks County.

Figure 4.3.4-4: Neshaminy Creek at old U.S. Route 611 during flood of August 13, 1955 (USACE, 1965).

Figure 4.3.4-5: Neshaminy Creek at south side of U.S. Route 611 bridge during flood of August 13, 1955 (USACE, 1965).

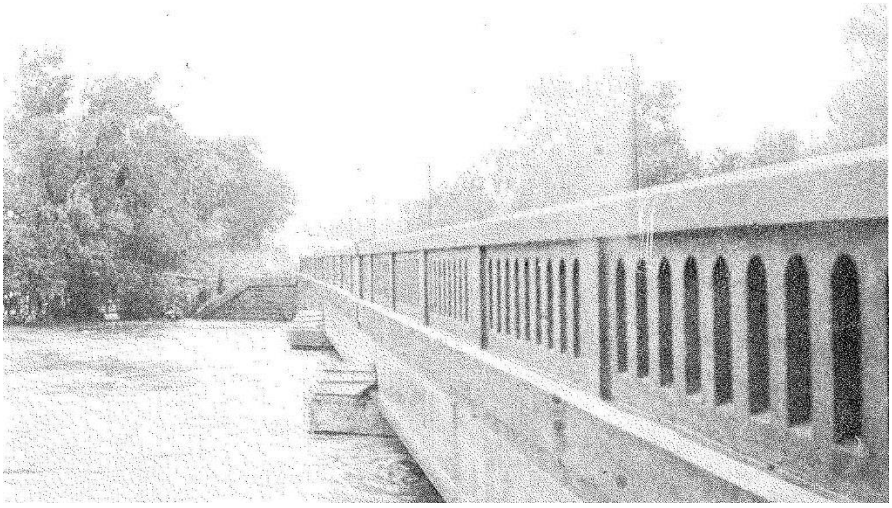


Figure 4.3.4-6: Spring Garden Mill Bridge (Route 332 west of Newtown) during flood of August 19, 1955 (USACE, 1965).

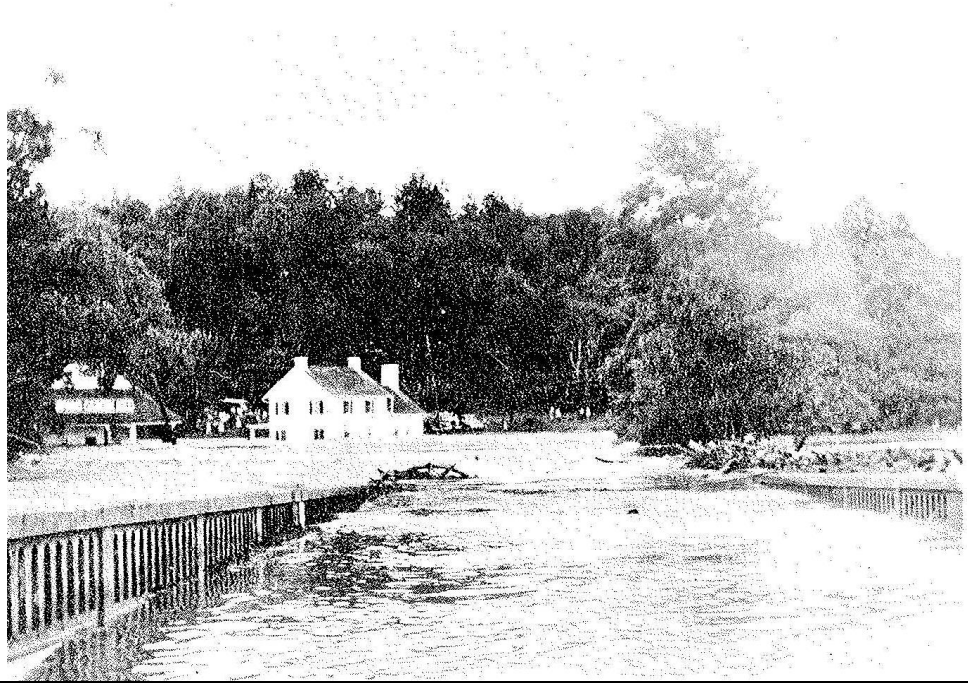


Figure 4.3.4-7: Neshaminy Creek, August 13, 1955 (Hurricane Connie), flood 17 feet above streambed; flood 25 feet above streambed on August 19, 1955 during Hurricane Dianne (USACE, 1965).

Bucks County has repeatedly experienced severe flooding (see Section 4.3.4.3). Although floods can cause damage to property and loss of life, floods are naturally occurring events that benefit riparian systems which have not been disrupted by human actions. Such benefits include groundwater recharge and the introduction of nutrient rich sediment improving soil fertility. However, the destruction of riparian buffers, changes to land use and land cover throughout a watershed, and the introduction of chemical or biological contaminants which often accompany human presence cause environmental harm when floods occur. Hazardous material facilities are potential sources of contamination during flood events. Other negative environmental impacts of flooding include: water-borne diseases, heavy siltation, damage, or loss of crops, and drowning of both humans and animals.

4.3.4.3. Past Occurrence

Bucks County has a long history of flooding events; the County HVA records eighteen major floods since 1933. Fourteen of the nineteen Presidential Disaster Declarations affecting Bucks County have stemmed from floods and flash floods, including flooding induced by coastal storms. Table 4.3.4-1 lists flood event information from 1993-2010 obtained from the NCDC. For more information on the historical losses from these floods, please see Section 4.4.3: Potential Loss Estimates.

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
11/28/1993	Multiple Counties. Flood/Flash Flood – A slow-moving storm caused widespread heavy rains and flooding across many counties in Pennsylvania.	None Reported
12/14/1993	Bucks, Delaware, and Philadelphia Counties. Tidal Flood – A deep low pressure area combined with the effect of a new moon caused the highest tides of the month and flooding along the Delaware River.	None Reported
8/22/1994	Langhorne. Flood/Flash Flood – 3.8 inches of rain in 24 hours caused flooding of the Neshaminy Creek.	None Reported
3/9/1995	Countywide. Flood/Flash Flood – No details provided.	None Reported
7/17/1995	Lower half of County. Flood/Flash Flood – Thunderstorm caused 5.25 inches of rain to fall in Doylestown; flash flooding caused roadway flooding in storm area.	None Reported
11/12/1995	Countywide. Flood/Flash Flood – Storm dropped 1.75 inches of rain, causing the flash flooding of creeks throughout the County and the Neshaminy Creek to reach flood stage.	None Reported
1/19/1996	Multiple Counties. Flood/Flash Flood – Snowmelt due to unseasonably warm weather combined with one to two inches of rain for flash flood and continued flooding.	None Reported
1/27/1996	Multiple Counties. Flood/Flash Flood – Between 1 and 1.5 inches of rain caused flooding countywide and forced multiple road closures	None Reported
6/12/1996	Southern Portion of the County. Flash Flood – Nearly stationary thunderstorms brought 3-11.5 inches of rain within four hours to southeast Bucks County, leading to a state of emergency.	$14,500,000
7/31/1996	Southern Portion of the County. Flash Flood – Thunderstorms with very heavy rain caused roadway flooding and small stream flooding.	None Reported

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
9/8/1996	Southern Portion of the County. Flash Flood – Rainfall caused urban and poor drainage flooding as well as small creek flooding.	None Reported
11/8/1996	Countywide. Flash Flood – Rainfall of about 2 inches caused flooding in small stream, complicated by fallen trees and leaves clogging basins and streams.	None Reported
10/19/1996	Countywide. Flash Flood – Heavy rain caused flooded basements, evacuations, and road washouts.	None Reported
12/2/1996	Countywide. Flash Flood – Heavy rain caused flooding on smaller streams as well as urban flooding in Bucks County.	None Reported
12/14/1996	Multiple Counties. Flood – Heavy rain associated with a slow-moving low pressure system near Delaware caused flooding in larger streams and rivers in Southeast Pennsylvania.	None Reported
4/2/1998	Countywide. Flood – A series of thunderstorms with heavy rain caused considerable urban and poor drainage flooding.	None Reported
5/12/1998	Multiple Counties. Tidal Flooding – Continuous rain, onshore flow up the Delaware Bay, and high astronomical tides produced widespread minor flooding at high tide along the Delaware River.	None Reported
9/17/1998	Countywide. Urban and Small Stream Flooding – A weak low pressure system produced heavy rain. Recent dry weather limited flooding to urban and small stream areas.	None Reported
1/3/1999	Multiple Counties. Tidal Flooding – Runoff from heavy precipitation and higher than normal tides caused minor flooding along the Delaware River and its tidal tributaries.	None Reported
3/22/1999	Countywide. Flood – Heavy rain affected all of the Lehigh Valley and Southeastern Pennsylvania, causing flooding throughout Bucks County.	None Reported
5/24/1999	Lower Bucks County. Flash Flood – A pair of thunderstorms brought very heavy downpours across lower Bucks County with an average of 2-3 inches falling within 2 hours.	None Reported
8/14/1999	Lower Bucks County. Flood – A series of thunderstorms caused urban and poor drainage flooding as well as flash flooding of small streams in Lower Bucks County, especially from Southampton to Yardley.	None Reported
9/16/1999	Multiple Counties. Tidal Flooding, Flash Flood – Hurricane Floyd caused heavy rain resulting in tidal flooding, flash flooding, utility interruptions, transportation disruptions, injuries, and deaths across Eastern Pennsylvania.	$22,000,000
7/30/2000	Southern Bucks County. Flood – Thunderstorms with torrential downpours caused flash flooding of the Mill Creek Basin, leading to significant structure damage, bridge washouts, and road closures.	$5,000,000
9/19/2000	Warrington. Flood – Heavy rain caused by the remnants of what was Hurricane Gordon caused poor drainage flooding in low-lying areas.	None Reported
12/17/2000	Countywide. Flood – Showers and thunderstorms caused urban and poor drainage flooding as well as flooding in major streams and rivers.	None Reported
6/16/2001	Southern Portion of the County. Flood – Tropical Storm Allison drenched the southern half of the County with up to ten inches of rain.	$1,500,000

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
8/4/2001	Croyden. Flash Flood – Slow moving thunderstorms with torrential downpours produced urban and flash flooding in and around Bristol Township.	None Reported
8/11/2001	Woodside. Flash Flood – Thunderstorms with torrential rains caused flash flooding of Rock Run in Lower Makefield and Yardley.	None Reported
11/17/2002	Dublin. Flood – A Northeaster produced steady, heavy rain across Southeast Pennsylvania.	None Reported
2/22/2003	Southern Portion of the County. Flash Flood – The combination of heavy rain and melting snow caused widespread roadway flooding and ponding in poor drainage areas; the Neshaminy Creek experienced ice jams.	None Reported
6/4/2003	Countywide. Flood – Two separate surges of heavy rain caused urban and poor drainage flooding and flooding on the Neshaminy and East Branch of the Perkiomen Creeks.	None Reported
7/22/2003	Countywide. Flash Flood – Two evenings of thunderstorms in a row caused flash flooding in upper Bucks County. Flooding was worst at Riegelsville.	None Reported
9/15/2003	Northwest Portion of the County. Flash Flood – Remnants of Tropical Storm Henri caused significant heavy rainfall of 3-4 inches.	None Reported
9/23/2003	Countywide. Flood – Heavy rainfall caused widespread poor drainage flooding and covered roads with 2-3 feet of water.	None Reported
9/28/2003	Central Portion. Flash Flood – Thunderstorms dropped 3-4 inches between Doylestown and Perkasie causing small stream flooding.	None Reported
10/27/2003	Countywide. Flood - Showers and thunderstorms associated with a slow moving cold front produced poor drainage flooding and stream flooding in Bucks County.	None Reported
10/29/2003	Countywide. Flood – Heavy rainfall across the county, especially in the lower portion, caused Neshaminy Creek to reach flood stage.	None Reported
11/5/2003	West Central Portion. Flash Flood - Thunderstorms caused flooding along smaller streams in the Neshaminy Creek Watershed and urban and poor drainage flooding.	None Reported
11/20/2003	Countywide. Flood – Heavy rain fell and caused poor drainage and creek flooding across the County.	None Reported
12/11/2003	Countywide. Flood - A combination of heavy rain and melting snow runoff caused widespread poor drainage flooding exacerbated by high tide, mudslides, and road closures.	None Reported
2/6/2004	Countywide. Flood – Heavy rain and snow melt caused poor drainage and creek flooding throughout the County.	None Reported
7/14/2004	New Britain. Flash Flood – Thunderstorms with heavy downpours produced stream and roadway flooding in the township.	None Reported
7/27/2004	Countywide. Flash Flood - Thunderstorms with very heavy rain caused road closures, stream flooding and vehicle rescues in two stripes across the county.	None Reported
7/28/2004	New Britain. Flash Flood – Thunderstorms with heavy downpours produced stream and roadway flooding in the township.	None Reported

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
8/1/2004	Penndel. Flash Flood - Thunderstorms with very heavy rain caused poor drainage and stream flooding in extreme southwest and east central Bucks County.	None Reported
9/18/2004	Countywide. Flood/Flash Flood – The remnants of Hurricane Ivan coupled with rain in the upper Delaware River Basin caused widespread poor drainage and creek flooding. Bucks County declared a disaster area.	$1,000,000
9/28/2004	Countywide. Flash Flood – The remnants of Hurricane Jeanne caused between 3-8 inches of rain, spurring road flooding, poor drainage, and small creek flooding.	None Reported
11/28/2004	Countywide. Flood - A strong cold front and a prolonged flow from the Gulf of Mexico and nearby Atlantic Ocean produced heavy rain across Bucks County. Storm totals of 2 to 3 inches produced widespread poor drainage flooding and creek and stream flooding.	None Reported
1/14/2005	Countywide. Flood – A slow-moving cold front dropped 1-2 inches of rain and led to urban and poor drainage flooding that and led to stream and creek flooding.	None Reported
4/3/2005	Countywide. Flood – A greater-than-50-year storm caused significant flooding, triggering widespread evacuation, road closures, and a state of emergency declaration.	None Reported
4/8/2005	Countywide. Flash Flood – Heavy rain that fell on already saturated ground caused stream flooding in northwestern Bucks County.	None Reported
10/8/2005	Northwest Portion of the County. Flash Flood – The remnants of Tropical Storm Tammy produced persistent and heavy rain across the County with storm total averages between 4-6 inches.	None Reported
12/16/2005	Langhorne. Flood – The combination of snow melt and excessive precipitation caused minor flooding along the Neshaminy Creek.	None Reported
6/28/2006	Multiple Counties. Flood/Flash Flood/Coastal Flood – Freshwater runoff from excessive precipitation combined with high astronomical tides caused moderate tidal flooding, extending inland on the tidal portions of Delaware River tributaries. At times other than high tide, major flooding occurred along the Delaware River, striking Yardley and New Hope the hardest.	$30,000,000
6/29/2006	Southwest Portion of the County. Flash Flood – Thunderstorms with heavy rain caused poor drainage flooding and some creek flooding in southwestern Bucks County.	None Reported
7/21/2006	North Portion of the County. Flash Flood - Thunderstorms with 3-4 inches of heavy rain caused poor drainage flooding and some creek flooding in northern Bucks County.	None Reported
9/2/2006	Langhorne. Flood – The remnants of Tropical Storm Ernest and a large high pressure system over Canada produced heavy rain and strong winds in Bucks County. This caused power outages and downed trees in and around Langhorne in particular.	None Reported

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
11/8/2006	Quakertown to Langhorne. Flood - A slow moving low pressure system that moved from the Gulf of Mexico caused heavy rain to fall averaging between 2 and 3 inches during about a twelve hour period. The heavy rain caused urban and poor drainage flooding exacerbated by fallen leaves that clogged catch basins.	None Reported
1/1/2007	Dublin. Flood - Heavy rain caused flooding along the East Branch of the Perkiomen Creek in upper Bucks County.	None Reported
3/2/2007	Andalusia. Flood - The borough of Croydon briefly experienced some minor street flooding, with two homes being surrounded by water as the Neshaminy Creek neared flood stage. Flooding also occurred along the Neshaminy Creek at Langhorne.	None Reported
3/2/2007	Bristol. Coastal Flood – Tidal flooding along the Delaware river in Bristol pushed water onto properties immediately along the river.	None Reported
4/15/2007	Quakertown. Flood - The heavy rain caused flooding across Bucks County with the worst reported flooding along the Neshaminy Creek. Ground floor apartments, roadways, and basements flooded in floods prone areas along the creek in Bensalem, Bristol, Middletown, Hulmeville, and Northampton. Minor coastal flooding was also seen along the Delaware River.	$1,000,000
4/27/2007	New Britain to Solebury, Langhorne. Flood/Flash Flood – Thunderstorms with heavy rain continued to repeat in a narrow band in central Bucks County, leading to road closures and multiple rescues.	$1,000,000
6/12/2007	Southampton. Flash Flood – Thunderstorms with very heavy rain caused stream and poor drainage flooding in Upper and Lower Southampton Townships.	None Reported
10/27/2007	Langhorne. Flood – A slow moving weather pattern led to approximately 5 inches of rain falling across the County, causing small creek and poor drainage flooding.	None Reported
2/13/2008	Langhorne. Flood - Runoff from the heavy rain and melting ice caused flooding along the Neshaminy Creek. The heavy rain also caused poor drainage flooding.	None Reported
3/8/2008	Bristol. Flash Flood – Runoff from the heavy rain caused flash flooding along the East Branch of the Perkiomen Creek as well as started flooding along the Neshaminy Creek. Some minor flooding also occurred along the Delaware River in Bridgeton.	None Reported
3/20/2008	Telford to Solebury. Flash Flood - Thunderstorms with heavy rain over saturated ground caused flash flooding along roadways and smaller streams in the Philadelphia northwest suburbs.	None Reported
6/4/2008	Neshaminy to Davisville; Langhorne. Flash Flood - Thunderstorms with heavy rain caused flash flooding of smaller streams as well as poor drainage flooding across central and lower Bucks Counties.	None Reported

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
9/28/2008	Kintersville to Ferndale. Flash Flood - Showers and thunderstorms with heavy rain caused the flooding and washouts of a few roads in Durham and Nockamixon Townships. A large mudslide occurred across Pennsylvania State Route 611 in Durham Township and closed it. Other major roads closed in the area included Center Hill and Kintner Hill Roads.	$750,000
12/12/2008	Newton to Langhorne. Flood - The main stem of the Neshaminy Creek flooded. The heavy rain also caused another section of the Delaware Canal wall to collapse just south of the Groundhog Lock between Raubsville and Riegelsville on the berm side of the waterway.	None Reported
5/7/2009	Erwinna Vansant Airport to Buckmanville. Flash Flood - Heavy rain from thunderstorms caused flooding across smaller creeks in central and upper Bucks County.	None Reported
6/13/2009	Bon Air to Jacksonville; Langhorne. Flash Flood - Slow moving thunderstorms with torrential downpours caused poor drainage as well as flash flooding of smaller streams and creeks including the headwaters of the Neshaminy Creek in and around Doylestown, Warwick, Warrington, and Westminster Townships in central Bucks County. Runoff from heavy rain upstream caused flooding along lower parts of the Neshaminy Creek.	None Reported
6/30/2009	Argus to Telford. Flash Flood - Thunderstorms with heavy rain caused poor drainage flooding as well as flooding of streams in the East Branch of the Perkiomen Creek basin in West Rockhill Township.	None Reported
2/2/2009	Keelersville to Springtown. Flash Flood - Thunderstorms with torrential downpours caused flash flooding of smaller streams and roadway flooding in upper Bucks County. Several roadways were closed.	None Reported
8/2/2009	Newtown. Flash Flood - Thunderstorms with torrential downpours caused poor drainage flooding as well as flooding along the Neshaminy Creek basin in lower or southern Bucks County. Doppler Radar storm total estimates reached three to four inches in the area. The Neshaminy Creek covered roads and backyards near Langhorne.	None Reported
10/24/2009	Trevose to Washington Crossing. Flash Flood - Showers and thunderstorms with heavy rain caused flash flooding of some of the smaller creeks as well as poor drainage flooding mainly in the central third of Bucks County.	None Reported
10/25/2009	Langhorne. Flood – Runoff from the heavy rain on this evening caused the Neshaminy Creek to reach flood stage. Precipitation caused flash flooding during the early evening.	None Reported
12/9/2009	Langhorne. Flood - The combination of snow melt and heavy rain caused poor drainage flooding and flooding along sections of the Neshaminy Creek.	None Reported
12/26/2009	Langhorne. Flood - The combination of melting snow and heavy rain produced field, poor drainage and stream and creek flooding in southeastern Pennsylvania throughout the Philadelphia Metropolitan Area.	None Reported

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
1/25/2010	Langhorne. Flood - Heavy rain that fell during the first half of the day on the 25th caused some river and poor drainage flooding in southeastern Pennsylvania. Event precipitation totals averaged 1.5 to 2 inches, but most of it fell between 6 a.m. and Noon EST.	None Reported
3/13/2010	Langhorne. Flood - Four days of rain, heaviest on the 13th, culminated in flooding across southeastern Pennsylvania. The Neshaminy Creek flooded Bridal Drive, but no homes were affected. Roadway flooding was reported from County Line to River Road in the county. Pennsylvania State Route 32 was closed due to flooding in Yardley and Solebury.	None Reported
3/10/2010	Langhorne. Flood - A series of low pressure systems that brought between two and four inches of rain from the evening of the 28th into the early morning of the 31st. Coupled with already wet conditions, this caused renewed flooding in southeastern Pennsylvania.	None Reported
10/1/2010	Quakertown to Tradesville. Flood - A series of low pressure systems that moved north along a slowly moving cold front brought heavy rain into Eastern Pennsylvania. Both Yardley and Lower Makefield closed River Road as waters from the Delaware River crept a few inches onto the roadway. Roadway flooding and closures including Erie Road were reported in Quakertown as the Tohickon Creek flooded.	None Reported
3/7/2011	LANGHORNE and RIEGELSVILLE. Flood - A slow moving cold front with waves of low pressure that developed along it brought a precipitation event that dropped between 1 and 3 inches of water equivalent over Eastern Pennsylvania. Precipitation ended briefly as snow. Snow melt contributed to the flooding which mainly affected the counties near or along the Delaware River.	None Reported
3/11/2011	LANGHORNE and RIEGELSVILLE. Flood - For the second time within a week heavy rain fell across Eastern Pennsylvania. An additional 1.5 to 5 inches of precipitation fell and caused more widespread river, stream, and poor drainage flooding including the Delaware, Lehigh, and Schuylkill Rivers. Generally minor flooding occurred on the Delaware and Schuylkill Rivers. Snowmelt in the upper reaches of the Lehigh and Delaware Basins contributed to the flooding. The worst reported damage was along the towpaths of the Delaware River in Bucks County.	$250,000
4/16/2011	LANGHORNE. Flood - Heavy rain caused poor drainage flooding in Eastern Pennsylvania and mainly minor to moderate creek and river flooding in Southeastern Pennsylvania. Precipitation totals averaged 1.5 to 3.0 inches with the highest amounts along the interstate 95 corridor.	None Reported
8/21/2011	CORNWELLS HGTS. Flash Flood - A series of thunderstorms with heavy rain caused poor drainage and stream flash flooding in Bucks County. Event precipitation totals averaged two to three inches.	None Reported
		None Reported

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
8/27/2011 - 8/28/2011	QUAKERTOWN and RIEGELSVILLE. Flash Flood - Irene produced heavy flooding rain, tropical storm force wind gusts with hundreds of thousands of outages, moderate tidal flooding along the Delaware River and one flooding related death in Eastern Pennsylvania over the weekend of August 27th and 28th. Moderate stream and river flooding occurred in the Poconos and Lehigh Valley and moderate to major river flooding occurred in southeast Pennsylvania. For many places in southeastern Pennsylvania, it was the worst creek and river flooding since Hurricane Floyd in 1999 or the remnants of Hurricane Jeanne in 2004. Flooding along non-tidal sections of the Delaware River was minor to moderate. About 500,000 PECO Energy and 420,000 Pennsylvania Power and Light customers lost power in Eastern Pennsylvania. For both utilities this ranked within the top five outages of all time. Preliminary damage estimates were around six million dollars. In addition to property damage, the winds and rains badly damaged the corn crop in southeastern Pennsylvania. The Delaware Water Gap National Recreational Area was closed through Labor Day Weekend (September 5th). Tropical storm force wind gusts overspread Eastern Pennsylvania during Irene. Among the highest wind gusts recorded during the storm, two were recorded in Bucks County: 44 mph in Newbold and 40 mph in Quakertown. During the evening of the 27th, The Southeastern Pennsylvania Transportation Authority halted all commuter rail service as multiple tornado warnings were issued, three large shelters were established in Philadelphia, and the Philadelphia International Airport was closed.	$700,000
9/6/2011 - 9/8/2011	TRUMBAUERSVILLE, GERYVILLE, and NESHAMINY. Flood - The remnants of Tropical Storm Lee that interacted with a stalled frontal boundary produced several days with periods of heavy rain across Eastern Pennsylvania. Event precipitation totals averaged 4 to 9 inches. The heavy rain caused widespread poor drainage flooding as well as moderate flooding along the Delaware and Schuylkill Basins and minor to moderate flooding along the Lehigh River Basin. Crests in the upper Schuylkill, Lehigh, and Delaware River Basins were higher than what occurred with Irene the previous month and the highest crests since late June of 2006 in most instances. The crests along the Delaware River were 2 to 4 feet higher than what occurred during Irene. Some of the smaller streams in southeastern Pennsylvania reached major flooding levels, but most of those crests were lower than what occurred with Irene. In addition to the freshwater flooding, moderate tidal flooding occurred along the lower Delaware River and its tributaries. In Eastern Pennsylvania, there were 22 homes and businesses that were destroyed, 201 that suffered major damage, 672 that had minor damage and 1217 others that were affected. The preliminary damage estimate for the state of Pennsylvania was five hundred million dollars.	None Reported

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
11/23/2011	LANGHORNE. Flood - Periods of rain, heavy at times, produced poor drainage flooding as well as minor to moderate flooding of creeks and rivers in Eastern Pennsylvania from the Lehigh Valley south through the Philadelphia Metropolitan Area. Event precipitation totals averaged two to three inches.	None Reported
12/7/2011	LANGHORNE. Flood - A protracted rain event with heavy rain caused poor drainage flooding in Eastern Pennsylvania. The heavy rain also caused minor to locally moderate river and creek flooding in Southeast Pennsylvania. Event precipitation totals averaged around two inches.	None Reported
5/15/2012	KEELERSVILLE. Flood - A weakening cold front helped trigger scattered showers and thunderstorms with heavy rain. Event precipitation totals during multiple thunderstorms reached between 2.0 and 3.5 inches and caused flash flooding and flooding of smaller streams and creeks in southeastern Pennsylvania.	None Reported
5/27/2012	SPINNERSTOWN. Flood - Series of thunderstorms with heavy rain produced poor drainage and creek flash flooding. Residual flooding in Bucks County along parts of the Perkiomen Creek as runoff went farther downstream. Doppler Radar storm total estimates reached around two inches in the upper part of the basin.	None Reported
8/1/2012	HARTSVILLE. Flash Flood - The combination of a weak cold front and a mid-level disturbance, along with an increasingly hot and humid air mass, triggered strong to severe thunderstorms, which produced heavy rain and flooding in Pennsylvania. Doppler Radar storm total estimates reached between 3 and 6 inches.	None Reported
12/21/2012	CORNWELLS HGTS. Flood - Major tidal flooding along the Delaware Bay and Delaware River. Moderate to heavy rain occurred with storm totals ranging between 1 to 3 inches. This rain resulted in poor drainage flooding as well as minor to moderate flooding of streams and creeks in Eastern Pennsylvania. In Philadelphia, the tidal flooding forced the closure of the southbound lanes of Interstate 95 at Columbus Boulevard. Columbus Boulevard/Delaware Avenue was flooded and closed in both directions between Washington and Fairmount Avenues. In Bucks County, tidal flooding affected the Radcliffe, Cedar, and Mill Street areas of Bristol Township. The high tide swamped the backyards and basements of stores in the business district along Radcliffe and Cedar Streets The Mill Street parking lot was under water as was the Landmark Wharf on Mill Street. The high tide in Philadelphia reached 10.35 feet above mean lower low water. This was the third highest tide on record. Major tidal flooding starts at 10.2 feet above mean lower low water. The high tide reached 12.13 feet above mean lower low water at Newbold Island (Bucks County). There are no established flood categories for this site. Strong winds occurred in the southeast part of the state, peak wind gusts included 55 mph in Newbold Island.	None Reported
1/31/2013	KEELERSVILLE. Flood - Heavy rain caused poor drainage flooding as well as stream and river flooding in southeastern Pennsylvania. Most of the waterway flooding was. Event totals averaged 1.5 to 3.0 inches.	None Reported

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
6/7/2013	LANGHORNE. Flood - The remnants of Tropical Storm Andrea moving up the Eastern Seaboard, led to waves of heavy rain and thunderstorms. Doppler radar storm total estimates ranged from around 2 to 4 inches of rain for the event across eastern Pennsylvania. Waves of heavy precipitation resulted in areas of flooding.	None Reported
6/10/2013	LANGHORNE. Flash Flood - Heavy rain that moved across southeast Pennsylvania during the day on the 10th caused renewed flooding in the area. Event precipitation totals averaged between 1.5 and 3.5 inches.	None Reported
6/27/2013	HARTSVILLE. Flood - A series of thunderstorms with very heavy rain caused flooding in the Philadelphia northwest suburbs that lasted overnight, with 2 to 3 inches in the hardest hit parts of Bucks County.	None Reported
7/13/2013	MORRISVILLE. Flood - Heavy downpours across sections of Bucks County that caused poor drainage and roadway flooding, with total estimates of 1 to 2.5 inches in sections of Bucks County.	None Reported
8/13/2013	CORNWELLS HGTS. Flash Flood - A complex of showers and thunderstorms produced both wind damage and flash flooding in southeastern Pennsylvania. Doppler Radar storm total estimates averaged 2.5 to 7.0 inches. In addition to widespread poor drainage flooding, flooding also affected sections of the Brandywine basin. Vehicle water rescues were performed in lower Bucks County. The AAA of Mid-Atlantic reported a 60 percent increase in assistance calls. Because the torrential rain coincided with the morning commute, traffic on some interstates were backed up for hours. SEPTA commuter regional rail lines experienced on average thirty minute system-wide delays through the morning. Arrival delays to Philadelphia International Airport reached 90 minutes.	None Reported
8/28/2013	QUAKERTOWN. Flash Flood - An area of rain with embedded thunderstorms caused flash flooding in upper Bucks County and brief minor flooding along the Frankford Creek.	None Reported
9/2/2013	FOUNTAINVILLE. Flash Flood - Clusters of showers and thunderstorms with torrential downpours occurred in southeast Pennsylvania This caused urban, poor drainage and small creek flash flooding. Event precipitation totals reached between 1.0 and 3.5 inches in many areas in and around the local Philadelphia area and marred traveling plans on this Labor Day.	None Reported
1/8/2014	MORRISVILLE. Flood - Ice jam flooding along the Delaware River north of the jam in Bucks County and along the Lehigh River in Northampton County before its confluence with the Delaware River.	None Reported

Table 4.3.4-1: Flood and flash flood events impacting Bucks County from 1993-2015 (NCDC, 2015). "Countywide" indicates several locations in the County were affected.

DATE	LOCATION & DESCRIPTION	PROPERTY DAMAGE
4/30/2014 - 5/1/2014	CORNWELLS HGTS. Flood - Very heavy rain caused widespread poor drainage, moderate to major creek flooding in Bucks County. Flooding along the Neshaminy Creek was the worst since Tropical Storm Irene on August 28, 2011. Even moderate tidal flooding occurred along the Delaware River. An apartment building along the East Branch of the Perkiomen Creek in Perkasie was evacuated because of flooding. Vehicles were stuck in flood waters in Bensalem Township. Townships reporting road closures due to flooding included Milford and New Britain. Event precipitation totals included 4.90 inches in Quakertown and Richlandtown, 4.82 inches in Warrington, 4.79 inches in Furlong, 4.57 inches in Warwick Township and 4.42 inches in Doylestown.	$200,000
7/14/2014	EDGELY. Flash Flood - Thunderstorms with very heavy rain caused poor drainage flash flooding in Bristol Township. Numerous roadways were flooded near the Delaware River and included Radcliffe Street, Farragut Street and Wilson Street. Event precipitation totals included 2.16 inches at the Northeast Philadelphia Airport, 2.01 inches in Warrington, 1.96 inches in Newtown and 1.92 inches in Jamison.	None Reported
7/14/2014	WEST BRISTOL. Flash Flood - Thunderstorms with very heavy rain caused poor drainage flash flooding on the campus of the Lower Bucks Hospital in Bristol Township. Flood waters started to cascade from the parking lots into the hospital's staircases. No patients had to be evacuated. Event precipitation totals included 2.16 inches at the Northeast Philadelphia Airport, 2.01 inches in Warrington, 1.96 inches in Newtown and 1.92 inches in Jamison.	$10,000
06/15/2015	SPRINGTOWN. Flash Flood - Slowly westward moving thunderstorms that formed along a backdoor cold front caused flash flooding in parts of Northampton and Upper Bucks Counties during the evening of the 15th. Reported event precipitation totals reached 2 to 3 inches. Doppler Radar storm total estimates exceeded 4 inches in south central Northampton County. Thunderstorms with torrential downpours caused poor drainage flooding as well as flash flooding of smaller creeks in Durham and Nockamixon Townships. Doppler Radar storm totals reached 3 to 4 inches near the Northampton County border.	None Reported

During the end of August and beginning of September 2011, Bucks County was impacted by flooding related to Hurricane Irene and Tropical Storm Lee. These storms resulted in four Presidential Disaster Declarations (See Table 4.2-1). Anecdotal stories report that flooding from the storms impacted power and water utilities throughout the county and caused road damage and home flooding in flood prone areas of the county. NOAA reports that these storms resulted in a total of $700,000 in property damage in Bucks County for Tropical Storm Irene and a preliminary (total) damage estimate for the Commonwealth of $500 million for Tropical Storm Lee (NCDC, 2015).

The National Flood Insurance Program identifies properties that frequently experience flooding. *Repetitive loss properties* are structures insured under the NFIP which have had at least two paid flood losses of more than $1,000 over any ten year period since 1978. A property is considered a *severe*

repetitive loss property either when there are at least four losses each exceeding $5,000 or when there are two or more losses where the building payments exceed the property value. According to the Pennsylvania Emergency Management Agency, there are 174 repetitive loss properties in Bucks County (PEMA, 2015). This represents a reduction of over 77% in repetitive loss properties in the county since 2010, as reported in the Pennsylvania Standard State All-Hazard Mitigation Plan (PEMA, 2010). Yardley Borough has by far the highest number of repetitive loss properties of any jurisdiction with 183 properties. Approximately 79 percent of the repetitive loss properties in the County are single-family residences. Table 4.3.4-2 displays the number of repetitive loss properties by municipality.

Table 4.3.4-2: Summary of the number and type of Repetitive Loss properties by municipality (PEMA, 2015).

MUNICIPALITY	TYPE					SUM OF REPETITIVE LOSS PROPERTIES
	NON-RESIDENTIAL	2-4 FAMILY	SINGLE FAMILY	CONDO	OTHER RESIDENT	
Bensalem Township	7	1	23	1	2	34
Bridgeton Township	5	3	50	0	1	59
Bristol Borough	0	0	3	0	0	3
Bristol Township	6	0	17	0	0	23
Buckingham Township	0	0	1	0	0	1
Chalfont Borough	0	0	1	0	0	1
Doylestown Borough	0	0	3	0	0	3
Doylestown Township	0	1	2	0	0	3
Durham Township	1	1	16	1	0	19
Falls Township	5	0	2	1	0	8
Hulmeville Borough	4	0	10	1	0	15
Langhorne Borough	2	0	9	0	0	11
Langhorne Manor Borough	0	0	2	0	0	2
Lower Makefield Township	0	0	36	0	0	36
Lower Southampton Township	7	0	10	0	0	17
Middletown Township	3	1	35	0	0	39
Milford Township	0	0	2	0	0	2
New Britain Township	0	0	1	0	0	1
New Hope Borough	29	5	31	5	8	78
Nockamixon Township	0	0	1	0	0	1
Northampton Township	4	0	9	0	0	13
Perkasie Borough	3	0	0	0	0	3
Plumstead Township	0	1	7	0	0	8
Quakertown Borough	0	1	3	0	0	4
Richland Township	1	1	1	0	0	3
Riegelsville Borough	2	5	29	0	1	37

Table 4.3.4-2: Summary of the number and type of Repetitive Loss properties by municipality (PEMA, 2015).

MUNICIPALITY	TYPE					SUM OF REPETITIVE LOSS PROPERTIES
	NON-RESIDENTIAL	2-4 FAMILY	SINGLE FAMILY	CONDO	OTHER RESIDENT	
Sellersville Borough	2	1	4	0	1	8
Solebury Township	8	1	37	0	0	46
Springfield Township	0	0	3	0	0	3
Tinicum Township	0	2	65	3	3	73
Wrightstown Township	0	1	1	0	0	2
Upper Makefield Township	1	0	71	0	0	72
Upper Southampton Township	0	0	8	0	0	8
Warminster Township	0	0	8	0	0	8
Warrington Township	1	0	12	0	0	13
Warwick Township	0	0	2	0	0	2
West Rockhill Township	0	0	2	0	0	2
Wrightstown Township	0	1	1	0	0	2
Yardley Borough	10	12	152	3	6	183
TOTAL	**101**	**38**	**670**	**15**	**22**	**846**

There are also 98 severe repetitive loss properties in the County, listed by municipality in Table 4.3.4-3. There were a total of 89 severe repetitive loss properties in Bucks County as reported in the 2010 Pennsylvania Standard State All-Hazard Mitigation Plan, which represents an approximate 10% increase in severe repetitive loss properties over the last five years. Again, the highest number of severe repetitive loss properties are in Yardley Borough. Over 92 percent of the severe repetitive loss properties in the County are single family residential occupancies.

Table 4.3.4-3: Summary of the number and type of Severe Repetitive Loss properties by municipality (PEMA, 2015).

MUNICIPALITY	TYPE					SUM OF SEVERE REPETITIVE LOSS PROPERTIES
	NON-RESIDENTIAL	2-4 FAMILY	SINGLE FAMILY	CONDO	OTHER RESIDENT	
Bensalem Township	0	0	3	0	0	3
Bridgeton Township	0	0	4	0	0	4
Bristol Township	0	0	1	0	0	1
Durham Township	0	0	3	0	0	3
Lower Makefield Township	0	0	6	0	0	6
Lower Southampton Township	0	0	1	0	0	1

Table 4.3.4-3: Summary of the number and type of Severe Repetitive Loss properties by municipality (PEMA, 2015).

MUNICIPALITY	TYPE					SUM OF SEVERE REPETITIVE LOSS PROPERTIES
	NON-RESIDENTIAL	2-4 FAMILY	SINGLE FAMILY	CONDO	OTHER RESIDENT	
Middletown Township	0	0	2	0	0	2
New Hope Borough	0	3	4	0	1	8
Northampton Township	0	0	1	0	0	1
Plumstead Township	0	0	2	0	0	2
Sellersville Borough	0	0	1	0	0	1
Solebury Township	0	0	10	0	0	10
Springfield Township	0	0	1	0	0	1
Tinicum Township	0	0	6	0	0	6
Upper Makefield Township	0	0	17	0	0	17
Upper Southampton Township	0	0	1	0	0	1
Warminster Township	0	0	1	0	0	1
Yardley Borough	0	3	27	0	0	30
TOTAL	**0**	**6**	**91**	**0**	**1**	**98**

Floods are the most common and costly natural catastrophe in the United States. In terms of economic disruption, property damage, and loss of life, floods are "nature's number-one disaster." For that reason, flood insurance is almost never available under industry-standard homeowner's and renter's policies. The best way for citizens to protect their property against flood losses is to purchase flood insurance through the NFIP.

Congress established the NFIP in 1968 to help control the growing cost of federal disaster relief. The NFIP is administered by the FEMA, part of the U.S. Department of Homeland Security (DHS). The NFIP offers federally-backed flood insurance in communities that adopt and enforce effective floodplain management ordinances to reduce future flood losses.

Since 1983, the chief means of providing flood insurance coverage has been a cooperative venture of FEMA and the private insurance industry known as the Write Your Own (WYO) Program. This partnership allows qualified property and casualty insurance companies to "write" (that is, issue) and service the NFIP's Standard Flood Insurance Policy (SFIP) under their own names.

Today, nearly 78 WYO insurance companies issue and service the NFIP under their own names (FEMA, 2015a). More than 5.2 million federal flood insurance policies are in force. These policies represent over 1.2 trillion in flood insurance coverage for homeowners, renters, and business owners throughout the United States and its territories. As of March 2015, Pennsylvania had a total of 68,936 policies in force across the state (FEMA, 2015b).

The NFIP provides flood insurance to individuals in communities that are members of the program. Membership in the program is contingent on the community adopting and enforcing floodplain management and development regulations.

The NFIP is based on the voluntary participation of communities of all sizes. In the context of this program, a "community" is a political entity – whether an incorporated city, town, township, borough, or village, or an unincorporated area of a county or parish – that has legal authority to adopt and enforce floodplain management ordinances for the area under its jurisdiction.

National Flood Insurance is available only in communities that apply for participation in the NFIP and agree to implement prescribed flood mitigation measures. Newly participating communities are admitted to the NFIP's Emergency Program. Most of these communities quickly earn "promotion" to the Regular Program.

The Emergency Program is the initial phase of a community's participation in the NFIP. In return for the local government's agreeing to adopt basic floodplain management standards, the NFIP allows local property owners to buy modest amounts of flood insurance coverage.

In return for agreeing to adopt more comprehensive floodplain management measures, an Emergency Program community can be "promoted" to the Regular Program. Local policyholders immediately become eligible to buy greater amounts of flood insurance coverage. Ninety percent of the municipalities in Bucks County are participating in the Regular Program.

The minimum floodplain management requirements include:

- Review and permit all development in the SFHA;
- Elevate new and substantially improved residential structures above the Base Flood Elevation;
- Elevate or dry floodproof new and substantially improved non-residential structures;
- Limit development in floodways;
- Locate or construct all public utilities and facilities so as to minimize or eliminate flood damage; and
- Anchor foundation or structure to resist floatation, collapse, or lateral movement.

In addition, Regular Program communities are eligible to participate in the NFIP's Community Rating System (CRS). Under the CRS, policyholders can receive premium discounts of 5 to 45 percent as their cities and towns adopt more comprehensive flood mitigation measures. Currently, no municipalities in Bucks County participate in CRS.

Table 4.3.4-4 lists the Bucks County municipalities participating in the NFIP, their initial FIRM identification date, and their current effective map dates. Note that Dublin, Ivyland, Richlandtown, Telford, and Trumbauersville Boroughs do not participate in the NFIP. Dublin, Ivyland, Richlandtown, and Telford Boroughs do not have SFHAs identified while Trumbauersville Borough has SFHA identified in the northeast corner of the Borough.

Table 4.3.4-4: Bucks County Municipal Participation in the National Flood Insurance Program (FEMA CIS, 2015).

COMMUNITY	PARTICIPATION STATUS	CID	INITIAL FIRM IDENTIFIED	CURRENT EFFECTIVE MAP DATE
Bedminster Township	Participating	421049	12/01/83	03/16/15
Bensalem Township	Participating	420181	07/17/78	03/16/15
Bridgeton Township	Participating	420182	09/30/77	03/16/15
Bristol Borough	Participating	420183	12/18/79	03/16/15
Bristol Township	Participating	420984	09/29/78	03/16/15
Buckingham Township	Participating	420985	03/15/79	03/16/15
Chalfont Borough	Participating	420184	12/28/76	03/16/15
Doylestown Borough	Participating	421410	06/01/84	03/16/15
Doylestown Township	Participating	420185	09/29/78	03/16/15
Dublin Borough	Not Participating	422676	06/20/01	
Durham Township	Participating	420186	08/15/78	03/16/15
East Rockhill Township	Participating	420187	08/01/77	03/16/15
Falls Township	Participating	420188	09/30/80	03/16/15
Haycock Township	Participating	421127	09/03/80	03/16/15
Hilltown Township	Participating	420189	01/30/81	03/16/15
Hulmeville Borough	Participating	420190	09/30/77	03/16/15
Ivyland Borough	Not Participating	422677	06/20/01	
Langhorne Manor Borough	Participating	422336	02/15/84	03/16/15
Langhorne Borough	Participating	421074	07/02/80	03/16/15
Lower Makefield Township	Participating	420191	09/30/77	03/16/15
Lower Southampton Township	Participating	420192	03/15/77	03/16/15
Middletown Township	Participating	420193	12/04/79	03/16/15
Milford Township	Participating	422337	06/01/82	03/16/15
Morrisville Borough	Participating	420194	09/30/77	03/16/15
New Britain Borough	Participating	420986	04/02/79	03/16/15
New Britain Township	Participating	420987	09/30/77	03/16/15
New Hope Borough	Participating	420195	12/15/77	03/16/15
Newtown Borough	Participating	420196	12/18/79	03/16/15
Newtown Township	Participating	421084	12/18/79	03/16/15
Nockamixon Township	Participating	420197	11/02/77	03/16/15
Northampton Township	Participating	420988	02/15/80	03/16/15
Penndel Borough	Participating	422678	05/18/99	03/16/15
Perkasie Borough	Participating	420198	03/01/77	03/16/15
Plumstead Township	Participating	420199	09/29/78	03/16/15
Quakertown Borough	Participating	420200	07/05/77	03/16/15
Richland Township	Participating	421095	06/15/81	03/16/15
Richlandtown Borough	Not Participating	422679	06/20/01	
Riegelsville Borough	Participating	420201	04/17/78	03/16/15

Table 4.3.4-4: Bucks County Municipal Participation in the National Flood Insurance Program (FEMA CIS, 2015).				
COMMUNITY	PARTICIPATION STATUS	CID	INITIAL FIRM IDENTIFIED	CURRENT EFFECTIVE MAP DATE
Sellersville Borough	Participating	420203	02/15/78	03/16/15
Silverdale Borough	Participating	422338	01/05/84	03/16/15
Solebury Township	Participating	420202	04/15/77	03/16/15
Springfield Township	Participating	420204	09/01/77	03/16/15
Telford Borough	Not Participating	422339	06/20/01	
Tinicum Township	Participating	420205	01/02/79	03/16/15
Trumbauersville Borough	Not Participating	422681	05/18/99	
Tullytown Borough	Participating	420206	02/01/80	03/16/15
Upper Makefield Township	Participating	420207	10/17/78	03/16/15
Upper Southampton Township	Participating	420989	04/03/78	03/16/15
Warminster Township	Participating	420990	03/01/78	03/16/15
Warrington Township	Participating	420208	09/29/78	03/16/15
Warwick Township	Participating	420209	09/29/78	03/16/15
West Rockhill Township	Participating	421123	07/05/84	03/16/15
Wrightstown Township	Participating	421045	08/15/78	03/16/15
Yardley Borough	Participating	420210	08/01/77	03/16/15

4.3.4.4. Future Occurrence

In Bucks County, flooding occurs commonly and can occur during any season of the year. Within the flood susceptible areas of Bucks County, it is expected that the character of flooding will remain essentially unchanged from what has been experienced for many years. However, some increase in the severity and frequency of flooding may result due to planned or recent development within the floodplains of the various county streams. The future occurrence of floods in Bucks County can be characterized as *highly likely* as defined by the probability criteria of the Risk Factor Methodology (see Table 4.4-1). Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. The NFIP uses historical records to determine the probability of occurrence for different extents of flooding. The probability of occurrence is expressed in percentages as the chance of a flood of a specific extent occurring in any given year.

The NFIP recognizes the 1 percent-annual-chance flood, also known as the *base flood*, as the standard for identifying properties subject to federal flood insurance purchase requirements. A 1%-annual-chance flood is a flood which has a 1% chance of occurring over a given year. The DFIRMs are used to identify areas subject to the 1- and 0.2 percent-annual-chance flooding. Areas subject to 2% and 10% annual chance events are not shown on maps; however, water surface elevations associated with these events are included in the flood source profiles contained in the Flood Insurance Study Report.

Table 4.3.4-5 shows a range of flood recurrence intervals and associated probabilities of occurrence.

Table 4.3.4-5: Recurrence intervals and associated probabilities of occurrence (FEMA, 2007).	
RECURRENCE INTERVAL	CHANCE OF OCCURRENCE IN ANY GIVEN YEAR (%)
10 year	10
50 year	2
100 year	1
500 year	0.2

4.3.4.5. Vulnerability Assessment

Bucks County is vulnerable to flooding that causes loss of lives, property damage, and road closures. However, for purposes of assessing vulnerability, the County focused on community assets that are located in the 1%-annual-chance floodplain. While greater and smaller floods are possible, information about the extent and depths for this floodplain is available for all municipalities countywide, thus providing a consistent basis for analysis. Flood vulnerability maps for each applicable local municipality, showing the 1%-annual-chance flood hazard area and addressable structures, critical facilities and transportation routes within it, are included in Appendix D. These maps were created using FEMA's DFIRM digital data.

Table 4.3.4-6 displays the number of addressable structures, mobile home parcels and structures, and populations intersecting the SFHA along with the total number of addressable structures, structures in mobile home parcels, and population in each municipality. The number of vulnerable addressable structures was calculated by overlaying the addressable structures with the SFHA as shown in the DFIRM data. Similarly, the estimated population in the SFHA was calculated by overlaying the centroids of Census blocks with the SFHA; while clearly an estimate, using the block centroid helps to minimize overestimation of floodprone populations. In order to estimate the number of mobile home structures in the SFHA, addressable structures that fall within parcels with the land use "mobile home" were selected; then the structures were intersected with the SFHA.

Overall, 2.44 percent of the addressable structures and 2.87 percent of the population of the County are most at risk to the 1%-annual-chance flood zone. Bristol Township has the highest number of addressable structures in the SFHA with 1,146, followed distantly by Yardley Borough which has 323 floodprone structures. Yardley and Riegelsville Boroughs have the highest percentage of structures in the SFHA; approximately 34 percent of all structures in these municipalities are located in the SFHA. Riegelsville Borough has by far the highest proportion of population living in the SFHA with nearly half (49.9%) of its population residing within the SFHA. Yardley Borough also has a significant amount of people living in the SFHA with 31.68 percent. Of all the jurisdictions that have SFHAs, Langhorne Borough, Penndel Borough, Silverdale Borough, and Trumbauersville Borough have no addressable structures in the SFHA. Additionally, 12 of the jurisdictions with SFHAs have 1 percent or fewer addressable structures in the SFHA. Many of these jurisdictions also have either no population or the lowest proportion of population in the SFHA.

Table 4.3.4-7 shows the number of structures in the SFHA by generalized land use type. Unsurprisingly, most vulnerable structures are residential properties.

Table 4.3.4-6: Structure and population vulnerability to floods in Bucks County.

MUNICIPALITY	TOTAL ADDRESSABLE STRUCTURES	TOTAL ADDRESSABLE STRUCTURES IN SFHA	% OF TOTAL ADDRESSABLE STRUCTURES IN SFHA	TOTAL POPULATION (2010)	POPULATION IN SFHA	% POPULATION IN SFHA
Bedminster Township	3,380	16	0.47	6,557	56	0.85
Bensalem Township	15,196	263	1.73	60,342	1,798	2.98
Bridgeton Township	995	182	18.29	1,277	262	20.52
Bristol Borough	2,231	31	1.39	9,841	107	1.09
Bristol Township	19,210	1146	5.97	54,636	2,508	4.59
Buckingham Township	7,607	38	0.50	20,120	185	0.92
Chalfont Borough	1,333	25	1.88	4,009	34	0.85
Doylestown Borough	2,810	40	1.42	8,332	94	1.13
Doylestown Township	5,475	36	0.66	17,565	369	2.10
Dublin Borough	541	0	0.00	2,158	0	0.00
Durham Township	967	68	7.03	1,144	45	3.93
East Rockhill Township	2,520	38	1.51	5,706	63	1.10
Falls Township	11,506	285	2.48	34,724	1,643	4.73
Haycock Township	1,783	61	3.42	2,232	177	7.93
Hilltown Township	6,027	2	0.03	15,032	168	1.12
Hulmeville Borough	409	35	8.56	1,003	153	15.25
Ivyland Borough	234	0	0.00	1,041	0	0.00
Langhorne Borough	718	0	0.00	1,622	0	0.00
Langhorne Manor Borough	436	0	0.00	1,437	2	0.14
Lower Makefield Township	9,883	248	2.51	32,582	1,087	3.34
Lower Southampton Township	7,181	96	1.34	18,877	77	0.41
Middletown Township	13,318	166	1.25	45,285	702	1.55
Milford Township	4,745	110	2.32	9,884	778	7.87
Morrisville Borough	3,358	133	3.96	8,138	338	4.15
New Britain Borough	979	5	0.51	3,152	9	0.29
New Britain Township	3,954	13	0.33	11,070	97	0.88

Table 4.3.4-6: Structure and population vulnerability to floods in Bucks County.

MUNICIPALITY	TOTAL ADDRESSABLE STRUCTURES	TOTAL ADDRESSABLE STRUCTURES IN SFHA	% OF TOTAL ADDRESSABLE STRUCTURES IN SFHA	TOTAL POPULATION (2010)	POPULATION IN SFHA	% POPULATION IN SFHA
New Hope Borough	827	136	16.44	2,528	414	16.38
Newtown Borough	1,005	5	0.50	2,248	47	2.09
Newtown Township	4,376	29	0.66	19,311	155	0.80
Nockamixon Township	2,591	15	0.58	3,443	14	0.41
Northampton Township	12,376	76	0.61	39,724	1,161	2.92
Penndel Borough	763	0	0.00	2,434	0	0.00
Perkasie Borough	3,043	30	0.99	8,511	143	1.68
Plumstead Township	5,032	32	0.64	12,478	58	0.46
Quakertown Borough	2,929	314	10.72	8,904	1,536	17.25
Richland Township	4,633	89	1.92	13,095	198	1.51
Richlandtown Borough	379	0	0.00	1,327	0	0.00
Riegelsville Borough	530	181	34.15	868	433	49.88
Sellersville Borough	1,307	46	3.52	4,249	272	6.40
Silverdale Borough	341	0	0.00	871	0	0.00
Solebury Township	4,260	149	3.50	8,688	156	1.80
Springfield Township	3,661	24	0.66	5,072	190	3.75
Telford Borough	633	0	0.00	2,207	0	0.00
Tinicum Township	3,306	275	8.32	3,968	290	7.31
Trumbauersville Borough	432	1	0.23	970	0	0.00
Tullytown Borough	836	38	4.55	1,872	69	3.69
Upper Makefield Township	3,509	178	5.07	8,193	252	3.08
Upper Southampton Township	5,421	50	0.92	15,152	151	1.00
Warminster Township	9,498	49	0.52	32,678	187	0.57
Warrington Township	5,568	50	0.90	23,418	440	1.88
Warwick Township	3,258	18	0.55	14,443	151	1.05
West Rockhill Township	2,661	24	0.90	5,261	63	1.20
Wrightstown Township	1,738	21	1.21	2,988	22	0.74

Table 4.3.4-6: Structure and population vulnerability to floods in Bucks County.

MUNICIPALITY	TOTAL ADDRESSABLE STRUCTURES	TOTAL ADDRESSABLE STRUCTURES IN SFHA	% OF TOTAL ADDRESSABLE STRUCTURES IN SFHA	TOTAL POPULATION (2010)	POPULATION IN SFHA	% POPULATION IN SFHA
Yardley Borough	950	323	34.00	2,453	777	31.68
TOTAL	**212,659**	**5,190**	**2.44**	**625,120**	**17,931**	**2.87**

Table 4.3.4-7: Structure and population vulnerability to floods in Bucks County.

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Bedminster Township	0	2	0	0	1	8	5	0	**16**
Bensalem Township	0	79	4	5	8	151	0	16	**263**
Bridgeton Township	0	11	0	2	1	165	0	3	**182**
Bristol Borough	0	16	2	1	2	5	4	1	**31**
Bristol Township	0	28	11	6	19	1066	8	8	**1146**
Buckingham Township	9	3	1	0	0	24	0	1	**38**
Chalfont Borough	0	8	0	0	2	14	1	0	**25**
Doylestown Borough	0	1	0	0	0	27	12	0	**40**
Doylestown Township	0	3	3	2	2	25	1	0	**36**
Dublin Borough	0	0	0	0	0	0	0	0	**0**
Durham Township	15	2	0	5	0	44	0	2	**68**
East Rockhill Township	15	2	0	0	6	15	0	0	**38**
Falls Township	1	10	3	24	14	225	6	2	**285**
Haycock Township	0	0	0	0	4	57	0	0	**61**
Hilltown Township	0	0	0	0	0	2	0	0	**2**
Hulmeville Borough	0	4	0	0	1	30	0	0	**35**
Ivyland Borough	0	0	0	0	0	0	0	0	**0**
Langhorne Borough	0	0	0	0	0	0	0	0	**0**
Langhorne Manor Borough	0	0	0	0	0	0	0	0	**0**
Lower Makefield Township	0	0	6	0	3	231	7	1	**248**

Table 4.3.4-7: Structure and population vulnerability to floods in Bucks County.

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Lower Southampton Township	0	14	2	13	13	53	0	1	**96**
Middletown Township	0	13	1	1	19	129	2	1	**166**
Milford Township	7	2	3	0	2	95	0	1	**110**
Morrisville Borough	0	5	14	28	1	70	15	0	**133**
New Britain Borough	0	1	0	1	0	3	0	0	**5**
New Britain Township	0	0	0	0	5	8	0	0	**13**
New Hope Borough	0	59	3	0	0	72	1	1	**136**
Newtown Borough	0	0	0	0	0	5	0	0	**5**
Newtown Township	0	16	1	0	5	7	0	0	**29**
Nockamixon Township	0	3	0	0	3	8	0	1	**15**
Northampton Township	1	12	1	0	9	49	1	3	**76**
Penndel Borough	0	0	0	0	0	0	0	0	**0**
Perkasie Borough	0	3	0	1	8	16	0	2	**30**
Plumstead Township	0	9	1	1	0	17	4	0	**32**
Quakertown Borough	0	22	18	7	10	251	0	6	**314**
Richland Township	10	12	2	0	0	53	6	6	**89**
Richlandtown Borough	0	0	0	0	0	0	0	0	**0**
Riegelsville Borough	0	14	2	0	3	152	2	8	**181**

Table 4.3.4-7: Structure and population vulnerability to floods in Bucks County.

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Sellersville Borough	0	7	8	0	1	28	2	0	**46**
Silverdale Borough	0	0	0	0	0	0	0	0	**0**
Solebury Township	0	20	16	1	10	99	0	3	**149**
Springfield Township	2	1	6	0	0	15	0	0	**24**
Telford Borough	0	0	0	0	0	0	0	0	**0**
Tinicum Township	8	22	2	2	50	184	1	6	**275**
Trumbauersville Borough	0	0	0	0	0	1	0	0	**1**
Tullytown Borough	0	15	0	12	1	8	2	0	**38**
Upper Makefield Township	0	4	0	0	6	157	1	10	**178**
Upper Southampton Township	0	0	0	0	0	50	0	0	**50**
Warminster Township	0	1	3	0	0	39	5	1	**49**
Warrington Township	0	0	0	0	1	49	0	0	**50**
Warwick Township	0	0	0	0	2	16	0	0	**18**
West Rockhill Township	0	0	1	0	1	11	11	0	**24**
Wrightstown Township	0	3	0	0	0	18	0	0	**21**
Yardley Borough	0	15	2	0	0	298	1	7	**323**
TOTAL	**68**	**442**	**116**	**112**	**213**	**4,050**	**98**	**91**	**5,190**

Table 4.3.3-8 displays the number of critical facilities that are located in the SFHA by jurisdiction. There are 24 critical facilities that are located in the SFHA, representing just over 3 percent of the County's total critical facilities. Bristol Township has the highest number of floodprone critical facilities in the County with 3 while Falls Township, Lower Makefield Township, New Hope Borough, Quakertown Borough, and Sellersville Borough each have 2 critical facilities in the floodplain. Other jurisdictions with critical facilities located in the SFHA include Bensalem Township, Buckingham Township, Doylestown Borough, Lower Southampton Township, Milford Township, Morrisville Borough, Northampton Township, Richland Township, Riegelsville Borough, Tinicum Township, and West Rockhill Township. Thirty of the jurisdictions have no critical facilities in the SFHA.

Table 4.3.4-8: Critical facilities vulnerable to flood by municipality in Bucks County.

MUNICIPALITY	TOTAL CRITICAL FACILITIES	TOTAL CRITICAL FACILITIES IN SFHA	% OF TOTAL CRITICAL FACILITIES IN SFHA
Bedminster Township	9	0	0.0%
Bensalem Township	59	1	1.7%
Bridgeton Township	3	0	0.0%
Bristol Borough	21	0	0.0%
Bristol Township	56	3	5.4%
Buckingham Township	19	1	5.3%
Chalfont Borough	11	0	0.0%
Doylestown Borough	20	1	5.0%
Doylestown Township	23	0	0.0%
Dublin Borough	6	0	0.0%
Durham Township	1	0	0.0%
East Rockhill Township	12	0	0.0%
Falls Township	30	2	6.7%
Haycock Township	2	0	0.0%
Hilltown Township	10	0	0.0%
Hulmeville Borough	3	0	0.0%
Ivyland Borough	4	0	0.0%
Langhorne Borough	8	0	0.0%
Langhorne Manor Borough	6	0	0.0%
Lower Makefield Township	26	2	7.7%
Lower Southampton Township	28	1	3.6%
Middletown Township	40	0	0.0%
Milford Township	13	1	7.7%
Morrisville Borough	13	1	7.7%
New Britain Borough	9	0	0.0%
New Britain Township	15	0	0.0%
New Hope Borough	8	2	25.0%
Newtown Borough	7	0	0.0%

Table 4.3.4-8: Critical facilities vulnerable to flood by municipality in Bucks County.			
MUNICIPALITY	TOTAL CRITICAL FACILITIES	TOTAL CRITICAL FACILITIES IN SFHA	% OF TOTAL CRITICAL FACILITIES IN SFHA
Newtown Township	31	0	0.0%
Nockamixon Township	7	0	0.0%
Northampton Township	28	1	3.6%
Penndel Borough	6	0	0.0%
Perkasie Borough	13	0	0.0%
Plumstead Township	16	0	0.0%
Quakertown Borough	20	2	10.0%
Richland Township	11	1	9.1%
Richlandtown Borough	3	0	0.0%
Riegelsville Borough	3	1	33.3%
Sellersville Borough	9	2	22.2%
Silverdale Borough	3	0	0.0%
Solebury Township	12	0	0.0%
Springfield Township	8	0	0.0%
Telford Borough	2	0	0.0%
Tinicum Township	12	1	8.3%
Trumbauersville Borough	4	0	0.0%
Tullytown Borough	9	0	0.0%
Upper Makefield Township	5	0	0.0%
Upper Southampton Township	20	0	0.0%
Warminster Township	36	0	0.0%
Warrington Township	23	0	0.0%
Warwick Township	14	0	0.0%
West Rockhill Township	12	1	8.3%
Wrightstown Township	6	0	0.0%
Yardley Borough	8	0	0.0%
TOTAL	**783**	**24**	**3.1%**

Additional information on flood vulnerability and losses in Bucks County, including the 1%-annual-chance flood event results from HAZUS, FEMA's loss estimation software, the number of parcels vulnerable to flood hazards and the assessed value of vulnerable parcels, is provided in Section 4.4.3: Potential Loss Estimates.

4.3.5. Hailstorm

4.3.5.1. Location and Extent

Hail precipitation is often produced at the front of a severe thunderstorm system or in conjunction with a tornado event. Hailstorms occur when ice crystals form within a low pressure front due to the rapid rise of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets

gradually accumulate on the ice crystals until, having developed sufficient weight, they fall as precipitation in the form of balls or irregularly shaped masses of ice. Hailstones are formed most commonly in thunderstorms with intense updraft, high liquid water content, large vertical extent, large water droplets, and cloud layers below freezing. Hailstorms are not limited to any particular geographic area of Bucks County, and neither the duration of the storm nor the extent of area affected by such an occurrence can be predicted.

4.3.5.2. Range of Magnitude

Hail is described qualitatively and quantitatively by its size and can range from 0.2 inches to 4.5 inches; the size of hail is dependent on the strength of the updraft, as shown in Table 4.3.5-1. Bucks County has experienced hail ranging in size from 0.75" to 2.00" in diameter, or from penny to hen egg size.

Table 4.3.5-1: Hailstone size and relationship to updraft speed (NOAA, 2013).

HAILSTONE SIZE	MEASUREMENT (INCHES)	UPDRAFT SPEED (MPH)
BB	< 0.25	< 24
Pea	0.25	24
Marble	0.50	35
Dime	0.70	38
Penny	0.75	40
Nickel	0.88	46
Quarter	1.00	49
Half Dollar	1.25	54
Walnut	1.50	60
Golf Ball	1.75	64
Hen Egg	2.00	69
Tennis Ball	2.50	77
Baseball	2.75	81
Tea Cup	3.00	84
Grapefruit	4.00	98
Softball	4.50	103

Hailstorms can cause significant damage to crops, livestock, and property. Damage is dependent on the size, duration, and intensity of hail precipitation. Those who do not seek shelter could face serious injury. Automobiles and aircraft are particularly susceptible to damage. Since hail precipitation usually occurs during thunderstorm events, the impacts of other hazards associated with thunderstorms (i.e. strong winds, intense precipitation, etc.) often occur simultaneously. Damage to trees, shrubbery, and other vegetation may occur during hailstorm events through defoliation. Unless there are compounding stresses, natural vegetation can typically recover over time following the event.

No deaths, injuries, or significant property damage have been recorded due to hail in Bucks County, however, five acres of corn fields were destroyed in Ferndale in Nockamixon Township on July 26, 2009. The cost was estimated at $400,000 for the ruined crops; this or a storm causing greater damage to crops is the worst case scenario in Bucks County.

Another notable incident occurred on March 21, 2003 when a severe thunderstorm dropped large hail in southern Bucks County. Hail as large as hen eggs fell in Yardley, golf-ball-size hail was reported in Bensalem, and quarter-size hail was reported in Morrisville (Bucks County, 2011).

4.3.5.3. Past Occurrence

The National Climatic Data Center report contains seventy-one references to hail as a reported incident in Bucks County from 1955 to 2014 causing $400,000 in crop damage as seen in Table 4.3.5-2. As is typical, most of these events occurred from April to August.

Table 4.3.5-2: History of Hailstorms in Bucks County (NCDC, 2015)

LOCATION	DATE	DIAMETER (IN)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Countywide	07/03/1975	0.75	0	0	$0.00	$0.00
Countywide	07/03/1975	1.50	0	0	$0.00	$0.00
Countywide	11/17/1977	2.00	0	0	$0.00	$0.00
Countywide	11/17/1977	1.50	0	0	$0.00	$0.00
Countywide	11/17/1977	1.50	0	0	$0.00	$0.00
Countywide	06/19/1978	0.75	0	0	$0.00	$0.00
Countywide	05/26/1983	0.75	0	0	$0.00	$0.00
Countywide	06/16/1985	1.00	0	0	$0.00	$0.00
Countywide	06/16/1985	1.00	0	0	$0.00	$0.00
Countywide	06/24/1985	1.50	0	0	$0.00	$0.00
Countywide	06/24/1985	1.50	0	0	$0.00	$0.00
Countywide	06/16/1986	1.75	0	0	$0.00	$0.00
Countywide	06/13/1987	1.00	0	0	$0.00	$0.00
Countywide	07/26/1987	0.75	0	0	$0.00	$0.00
Countywide	09/22/1987	0.75	0	0	$0.00	$0.00
Countywide	09/22/1987	0.75	0	0	$0.00	$0.00
Countywide	09/22/1987	0.75	0	0	$0.00	$0.00
Countywide	09/22/1987	1.75	0	0	$0.00	$0.00
Countywide	05/23/1988	0.75	0	0	$0.00	$0.00
Chalfont	08/13/1994	0.75	0	0	$0.00	$0.00
New Hope	06/12/1996	1.75	0	0	$0.00	$0.00
Quakertown	05/01/1997	1.00	0	0	$0.00	$0.00
Bristol	05/01/1997	0.75	0	0	$0.00	$0.00
Sellersville	05/06/1998	Unknown	0	0	$0.00	$0.00
Bristol	05/24/1999	0.75	0	0	$0.00	$0.00
Quakertown	05/13/2000	2.00	0	0	$0.00	$0.00
Chalfont	5/13/2000	0.88	0	0	$0.00	$0.00
Levittown	5/13/2000	0.75	0	0	$0.00	$0.00
Chalfont	5/24/2000	0.88	0	0	$0.00	$0.00
Levittown	7/16/2000	0.75	0	0	$0.00	$0.00
Perkasie	06/30/2001	Unknown	0	0	$0.00	$0.00
Buckingham Station	05/02/2002	0.75	0	0	$0.00	$0.00
Warminster	05/31/2002	0.75	0	0	$0.00	$0.00
Southampton	5/31/2002	0.75	0	0	$0.00	$0.00
Richlandtown	07/23/2002	Unknown	0	0	$10,000.00	$0.00
Langhorne	03/21/2003	2.00	0	0	$0.00	$0.00

Table 4.3.5-2: History of Hailstorms in Bucks County (NCDC, 2015)

LOCATION	DATE	DIAMETER (IN)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Doylestown	05/18/2004	0.88	0	0	$0.00	$0.00
Milford Square	05/24/2004	1.75	0	0	$0.00	$0.00
Pt Pleasant	05/24/2004	1.50	0	0	$0.00	$0.00
Springtown	05/24/2004	1.00	0	0	$0.00	$0.00
Warminster	08/11/2004	1.00	0	0	$0.00	$0.00
Buckingham Station	08/04/2005	0.88	0	0	$0.00	$0.00
Trevose	06/29/2006	0.75	0	0	$0.00	$0.00
Perkasie	08/07/2006	0.75	0	0	$0.00	$0.00
Perkasie	8/26/2006	0.75	0	0	$0.00	$0.00
Warminster	8/26/2006	1.00	0	0	$0.00	$0.00
Andalusia	06/12/2007	0.88	0	0	$0.00	$0.00
Langhorne	06/12/2007	0.88	0	0	$0.00	$0.00
Ferndale	08/17/2007	1.00	0	0	$0.00	$0.00
Plumstead	05/31/2008	0.75	0	0	$0.00	$0.00
Quakertown	03/29/2009	0.88	0	0	$0.00	$0.00
Quakertown	06/15/2009	1.75	0	0	$0.00	$0.00
Morrisville	07/16/2009	1.00	0	0	$0.00	$0.00
Ferndale	07/26/2009	1.50	0	0	$0.00	$400,000.00
Ferndale	05/27/2010	0.75	0	0	$0.00	$0.00
Danboro	05/15/2011	1.00	0	0	$0.00	$0.00
Stoopville	06/01/2011	1.00	0	0	$0.00	$0.00
New Britain	06/09/2011	0.75	0	0	$0.00	$0.00
Perkasie	06/09/2011	0.75	0	0	$0.00	$0.00
Newtown	08/18/2011	1.00	0	0	$0.00	$0.00
Furlong	08/18/2011	0.75	0	0	$0.00	$0.00
Trevose	08/21/2011	0.88	0	0	$0.00	$0.00
Chalfont	05/24/2012	1.00	0	0	$0.00	$0.00
Argus	05/24/2012	1.00	0	0	$0.00	$0.00
Quakertown	05/24/2012	0.88	0	0	$0.00	$0.00
Dublin	06/29/2012	0.75	0	0	$0.00	$0.00
Warrington	07/04/2012	0.75	0	0	$0.00	$0.00
New Hope	07/28/2012	0.75	0	0	$0.00	$0.00
Washington Crossing	07/28/2012	0.88	0	0	$0.00	$0.00
Trumbauersville	06/19/2014	1.00	0	0	$0.00	$0.00
Springtown	08/21/2014	0.75	0	0	$0.00	$0.00

These storms are also illustrated in the map shown in Figure 4.3.5-1. Hail events have occurred throughout Bucks County, but there are two trajectory paths in the southern part of the county where hail events have occurred in the past.

Figure 4.3.5-1: Bucks County Hailstorm History from 1950 to 2014

4.3.5.4. Future Occurrence

It is not possible to predict the formation of a hailstorm with more than a few days' lead time. The past occurrences described above, however, indicate that this event is one that can happen several times in any given year, most likely during the late spring and summer months. Based on prior occurrences, the County can expect anywhere from one to five recordable hailstorms each year. The future occurrence of hailstorm can be considered possible as defined by the Risk Factor methodology probability criteria (see Table 4.4-1).

4.3.5.5. Vulnerability Assessment

All of Bucks County, including all critical infrastructure, is vulnerable to the effects of hail, as the storm cells that produce this hazard are spread over a large (multicounty) area. The area of damage due to these storms is relatively small, since a single storm does not cause widespread devastation, but it may cause damage in a focused area of the storm. Hail can cause serious damage to automobiles, aircraft, skylights, livestock, and crops – most notably corn and soybeans. The National Weather Service reports that hail causes $1 billion in damage to property and crops each year in the United States. Bucks County is especially vulnerable to hail as much of the region is used for farming.

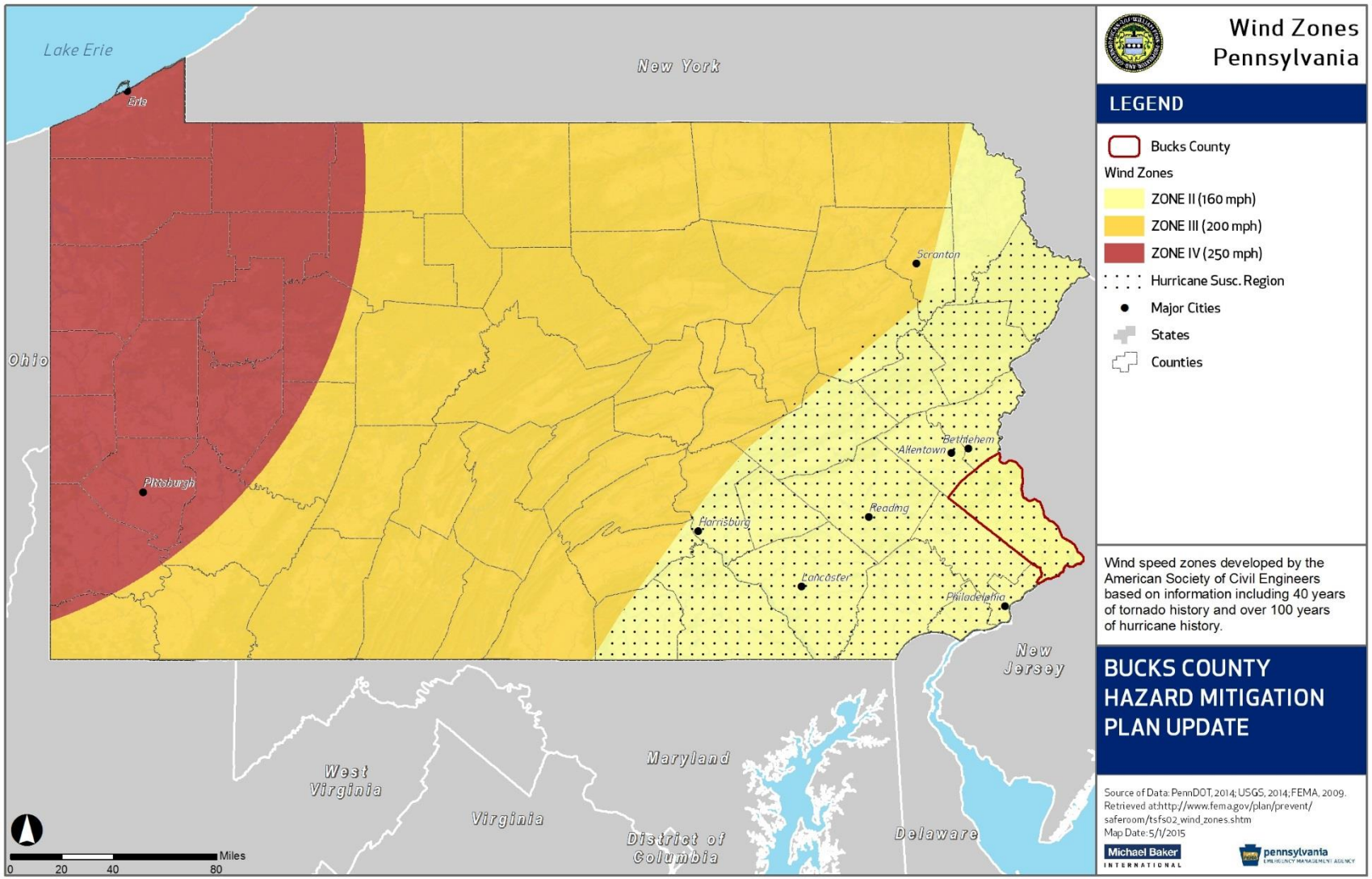
4.3.6. Hurricane, Tropical Storm, Nor'easter

4.3.6.1. Location and Extent

Bucks County is located about 50 miles inland from the Delaware Bay and approximately 45 miles inland from the Atlantic Coast, meaning it is in an area of Pennsylvania where tropical storms could track inland causing heavy rainfall and strong winds. These storms are regional events that can impact very large areas hundreds to thousands of miles across over the life the storm. All communities within Bucks County are equally subject to the impacts of hurricanes, tropical storms, and Nor'easters that track through or near the County. Areas in Bucks County which are subject to flooding, wind, and winter storm damage are particularly vulnerable.

Figure 4.3.6-1 shows wind speed zones developed by the American Society of Civil Engineers based on information including 40 years of tornado history and over 100 years of hurricane history. It identifies wind speeds that could occur across the United States to be used as the basis for design and evaluation of the structural integrity of shelters and critical facilities. Bucks County falls within Zone II, meaning design wind speeds for shelters and critical facilities should be able to withstand a 3-second gust of up to 160 mph, regardless of whether the gust is the result of a tornado, hurricane, tropical storm, or windstorm event. More detail on tornados and windstorms is discussed in Section 4.3.10. Figure 4.3.6-1 also illustrates that Bucks County falls entirely within the identified Hurricane Susceptibility Region.

Figure 4.3.6-1: Wind Speed Zones in Bucks County.



4.3.6.2. Range of Magnitude

Tropical cyclones impacting Bucks County develop in tropical or sub-tropical waters found in the Atlantic Ocean, Gulf of Mexico, or Caribbean Sea. Tropical cyclones with maximum sustained winds of less than 39 miles per hour (mph) are called *tropical depressions*. A *tropical storm* is a cyclone with maximum sustained winds between 39-74 mph. These storms sometimes develop into *hurricanes* with wind speeds in excess of 74 mph. *Extra-tropical* is a term used to describe a hurricane or tropical storm whose cyclone has lost its "tropical" characteristics and has cold air at its core, rather than warm air. While an extra-tropical storm denotes a change in weather pattern and how a coastal storm is gathering energy, it may still have winds that are tropical storm or hurricane force.

The impacts associated with hurricanes and tropical storms are primarily wind damage and flooding. It is not uncommon for tornadoes to develop during these events. Historical tropical storm and hurricane events have brought intense rainfall, sometimes leading to damaging floods, northeast winds, which, combined with waterlogged soils, caused trees and utility poles to fall.

The impact tropical storm or hurricane events have on an area is typically measured in terms of wind speed. Expected damage from hurricane force winds is measured using the Saffir-Simpson Scale. The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential (characteristic of tropical storms and hurricanes), which are combined to estimate potential damage. Table 4.3.6-1 lists Saffir-Simpson Scale categories with associated wind speeds and expected damages. Categories 3, 4, and 5 are classified as "major" hurricanes. While major hurricanes comprise only 20 of all tropical cyclones making landfall, they account for over 70 percent of the damage in the United States. The intensity of a storm is also impacted by its orientation, location of landfall, and speed. The likelihood of these damages occurring in Bucks County is assessed in Section 4.3.6.4, *Future Occurrence*.

Table 4.3.6-1: Saffir-Simpson Scale categories with associated wind speeds and damages (NHC, 2009).

STORM CATEGORY	WIND SPEED (MPH)	DESCRIPTION OF DAMAGES
1	74-95	**MINIMAL**: Damage is limited primarily to shrubbery and trees, unanchored mobile homes, and signs. No significant structural damage.
2	96-110	**MODERATE:** Some trees are toppled, some roof coverings are damaged, and major damage occurs to mobile homes. Some roofing material, door, and window damage.
3	111-130	**EXTENSIVE**: Some structural damage to small residences and utility buildings, with a minor amount of curtain wall failures. Mobile homes are destroyed. Large trees are toppled. Terrain may be flooded well inland.
4	131-155	**EXTREME**: Extensive damage to roofs, windows, and doors; roof systems on small buildings completely fail. More extensive curtain wall failures. Terrain may be flooded well inland.
5	>155	**CATASTROPHIC:** Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Massive evacuation of residential areas may be required.

It is important to recognize the potential for flooding events during hurricanes and tropical storms; the risk assessment and associated impact for these events is included Section 4.3.4. Wind impacts in Bucks County generally include downed trees and utility poles, which can spark widespread utility interruptions. Wind impacts are particularly an issue for mobile homes and other manufactured housing; these structures are often not well-anchored and are highly susceptible to wind damage in a hurricane, tropical storm, or Nor'easter. More details on the impacts of and vulnerability to high winds is discussed in Section 4.3.12.

The worst case hurricane, tropical storm, or Nor'easter event in Bucks County was Hurricane Diane, whose center of circulation passed over Bucks County in 1955 and resulted in a Presidential Disaster Declaration. Diane made landfall in North Carolina on August 17, taking a west-northwest track that cut through central Virginia, Maryland, southeast Pennsylvania, New Jersey, and New York. The storm tracked into south-central Pennsylvania, turning eastward and soaking eastern and southeastern Pennsylvania, including Bucks County. The state storm summary for Diane reported that "the Hurricane Flood of 1955, which affected 6,600 square miles, 'was the most disastrous flood ever to strike eastern Pennsylvania'" (Gelber, 2002). This storm is considered the ninth most costly hurricane event (adjusted costs to 1994 dollars), with cumulative damages of $7 million in the Northeastern United States.

4.3.6.3. Past Occurrence

The National Oceanic and Atmospheric Administration's Coastal Services Center maintains records of all coastal storms occurring in the United States since the 1850s. Table 4.3.6-2 lists all coastal storms having centers of circulation to pass through or within 25 miles of Bucks County. Typically when these storms reached Bucks County, they had lost their hurricane speed winds, so structural damage has not been as bad as coastal communities experienced. The exception to this is the unnamed 1903 event, which retained its hurricane-force winds as it passed over the southern portion of the County.

Table 4.3.6-2: Previous coastal storms tracking through or near Bucks County (NOAA Coastal Services Center, 2010)

YEAR	EVENT	STRENGTH IN/NEAR BUCKS COUNTY
1988	Chris	Tropical Depression
1955	Diane	Tropical Storm
1952	Able	Tropical Storm
1945	Not Named	Extra-tropical Storm
1939	Not Named	Tropical Depression
1934	Not Named	Extra-tropical Storm
1929	Not Named	Extra-tropical Storm
1915	Not Named	Tropical Storm
1903	Not Named	Category 1 Hurricane/Tropical Storm
1899	Not Named	Extra-tropical Storm
1893	Not Named	Tropical Storm

It is important to note that a number of hurricane, tropical storm, and nor'easter events have impacted the County without tracking through or near it; these storm events include Hurricanes Agnes (1972), Floyd (1999), Tropical Storm Allison (2001) and Tropical Depression Ivan (2004). Each of these storm events

resulted in a Presidential Disaster Declaration. Recently, Bucks County was impacted by flooding related to Hurricane Irene and Tropical Storm Lee during the end of August and beginning of September 2011. These storms resulted in four Presidential Disaster Declarations. Recovery from these storms is still in progress as the 2011 version of the Bucks County HMP is being reviewed by FEMA. Anecdotal stories report that flooding from the storms impacted power and water utilities throughout the county and caused road damage and home flooding in flood prone areas of the county.

It is important to note that a number of hurricane, tropical storm, and nor'easter events have impacted the County without tracking through or near it; these storm events include Hurricanes Agnes (1972), Floyd (1999), Tropical Storm Allison (2001), Tropical Depression Ivan (2004), Hurricane Irene (2011), Tropical Storm Lee (2011), and Hurricane Sandy (2012). Each of these storm events resulted in a Presidential Disaster Declaration. Recently, Bucks County was impacted by flooding related to Hurricane Irene and Tropical Storm Lee during the end of August and beginning of September 2011. In 2012, Bucks County was impacted by Hurricane Sandy as it traveled through the area. The area experienced downed trees, flooding, and utility interruption. A day after the storm passed, PECO reported 170,000 customers without power throughout the county (Bucks County, 2012). Figure 4.3.6-2 includes two pictures illustrating some of the damage that was done in Bucks County from Hurricane Sandy.

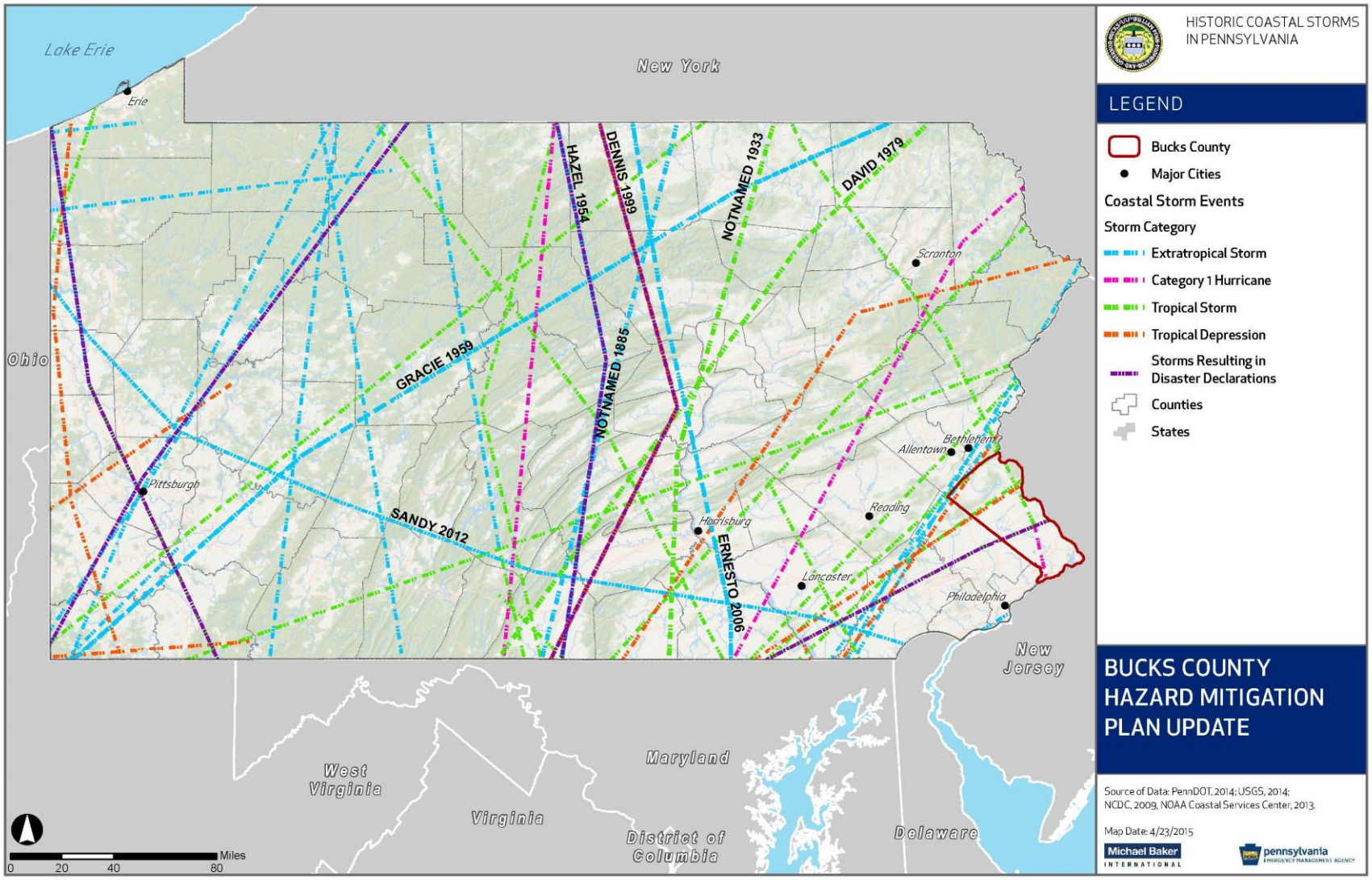
Figure 4.3.6-2: Photos of Hurricane Sandy Aftermath in Bucks County (Bucks County Courier Times, 2013).

Trees fell across the county, including on this car in Bristol Township.

The Bristol Wharf experienced flooding and roof damage.

Figure 4.3.6-3 shows all of the historic coastal storms which have passed through the Commonwealth of Pennsylvania. As previously stated, even if a storm did not pass through Bucks County, the wind and rain from the storm could have still impacted the county.

Figure 4.3.6-3: Historic Coastal Storms in Pennsylvania



4.3.6.4. Future Occurrence

Although hurricanes and tropical storms can cause flood events consistent with 1 percent- and 2 percent-level frequency, their probability of occurrence is measured relative to wind speed. Table 4.3.6-3 shows the probability of winds that reach the strength of tropical storms and hurricane conditions in Bucks County and surrounding areas based on a statistical sample region of more than 30,000 square miles over a period of 46 years.

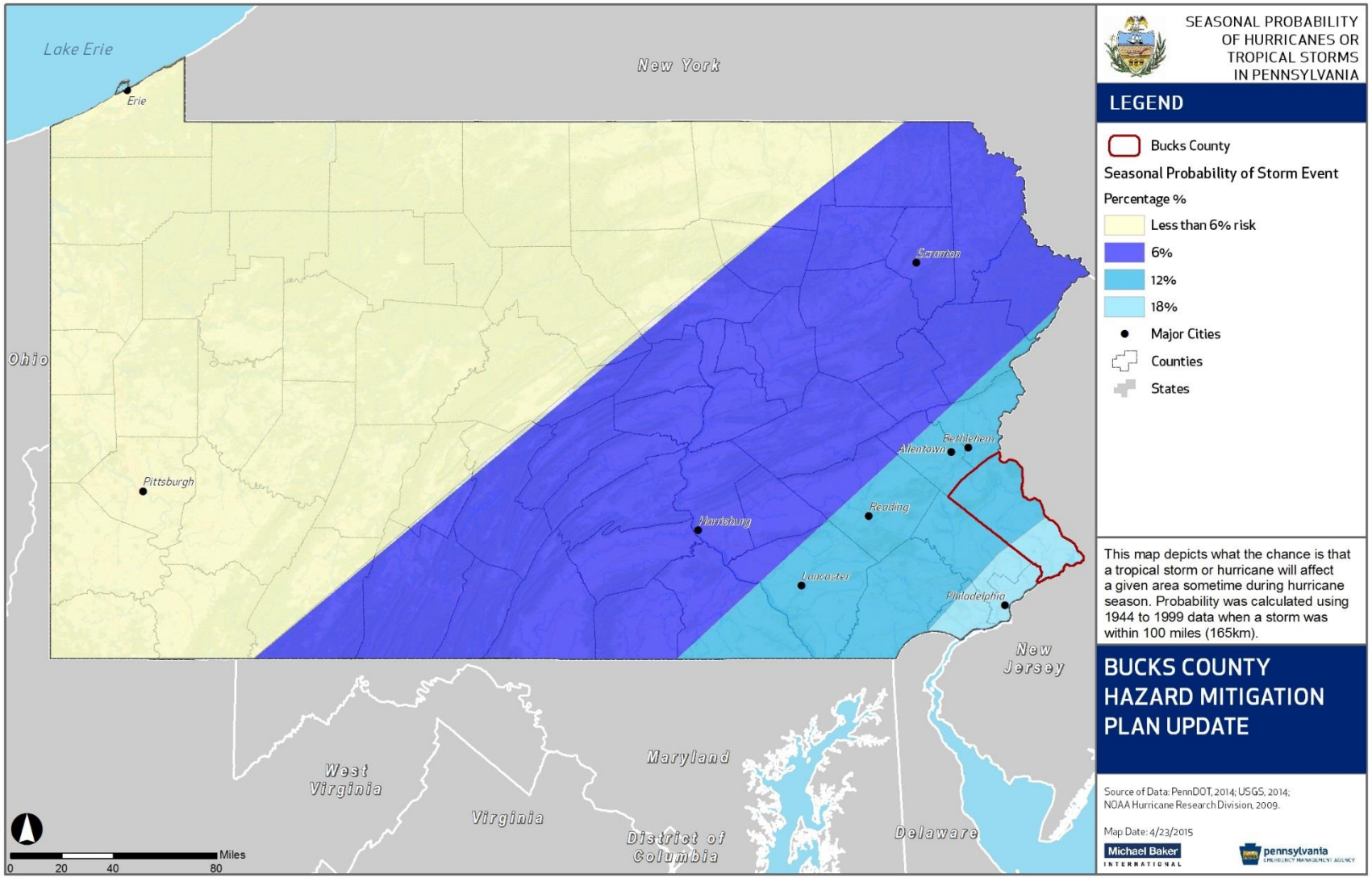
Table 4.3.6-3: Annual probability of tropical storm and hurricane strength wind speeds for (FEMA, 2000).

WIND SPEED (MPH)	CORRESPONDING SAFFIR-SIMPSON TROPICAL STORM/HURRICANE CATEGORIES	ANNUAL PROBABILITY OF OCCURRENCE (%)
45-77	Tropical Storms and Category 1 Hurricanes	85.59
78-118	Category 1 to 2 Hurricanes	14.21
119-138	Category 3 to 4 Hurricanes	0.172
139-163	Category 4 to 5 Hurricanes	0.022
164-194	Category 5 Hurricanes	0.002

Table 4.3.6-3 includes wind speeds for all types of storms and is not specific to cyclonic winds. In Bucks County and surrounding areas, the annual probability for winds that equal the strength of tropical storms (over 39 mph) is approximately 86 percent. The probability for winds at category 1 or 2 hurricane strength (78-118 mph) is greater than fourteen percent in any given year. Using Table 4.3.6-1, these wind speeds correspond to *minimal* or *moderate* expected damages. The annual probability of winds exceeding 118 mph is less than 0.2.

The National Oceanic and Atmospheric Administration Hurricane Research Division published the map included as Figure 4.3.6-4 showing the chance that a tropical storm or hurricane will affect a given area during the entire Atlantic hurricane season, which is officially June 1st through November 30th. Note that this figure does not provide information on the probability of various storm intensities. However, based on historical data between 1944 and 1999, this map reveals there is approximately a twelve percent chance of experiencing a tropical storm or hurricane event between June 1st and November 30th of any given year in the northern portions of the County and an eighteen percent chance in the southeastern portion of the County. This translates to a future occurrence of *possible*, as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

Figure 4.3.6-4: Seasonal probability of a hurricane or tropical storm affecting Bucks County.



4.3.6.5. Vulnerability Assessment

A vulnerability assessment for hurricanes and tropical storms focuses on the impacts of flooding and severe wind. Therefore, the assessment for flood-related vulnerability is addressed in Section 4.3.4.5 and vulnerability to wind damage is addressed in Section 4.3.10.5. The County is also vulnerable to severe winter weather impacts caused by Nor'easters which are evaluated in Section 4.3.14.

4.3.7. Landslide

4.3.7.1. Location and Extent

Rockfalls and other slope failures can occur in areas of Bucks County with moderate to steep slopes. Many slope failures are associated with precipitation events – periods of sustained above-average precipitation, specific rainstorms, or snowmelt events. Areas experiencing erosion, decline in vegetation cover, and earthquakes are also susceptible to landslides. Human activities that contribute to slope failure include altering the natural slope gradient, increasing soil water content, and removing vegetation cover.

The risk of landslide incidents is not consistent throughout the state of Pennsylvania. Figure 4.3.7-1 shows Pennsylvania's areas of low, moderate, and combo-high landslide susceptibility as determined by the U.S. Geological Survey. Bucks County is located within a low landslide hazard zone, but if a landslide does occur it is more likely to occur in hill and valley areas. Areas of steep slopes associated with the banks of major watercourses in the County including the Delaware River or Neshaminy Creek could collapse under heavy rainfall to produce a localized landslide; Steep slopes may also be prevalent among many of roads cut into hillsides. The potential of damage to lives or property from this type of natural hazard is significant. Figure 4.3.7-2 shows the steep slope soils as defined by the Natural Resources Conservation Service (NRCS).

Figure 4.3.7-1: Bucks County landslide susceptibility and incidence (USGS, 2014).

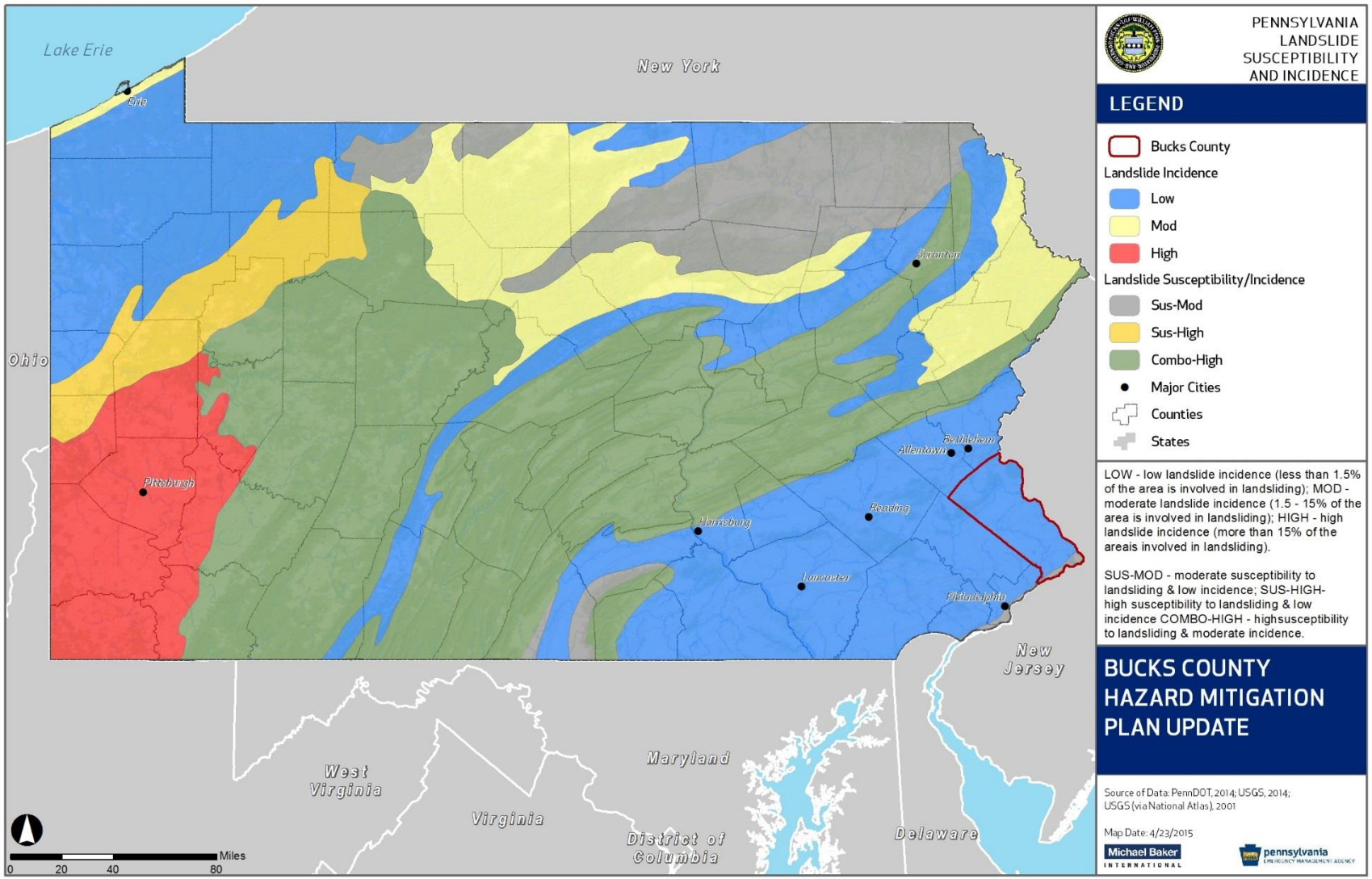
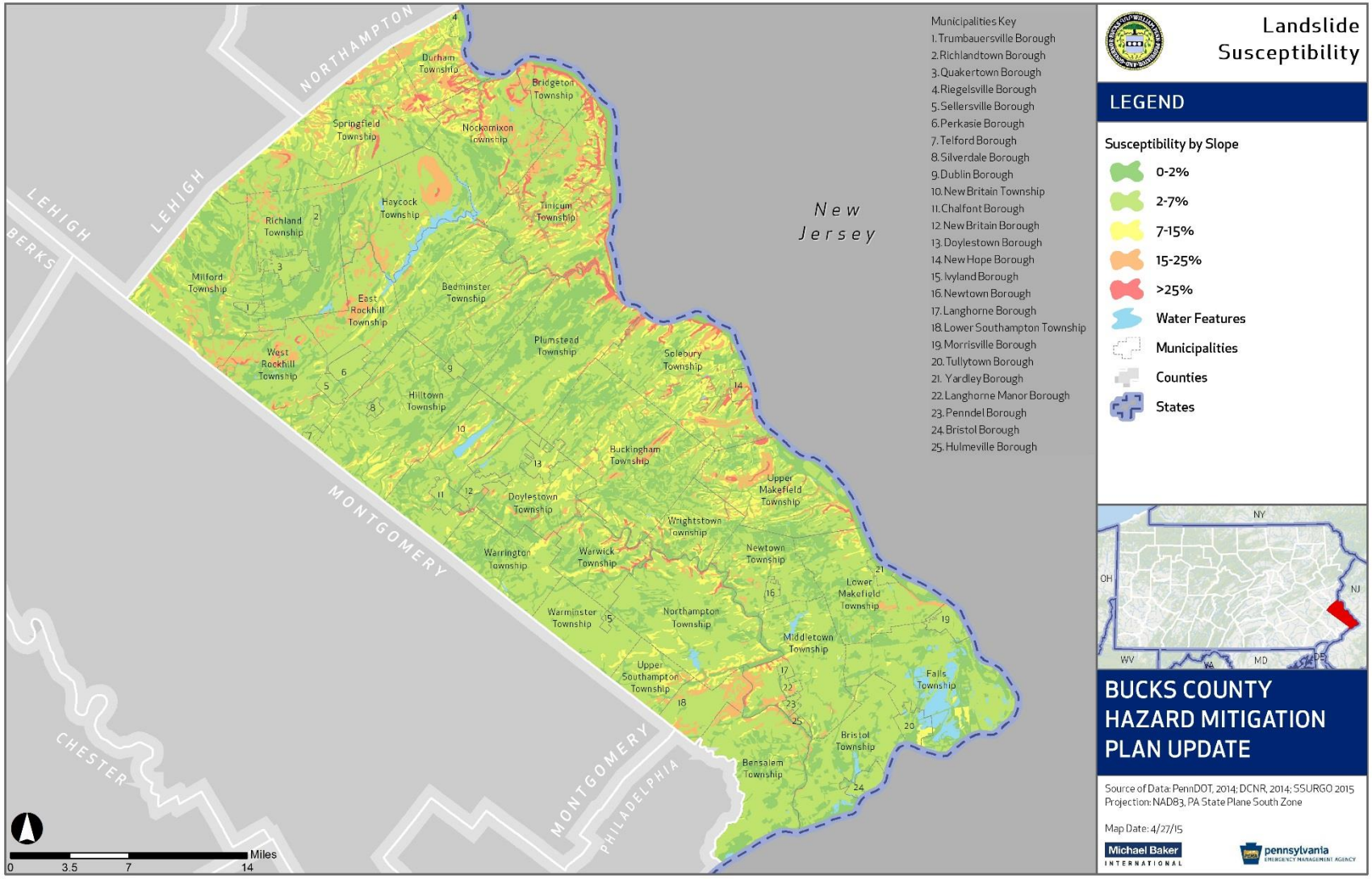


Figure 4.3.7-2: Bucks County close-up of municipalities with moderate landslide susceptibility and incidence (NRCS, 2014).



4.3.7.2. Range of Magnitude

Landslides cause damage to transportation routes, utilities, and buildings. They can also create travel delays and other side effects. Fortunately, deaths and injuries due to landslides are rare in Pennsylvania. Almost all of the known deaths due to landslides have occurred when rockfalls or other slides along highways have involved vehicles. Storm induced debris flows are the only other type of landslide likely to cause death and injuries. As residential and recreational development increases on and near steep slopes, the hazard from these rapid events will also increase. Most Pennsylvania landslides are moderate to slow moving and damage assets rather than people.

The Pennsylvania Department of Transportation and large municipalities incur substantial costs due to landslide damage and to extra construction costs for new roads in known landslide-prone areas. A 1991 estimate showed an average of $10 million per year is spent on landslide repair contracts across the Commonwealth and a similar amount is spent on mitigation costs for grading projects (DCNR, 2014a).

The impact of landslides on the environment depends on the size and specific location of the event. In general, impacts include:

- Changes to topography
- Damage or destruction of vegetation
- Potential diversion or blockage of water in the vicinity of streams, rivers, etc…
- Increased sediment runoff both during and after event

Beyond the environmental impacts, landslides can have serious impacts on transportation routes, utilities, and buildings depending on their location. Landslides may decrease property values, and the costs of litigation may be significant to local communities.

The worst case scenario for a landslide in Bucks County would be a landslide with a sudden onset, leaving residents of a downslope area without warning before it caused severe damage to assets and potentially endangered lives. In addition, a major landslide could impact transportation networks, preventing effective response to the scene of the incident.

4.3.7.3. Past Occurrence

There is no central database of landslide events in Bucks County, and it does not appear that records of major landslides for the County exist. However, since landslides often occur during periods of heavy rain or snowmelt, it is possible to examine the past occurrence of these events. At least 42 of these events have been recorded by the NOAA NCDC.

Table 4.3.7-1: Heavy Rain and Heavy Snow Events in Bucks County (NCDC, 2015)

COUNTY NAME	LOCATION	DATE	EVENT TYPE
Bucks County	Countywide	1/24/1997	Heavy Rain
Bucks County	Countywide	5/25/1997	Heavy Rain
Bucks County	Countywide	6/1/1997	Heavy Rain
Bucks County	Countywide	7/23/1997	Heavy Rain
Bucks County	Countywide	9/11/1997	Heavy Rain

Table 4.3.7-1: Heavy Rain and Heavy Snow Events in Bucks County (NCDC, 2015)			
COUNTY NAME	LOCATION	DATE	EVENT TYPE
Bucks County	Countywide	12/29/1997	Heavy Rain
Bucks County	Countywide	1/23/1998	Heavy Rain
Bucks County	Countywide	2/23/1998	Heavy Rain
Bucks County	Countywide	3/8/1998	Heavy Rain
Bucks County	Countywide	4/9/1998	Heavy Rain
Bucks County	Countywide	10/8/1998	Heavy Rain
Bucks County	Countywide	1/3/1999	Heavy Rain
Bucks County	Springtown	8/13/1999	Heavy Rain
Bucks County	Countywide	8/25/1999	Heavy Rain
Bucks County	Doylestown	9/9/1999	Heavy Rain
Bucks County	Countywide	12/13/1999	Heavy Rain
Bucks County	Countywide	3/21/2000	Heavy Rain
Bucks County	Chalfont	4/21/2000	Heavy Rain
Bucks County	Countywide	9/14/2000	Heavy Rain
Bucks County	Countywide	11/26/2000	Heavy Rain
Bucks County	Countywide	3/29/2001	Heavy Rain
Bucks County	Countywide	5/26/2001	Heavy Rain
Bucks County	Countywide	6/1/2001	Heavy Rain
Bucks County	Countywide	10/10/2002	Heavy Rain
Bucks County	Countywide	5/26/2003	Heavy Rain
Bucks County	Dublin	6/20/2003	Heavy Rain
Bucks County	Telford	8/5/2003	Heavy Rain
Bucks County	Countywide	4/13/2004	Heavy Rain
Bucks County	Countywide	7/12/2004	Heavy Rain
Bucks County	Countywide	3/28/2005	Heavy Rain
Bucks County	Countywide	7/8/2005	Heavy Rain
Bucks County	Quakertown	11/16/2006	Heavy Rain
Bucks County	Bristol	7/18/2007	Heavy Rain
Bucks County	Spinnerstown	9/6/2008	Heavy Rain
Bucks County	Lower Bucks (Zone)	12/10/2013	Heavy Snow
Bucks County	Lower Bucks (Zone)	1/2/2014	Heavy Snow
Bucks County	Upper Bucks (Zone)	1/2/2014	Heavy Snow
Bucks County	Upper Bucks (Zone)	1/21/2014	Heavy Snow
Bucks County	Lower Bucks (Zone)	1/21/2014	Heavy Snow
Bucks County	Upper Bucks (Zone)	2/3/2014	Heavy Snow
Bucks County	Lower Bucks (Zone)	2/3/2014	Heavy Snow
Bucks County	Lower Bucks (Zone)	2/16/2015	Heavy Snow

However, none of these events directly resulted in recorded deaths, injuries, or significant damage to properties and crops. Recent seasons have seen many heavy snowfall events, and occurrences of heavy rain are fairly consistent over time.

4.3.7.4. Future Occurrence

Based on historical events, significant landslides are not likely to occur in Bucks County. However, mismanaged intense development in steeply sloped areas could increase their frequency of occurrence. Additionally, periods of intense rain or snowmelt will heighten the risk of landslides. The probability of future landslide events can be considered likely according to the Risk Factor Methodology (see Table 4.4-1).

4.3.7.5. Vulnerability Assessment

Any landslide events that do occur in Bucks County would take place in steeply sloped areas. In addition, places where landforms have been altered for purposes of highway construction or other development may be uniquely vulnerable to landslide hazards. This is especially true if development is located at the base or crest of cliffs or near large highway cut-outs. These areas should be considered vulnerable to landslides, particularly if mitigation measures have not been implemented.

Table 4.3.7-2 summarizes the number of existing buildings and critical facilities in the County that are located in areas with steep slopes identified by the NRCS and mapped in Figure 4.3.7-2.

Table 4.3.7-2: Structures and critical facilities located in steep slope areas of Bucks County.

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN STEEP SLOPE AREAS	PERCENT OF STRUCTURES IN STEEP SLOPE AREAS	TOTAL CRITICAL FACILITIES IN MUNICIPALITY	TOTAL CRITICAL FACILITIES IN STEEP SLOPE AREAS	PERCENT CRITICAL FACILITIES IN STEEP SLOPE AREAS
Bedminster Township	3380	78	2.31	9	0	0.00
Bensalem Township	15196	1187	7.81	59	4	6.78
Bridgeton Township	995	103	10.35	3	0	0.00
Bristol Borough	2231	0	0.00	20	0	0.00
Bristol Township	19210	128	0.67	57	0	0.00
Buckingham Township	7607	198	2.60	19	1	5.26
Chalfont Borough	1333	15	1.13	11	0	0.00
Doylestown Borough	2810	12	0.43	20	0	0.00
Doylestown Township	5475	203	3.71	21	0	0.00
Dublin Borough	541	0	0.00	6	0	0.00
Durham Township	967	242	25.03	1	0	0.00
East Rockhill Township	2520	192	7.62	12	0	0.00
Falls Township	11506	0	0.00	30	0	0.00
Haycock Township	1783	266	14.92	2	0	0.00
Hilltown Township	6027	84	1.39	10	0	0.00

Table 4.3.7-2: Structures and critical facilities located in steep slope areas of Bucks County.

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN STEEP SLOPE AREAS	PERCENT OF STRUCTURES IN STEEP SLOPE AREAS	TOTAL CRITICAL FACILITIES IN MUNICIPALITY	TOTAL CRITICAL FACILITIES IN STEEP SLOPE AREAS	PERCENT CRITICAL FACILITIES IN STEEP SLOPE AREAS
Hulmeville Borough	409	99	24.21	3	0	0.00
Ivyland Borough	234	0	0.00	4	0	0.00
Langhorne Borough	718	31	4.32	8	0	0.00
Langhorne Manor Borough	436	99	22.71	6	0	0.00
Lower Makefield Township	9883	513	5.19	26	0	0.00
Lower Southampton Township	7181	1994	27.77	28	0	0.00
Middletown Township	13318	1074	8.06	41	0	0.00
Milford Township	4745	270	5.69	13	0	0.00
Morrisville Borough	3358	24	0.71	13	0	0.00
New Britain Borough	979	0	0.00	10	0	0.00
New Britain Township	3954	160	4.05	16	0	0.00
New Hope Borough	827	179	21.64	8	0	0.00
Newtown Borough	1005	0	0.00	7	0	0.00
Newtown Township	4376	91	2.08	31	0	0.00
Nockamixon Township	2591	415	16.02	7	0	0.00
Northampton Township	12376	146	1.18	28	0	0.00
Penndel Borough	763	10	1.31	5	0	0.00
Perkasie Borough	3043	2	0.07	13	0	0.00
Plumstead Township	5032	206	4.09	16	0	0.00
Quakertown Borough	2929	0	0.00	20	0	0.00
Richland Township	4633	364	7.86	11	0	0.00
Richlandtown Borough	379	0	0.00	3	0	0.00
Riegelsville Borough	530	6	1.13	3	0	0.00
Sellersville Borough	1307	0	0.00	9	0	0.00
Silverdale Borough	341	0	0.00	3	0	0.00
Solebury Township	4260	524	12.30	12	0	0.00
Springfield Township	3661	422	11.53	8	1	12.50
Telford Borough	633	0	0.00	2	0	0.00
Tinicum Township	3306	429	12.98	12	1	8.33
Trumbauersville Borough	432	0	0.00	4	0	0.00
Tullytown Borough	836	0	0.00	9	0	0.00

Table 4.3.7-2: Structures and critical facilities located in steep slope areas of Bucks County.						
MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN STEEP SLOPE AREAS	PERCENT OF STRUCTURES IN STEEP SLOPE AREAS	TOTAL CRITICAL FACILITIES IN MUNICIPALITY	TOTAL CRITICAL FACILITIES IN STEEP SLOPE AREAS	PERCENT CRITICAL FACILITIES IN STEEP SLOPE AREAS
Upper Makefield Township	3509	241	6.87	5	0	0.00
Upper Southampton Township	5421	209	3.86	20	0	0.00
Warminster Township	9498	26	0.27	36	0	0.00
Warrington Township	5568	0	0.00	23	0	0.00
Warwick Township	3258	47	1.44	14	1	7.14
West Rockhill Township	2661	175	6.58	12	0	0.00
Wrightstown Township	1738	54	3.11	6	1	16.67
Yardley Borough	950	0	0.00	8	0	0.00
Grand Total	212,659	10,518	4.95	783	9	1.15

Table 4.3.7-3 shows the number of structures in each municipality located in areas susceptible to landslide by land use type. The land use type displaying the greatest vulnerability to landslide hazards is residential.

Table 4.3.7-3: Structures in landslide zone by land use type per municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Bedminster Township	24	0	0	0	0	51	0	3	**78**
Bensalem Township	0	32	18	1	1	1118	1	16	**1,187**
Bridgeton Township	0	0	0	0	5	95	0	3	**103**
Bristol Borough	0	0	0	0	0	0	0	0	**0**
Bristol Township	0	5	2	0	1	120	0	0	**128**
Buckingham Township	0	1	5	0	0	192	0	0	**198**
Chalfont Borough	0	0	0	0	0	15	0	0	**15**
Doylestown Borough	0	0	0	0	1	9	2	0	**12**
Doylestown Township	0	0	1	0	0	199	1	2	**203**
Dublin Borough	0	0	0	0	0	0	0	0	**0**
Durham Township	20	2	0	0	0	215	0	5	**242**
East Rockhill Township	3	0	1	0	1	184	0	3	**192**
Falls Township	0	0	0	0	0	0	0	0	**0**
Haycock Township	3	1	0	0	1	260	0	1	**266**
Hilltown Township	4	0	0	0	0	80	0	0	**84**
Hulmeville Borough	0	4	0	0	0	94	0	1	**99**
Ivyland Borough	0	0	0	0	0	0	0	0	**0**
Langhorne Borough	0	0	0	0	5	24	2	0	**31**
Langhorne Manor Borough	0	0	0	0	0	99	0	0	**99**
Lower Makefield Township	0	0	0	0	1	512	0	0	**513**
Lower Southampton Township	0	60	9	5	45	1862	1	12	**1,994**

Table 4.3.7-3: Structures in landslide zone by land use type per municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Middletown Township	0	18	3	0	9	1025	4	15	**1,074**
Milford Township	6	0	0	2	4	254	0	4	**270**
Morrisville Borough	0	0	0	0	0	24	0	0	**24**
New Britain Borough	0	0	0	0	0	0	0	0	**0**
New Britain Township	0	0	3	0	0	157	0	0	**160**
New Hope Borough	0	5	7	0	0	165	2	0	**179**
Newtown Borough	0	0	0	0	0	0	0	0	**0**
Newtown Township	0	0	8	0	0	83	0	0	**91**
Nockamixon Township	17	26	3	0	5	352	2	10	**415**
Northampton Township	4	11	1	3	7	119	1	0	**146**
Penndel Borough	0	0	0	0	0	10	0	0	**10**
Perkasie Borough	0	0	0	0	0	2	0	0	**2**
Plumstead Township	0	11	0	1	11	182	0	1	**206**
Quakertown Borough	0	0	0	0	0	0	0	0	**0**
Richland Township	6	3	1	3	0	342	0	9	**364**
Richlandtown Borough	0	0	0	0	0	0	0	0	**0**
Riegelsville Borough	0	3	0	0	0	3	0	0	**6**
Sellersville Borough	0	0	0	0	0	0	0	0	**0**
Silverdale Borough	0	0	0	0	0	0	0	0	**0**
Solebury Township	2	17	3	0	0	491	1	10	**524**
Springfield Township	31	5	5	2	1	372	0	6	**422**

Table 4.3.7-3: Structures in landslide zone by land use type per municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Telford Borough	0	0	0	0	0	0	0	0	**0**
Tinicum Township	19	7	5	0	17	369	1	11	**429**
Trumbauersville Borough	0	0	0	0	0	0	0	0	**0**
Tullytown Borough	0	0	0	0	0	0	0	0	**0**
Upper Makefield Township	4	0	1	0	14	219	1	2	**241**
Upper Southampton Township	0	4	1	0	0	204	0	0	**209**
Warminster Township	0	0	0	0	0	26	0	0	**26**
Warrington Township	0	0	0	0	0	0	0	0	**0**
Warwick Township	4	0	0	0	5	34	4	0	**47**
West Rockhill Township	9	0	0	7	10	135	0	14	**175**
Wrightstown Township	0	0	1	0	0	52	0	1	**54**
Yardley Borough	0	0	0	0	0	0	0	0	**0**
Grand Total	**156**	**215**	**78**	**24**	**144**	**9749**	**23**	**129**	**10,518**

4.3.8. Lightning Strike

4.3.8.1. Location and Extent

Lightning is a discharge of electrical energy resulting from the build-up of positive and negative charges within a thunderstorm. The flash or "bolt" of light usually occurs within clouds or between clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000°F. On average, 89 people are killed each year by lightning strikes in the United States. Within Pennsylvania, the annual average number of thunder and lightning events in a given area can expect ranges between 40-70 events per year (FEMA, 1997).

Lightning events occur across the entire Commonwealth. Different areas experience varying event frequencies, but in all cases, lightning strikes occur primarily during the summer months. While the impact of flash events is highly localized, strong storms can result in numerous widespread events over a broad area. In addition, the impacts of an event can be serious or widespread if lightning strikes a particularly significant location, such as a power station or large public venue.

4.3.8.2. Range of Magnitude

Each year, lightning is responsible for the deaths of almost one hundred people, injuries to several hundred more, and millions of dollars in property damage in the United States (NOAA NWS, 2012). In many cases, heart damage, inflated lungs, or brain damage have resulted from lightning strikes, leading to death. Loss of consciousness, amnesia, paralysis, and burns are reported by many who have survived. Deaths and injuries to livestock and other animals, thousands of forest and brush fires, as well as millions of dollars in damage to buildings, communications systems, power lines, and electrical systems are also the result of lightning.

The worst case scenario for lightning strike in Bucks County would be an electrical storm that endangered lives while also causing secondary effects such as starting a wildfire or interrupting utility and communication transmissions.

4.3.8.3. Past Occurrence

Total deaths caused by lightning from 1959 to 2011 were collected for each state, ranking Pennsylvania ninth (130 deaths) in the country (NOAA, 2012). From 1959 to 1994, Pennsylvania ranked third among all states with 644 casualties (i.e., combination of deaths and injuries). This represents approximately 5% of casualties, which occurred throughout the U.S. over that 35-year period. Pennsylvania ranked first among all states in the U.S. with 1,441 damage reports. However, it is unclear what the total dollar value is for these damages, and there is no account of the spatial distribution of damages below the state level (NOAA NWS, 1997).

Pennsylvania ranks third nationally in the number of lightning injuries that occur per year. Figure 4.3.8-1 shows how the incident rate in Bucks County compares with the rest of the state. Data on lightning strikes from 1950 to 2011 in Bucks County is presented as Table 4.3.8-1.

The NOAA NCDC Storm Events Database lists 57 lightning events in Bucks County. These incidents are listed in Table 4.3.8-1.

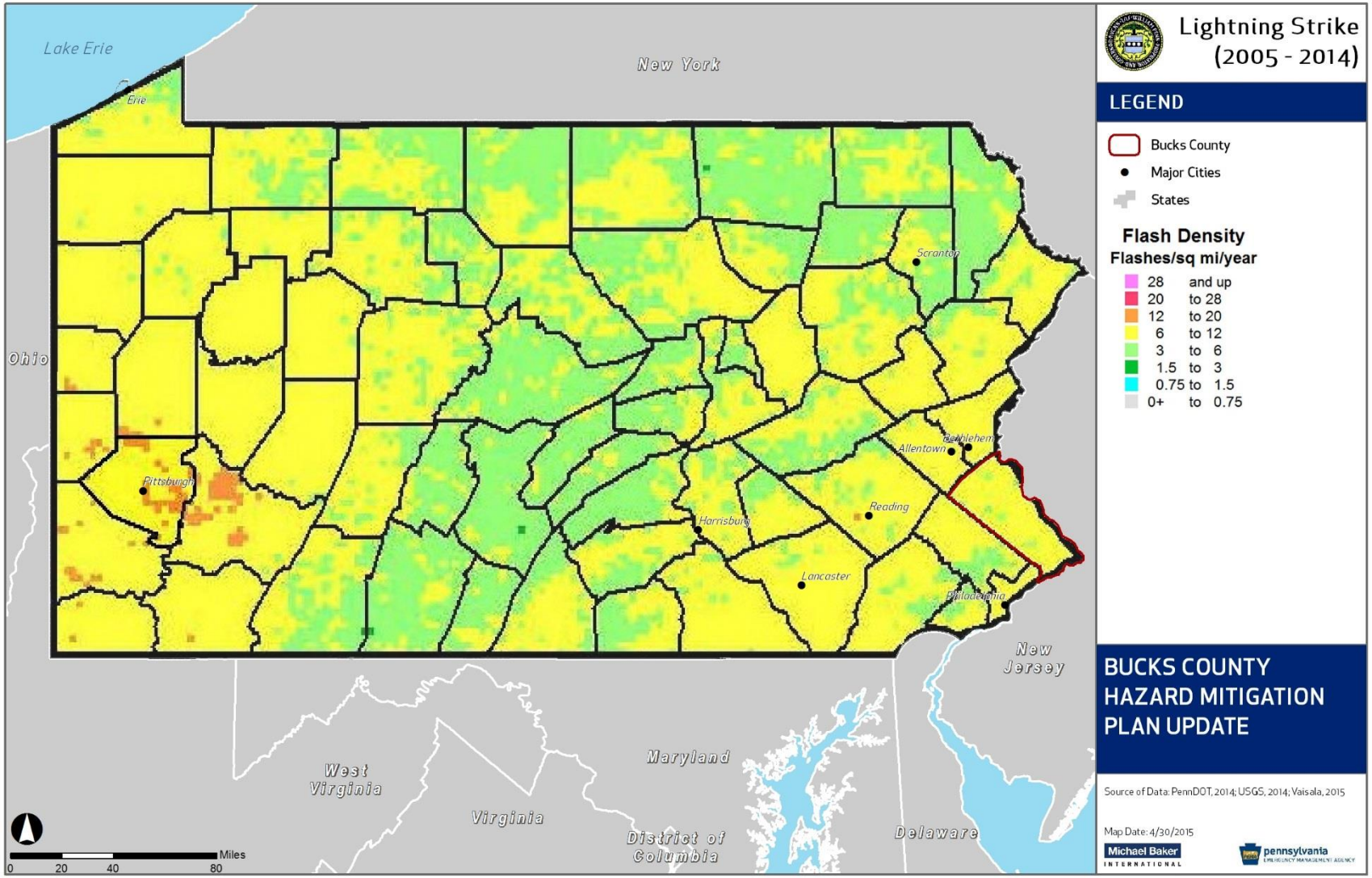
Table 4.3.8-1: Lightning Strike Events in Bucks County (NCDC, 2015)

COUNTY	LOCATION	DATE	EVENT	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bucks County	Sellersville	6/12/1996	Lightning	0	0	0	0
Bucks County	Plumstead	7/14/1996	Lightning	0	1	0	0
Bucks County	Buckingham Valley	7/14/1996	Lightning	0	0	150,000	0
Bucks County	Plumstead	5/6/1997	Lightning	0	0	0	0
Bucks County	New Britain	5/6/1998	Lightning	0	0	0	0
Bucks County	Langhorne	5/25/1998	Lightning	0	0	0	0
Bucks County	Milford Square	9/7/1998	Lightning	0	0	300,000	0
Bucks County	Doylestown	4/11/1999	Lightning	0	0	0	0
Bucks County	Woodside	5/24/1999	Lightning	0	0	0	0
Bucks County	Hulmeville	5/24/1999	Lightning	0	0	0	0
Bucks County	Hulmeville	8/14/1999	Lightning	0	0	0	0
Bucks County	New Hope	8/26/1999	Lightning	0	0	0	0
Bucks County	Doylestown	5/13/2000	Lightning	0	0	0	0
Bucks County	Milford Square	10/4/2000	Lightning	0	0	20,000	0
Bucks County	Quakertown	10/4/2000	Lightning	0	0	1,000	0
Bucks County	Perkasie	6/30/2001	Lightning	0	7	100,000	0
Bucks County	Perkasie	6/30/2001	Lightning	0	0	0	0
Bucks County	Plumstead	5/2/2002	Lightning	0	0	0	0
Bucks County	Bristol	6/6/2002	Lightning	0	1	0	0
Bucks County	Bristol	7/19/2002	Lightning	0	0	0	0
Bucks County	Woodside	8/2/2002	Lightning	0	0	0	0
Bucks County	Quakertown	8/13/2003	Lightning	0	0	0	0
Bucks County	Croyden	8/27/2003	Lightning	0	0	0	0
Bucks County	Bristol	8/30/2003	Lightning	0	0	50,000	0
Bucks County	New Hope	8/21/2004	Lightning	0	0	0	0
Bucks County	Warrington	6/29/2005	Lightning	0	0	250,000	0
Bucks County	Quakertown	7/1/2005	Lightning	0	0	0	0
Bucks County	Wrightstown	7/27/2005	Lightning	0	0	200,000	0
Bucks County	Hilltown	8/8/2005	Lightning	0	0	1,000	0
Bucks County	Langhorne	8/14/2005	Lightning	0	0	1,000	0
Bucks County	Buckingham Station	8/14/2005	Lightning	0	0	25,000	0
Bucks County	Buckingham Station	8/7/2006	Lightning	0	0	100,000	0
Bucks County	Silverdale	5/16/2007	Lightning	0	0	1,000	0
Bucks County	Dolington	5/21/2008	Lightning	0	0	25,000	0
Bucks County	Doylestown	5/31/2008	Lightning	0	0	10,000	0
Bucks County	Yardley Farms	7/23/2008	Lightning	0	0	5,000	0
Bucks County	Parktown Estates	7/23/2008	Lightning	0	2	0	0
Bucks County	Silverdale	7/27/2008	Lightning	0	0	100,000	0

Table 4.3.8-1: Lightning Strike Events in Bucks County (NCDC, 2015)							
COUNTY	LOCATION	DATE	EVENT	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bucks County	Silverdale	8/18/2009	Lightning	0	0	10,000	0
Bucks County	Sellersville	3/14/2010	Lightning	0	0	10,000	0
Bucks County	Morrisville	5/31/2010	Lightning	0	0	10,000	0
Bucks County	Levittown	6/24/2010	Lightning	0	0	5,000	0
Bucks County	New Hope	7/12/2010	Lightning	0	0	500,000	0
Bucks County	West Bristol	5/16/2012	Lightning	0	0	250,000	0
Bucks County	Woodbourne	7/15/2012	Lightning	0	0	250,000	0
Bucks County	Wrightstown	7/28/2012	Lightning	0	0	5,000	0
Bucks County	Neshaminy	8/9/2012	Lightning	0	0	10,000	0
Bucks County	Blooming Glen	7/23/2013	Lightning	0	0	10,000	0
Bucks County	Brick Tavern	6/13/2014	Lightning	0	0	25,000	0
Bucks County	Trumbauersville	6/19/2014	Lightning	0	0	5,000	0
Bucks County	Trumbauersville	6/19/2014	Lightning	0	0	1,000	0
Bucks County	Chalfont	6/19/2014	Lightning	0	0	100,000	0
Bucks County	Farm School	6/19/2014	Lightning	0	0	2,000	0
Bucks County	Stanwood	7/2/2014	Lightning	0	0	500,000	0
Bucks County	Bristol Township	7/2/2014	Lightning	0	0	500,000	0
Bucks County	Doylestown	7/8/2014	Lightning	0	0	2000	0
Bucks County	Newtown	7/23/2014	Lightning	0	0	1000	0
Totals				0	11	3,535,000	0

As a result of lightning, 11 people in Bucks County suffered injuries and property damages totaled over $3.5 million. Figure 4.3.8-1 depicts the historic yearly average of lightning strikes in Bucks County relative to other areas of the Commonwealth.

Figure 4.3.8-1: Lightning Event History for Pennsylvania and Bucks County (USGS, 2014)



4.3.8.4. Future Occurrence

Lightning strikes the earth about 100 times every second. Each year in the United States, approximately 400 people are struck (about one for every 86,000 lightning flashes in the U.S.), and 17,400 fires are caused by lightning. July is the peak month for lightning strikes in the United States. The probability of a lightning strike on a given building is a function of the object's lightning-attractive area (e.g., a tall metal pole is more likely to be struck by lightning than a shorter non-conductive objects).

Based on historical lightning events in Bucks County and the Risk Factor Analysis, the future probability of damaging lightning events should be considered highly likely according to the Risk Factor Methodology (see Table 4.4-1).

4.3.8.5. Vulnerability Assessment

The environmental impacts most often associated with lightning strikes include damage to or death of trees and ignition of wildfires. During the years of 2000 – 2012, the NCDC reported that lightning caused 16 deaths, 159 injuries, and property damage of $14,310,000 in Pennsylvania. Bucks County alone experienced over three million dollars in losses due to lightning since 1996.

In general, the area of Bucks County is equally vulnerable to lightning, and the impact of lightning would likely be greatest on structures, although there is also risk of injury and death. The worst case scenario would be a lightning event causing significant property damage and massive injury or death.

Losses due to lightning can be lessened by installing surge protection on critical electronic, lighting, or information technology systems. Lightning protection devices and methods, such as lightning rods and grounding, can be installed on a community's communications infrastructure and other critical facilities to reduce losses.

4.3.9. Pandemic and Infectious Disease

4.3.9.1. Location and Extent

Pandemic is defined as an extensively epidemic disease affecting or attacking the population of an extensive region, including several countries, and/or continent(s). Generally, pandemic diseases cause sudden, pervasive illness in all age groups on a global scale.

Pandemic and infectious disease events cover a wide geographical area and can affect large populations, potentially including the entire population of Bucks County and beyond. The exact size and extent of an infected population is dependent upon how easily the illness is spread, the mode of transmission, and the amount of contact between infected and uninfected individuals. The transmission rates of pandemic illnesses are often higher in denser areas where there are large concentrations of people. The transmission rate of infectious disease will depend on the mode of transmission of a given illness. Pandemic events can also occur after other natural disasters, particularly floods, when there is the potential for bacteria to grow and contaminate water.

Through the risk assessment process, the HMPT identified pandemic as a new hazard for the 2016 HMP because of the concern with pandemic influenza. Emergency and health officials previously identified pandemic as a hazard, and they have been developing and conducting annual pandemic drills as a part of

National Preparedness Month activities in response to this threat. During the drill, health officials and volunteers open and operate vaccination locations throughout the county (see Figure 4.3.9-1).

Figure 4.3.9-1: Volunteers staffing one of the vaccination locations opened for the 8th Annual Pandemic Flu Drill at Truman High School. The drill issued approximately 1,300 shots to the public at this location and 4,500 shots countywide (Photograph courtesy of buckscounty.org, 2013).

Pandemic influenza planning began across Pennsylvania in response to the H5N1 (avian) flu outbreak in Asia, Africa, Europe, the Pacific, and the Near East in the late 1990s and early 2000s. H5N1 did not reach pandemic proportions in the United States, but Pennsylvania and local departments of health began actively planning for an occurrence of an influenza pandemic. As stated in the Pennsylvania Department of Health (DOH) Influenza Pandemic Response Plan, "an influenza pandemic is inevitable and will probably give little warning" (PA DOH, 2005).

Influenza, also known as "the flu", is a contagious disease that is caused by the influenza virus and most commonly attacks the respiratory tract in humans. Influenza is considered to have pandemic potential if it is novel, meaning that people have no immunity to it, virulent, meaning that it causes deaths in normally healthy individuals, and easily transmittable from person-to-person.

4.3.9.2. Range of Magnitude

The magnitude of a pandemic or infectious disease threat in Bucks County will range significantly depending on the aggressiveness of the virus in question and the ease of transmission. Pandemic influenza is fairly easily transmitted from person-to-person, but advances in medical technologies have greatly reduced the number of deaths caused by influenza over time. In terms of lives lost, the impact various pandemic influenza outbreaks have had globally over the last century has declined. The severity

of illness from the 2009 H1N1 influenza flu virus varied as expected with any influenza pandemic. The gravest cases occurring mainly among those considered at high risk: children, the elderly, pregnant women, and chronic disease patients with reduced immune system capacity. Most people infected with H1N1 in 2009 recovered without needing medical treatment, and this flu strain is now included in flu shots. According to the CDC, about 70% of those who hospitalized with the 2009 H1N1 flu virus in the United States belonged to a high risk group (CDC, 2009). This pattern is expected to continue with future novel flu strains.

The magnitude of a pandemic may be exacerbated by the fact that an influenza pandemic will cause outbreaks across Pennsylvania, limiting the ability to transfer assistance from one jurisdiction to another. Additionally, effective preventative and therapeutic measures, including vaccines and other medications, will likely be in short supply or will not be available.

There are no true environmental impacts in pandemic disease outbreaks, but there may be significant economic and social costs beyond the possibility of deaths. Widespread illness may increase the likelihood of shortages of personnel to perform essential community services. In addition, high rates of illness and worker absenteeism occur within the business community, and these contribute to social and economic disruption. Social and economic disruptions could be temporary, but may be amplified in today's closely interrelated and interdependent systems of trade and commerce. Social disruption may be greatest when rates of absenteeism impair essential services, such as power, transportation, and communications.

In addition to the physical effects of pandemic disease outbreaks, there are also psychological effects as well. As the public becomes aware of the potential of a disease outbreak, a certain portion of the population will become fearful of contamination. This can result in a higher amount of good vigilance to avoid becoming infected by the disease, but it can also result in hyper-vigilance, including a higher amount of walking well going to hospitals and emergency health care facilities.

The 1918 Spanish flu pandemic remains the worst case pandemic event on record. While mortality figures were probably under-reported, in the first month of the pandemic alone, 8,000 Pennsylvanians died from the flu or its complications (US DHHS, 2010).

4.3.9.3. Past Occurrence

The United States Department of Health and Human Services estimates that influenza pandemics have occurred for at least 300 years at unpredictable intervals. There have been several pandemic influenza outbreaks over the past 100 years. A list of events worldwide is shown in Table 4.3.9-1.

Table 4.3.9-1: List of previous significant outbreaks of influenza over the past century (PA DOH, 2014).

DATE	PANDEMIC NAME/SUBTYPE	WORLDWIDE DEATHS (APPROXIMATE)
1918-1920	Spanish Flu / H1N1	50 million
1957-1958	Asian Flu / H2N2	1-3 million
1968-1969	Hong Kong Flu / H3N2	1 million
2009 - 2010	Swine Flu / A/H1N1	25,174

Deaths occurred in the United States as a result of the Spanish Flu, Asian flu, and Hong Kong Flu outbreaks. The Spanish Flu claimed 500,000 lives in the United States, and there were 350,000 cases in Pennsylvania. Most deaths resulting from the Asian flu occurred between September, 1957 and March, 1958; there were about 70,000 deaths in the United States and approximately 15% of the population of Pennsylvania was affected. The first cases of the Hong Kong Flu in the U.S. were detected in September of 1968 with deaths peaking between December, 1968 and January, 1969 (Global Security, 2009).

In the 2009/2010 season, when H1N1 was a primary concern, there were 1,607 confirmed flu cases in Bucks County, one of the highest amount of reported cases in a county in Pennsylvania. In the most recent intense influenza season, the 2012/2013 season which began earlier than most flu seasons, there were 1,266 confirmed flu cases in Bucks County (PA DOH, 2014a).

4.3.9.4. Future Occurrence

Future occurrences of pandemic influenza are unclear. The precise timing of pandemic influenza is uncertain, but occurrences are most likely when the Influenza Type A virus makes a dramatic change, or antigenic shift, that results in a new or "novel" virus to which the population has no immunity. This emergence of a novel virus is the first step toward a pandemic. Future pandemics may also emerge from other diseases, especially invasive pathogens that Pennsylvanians do not have natural immunity to.

Looking at the number of historical incidences of pandemic-potential diseases, the probability of future pandemic events can be considered possible according to the Risk Factor Methodology (see Table 4.4-1).

4.3.9.5. Vulnerability Assessment

In general, jurisdictions that are more densely populated are more vulnerable to disease threats when the disease is directly spread from human to human, but every jurisdiction in Bucks County has some vulnerability to pandemic and infectious disease threats. Certain population groups are at higher risk of pandemic flu infection. This population group includes people 65 years and older, children younger than 5 years old, pregnant women, and people of any age with certain chronic medical conditions. Schools, colleges, convalescent centers, and other institutions serving those younger than 5 years old and older than 65 years old, are locations conducive to faster transmission of pandemic influenza since populations identified as being at high risk are concentrated at these facilities or because of a large number of people living in close quarters. The highest concentration of schools, retirement homes, and senior centers is found in the Bristol, Bensalem, and Middletown Townships.

4.3.10. Radon Exposure

4.3.10.1. Location and Extent

Radioactivity caused by airborne radon has been recognized for many years as an important component in the natural background radioactivity exposure of humans, but it was not until the 1980s that the wide geographic distribution of elevated values in houses and the possibility of extremely high radon values in houses were recognized. In 1984, routine monitoring of employees leaving the Limerick nuclear power plant near Reading, PA while it was still under construction and not yet functional, showed that readings on a construction worker at the plant frequently exceeded expected radiation levels. However, only natural, nonfission-product radioactivity was detected on him.

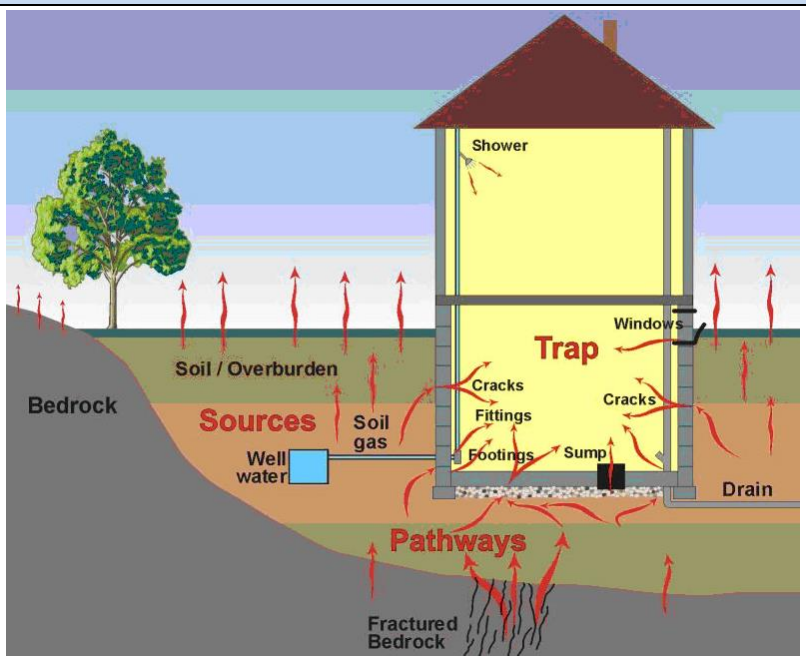
Subsequent testing of the employee's home in the Reading Prong section of Pennsylvania showed extremely high radon levels around 2,500 pCi/L (pico Curies per Liter). To put this amount in perspective, the Environmental Protection Agency (EPA) guidelines state that actions should be taken if radon levels exceed 4 pCi/L in a home, and uranium miners have a maximum exposure of 67 pCi/L. As a result of this event, the Reading Prong became the focus of the first large-scale radon scare in the world.

Radon is a gas that cannot be seen or smelled. It is a noble gas that originates by the natural radioactive decay of uranium and thorium. Like other noble gases (e.g., helium, neon, and argon), radon forms essentially no chemical compounds and tends to exist as a gas or as a dissolved atomic constituent in groundwater. Two isotopes of radon are significant in nature, 222Rn and 220Rn, formed in the radioactive decay series of 238U and 232Th, respectively. The isotope thoron (i.e. 220Rn) has a half-life (time for decay of half of a given group of atoms) of 55 seconds, barely long enough for it to migrate from its source to the air inside a house and pose a health risk. However, radon (i.e. 222Rn), which has a half-life of 3.8 days, is a widespread hazard. The distribution of radon is correlated with the distribution of radium (i.e. 226Ra), its immediate radioactive parent, and with uranium, its original ancestor. Due to the short half-life of radon, the distance that radon atoms can travel from their parent before decay is generally limited to distances of feet or tens of feet.

Three sources of radon in houses are now recognized (shown in Figure 4.3.10-1):

- Radon in soil air that flows into the house;
- Radon dissolved in water from private wells and exsolved during water usage; this is rarely a problem in Pennsylvania; and
- Radon emanating from uranium-rich building materials (e.g. concrete blocks or gypsum wallboard); this is not known to be a problem in Pennsylvania.

Figure 4.3.10-1: Sketch of radon entry points into a house (Arizona Geological Survey, 2006).



High radon levels were initially thought to be exacerbated in houses that are tightly sealed, but it is now recognized that rates of air flow into and out of houses, plus the location of air inflow and the radon content of air in the surrounding soil, are key factors in radon concentrations. Outflows of air from a house, caused by a furnace, fan, thermal "chimney" effect, or wind effects, require that air be drawn into the house to compensate. If the upper part of the house is tight enough to impede influx of outdoor air (radon concentration generally <0.1 pCi/L), then an appreciable fraction of the air may be drawn in from the soil or fractured bedrock through the foundation and slab beneath the house, or through cracks and openings for pipes, sumps, and similar features. Soil gas typically contains from a few hundred to a few thousand pCi/L of radon; therefore, even a small rate of soil gas inflow can lead to elevated radon concentrations in a house.

The radon concentration of soil gas depends upon a number of soil properties, the importance of which is still being evaluated. In general, ten to fifty percent of newly formed radon atoms escape the host mineral of their parent radium and gain access to the air-filled pore space. The radon content of soil gas clearly tends to be higher in soils containing higher levels of radium and uranium, especially if the radium occupies a site on or near the surface of a grain from which the radon can easily escape. The amount of pore space in the soil and its permeability for air flow, including cracks and channels, are important factors determining radon concentration in soil gas and its rate of flow into a house. Soil depth and moisture content, mineral host and form for radium, and other soil properties may also be important. For houses built on bedrock, fractured zones may supply air having radon concentrations similar to those in deep soil.

Areas where houses have high levels of radon can be divided into three groups in terms of uranium content in rock and soil:

- Areas of very elevated uranium content (>50 ppm) around uranium deposits and prospects. Although very high levels of radon can occur in such areas, the hazard normally is restricted to within a few hundred feet of the deposit. In Pennsylvania, such localities occupy an insignificant area.
- Areas of common rocks having higher than average uranium content (5 to 50 ppm). In Pennsylvania, such rock types include granitic and felsic alkali igneous rocks and black shales. In the Reading Prong, high uranium values in rock or soil and high radon levels in houses are associated with Precambrian granitic gneisses commonly containing 10 to 20 ppm uranium, but locally containing more than 500 ppm uranium. In Pennsylvania, elevated uranium occurs in black shales of the Devonian Marcellus Formation and possibly the Ordovician Martinsburg Formation. High radon values are locally present in areas underlain by these formations.
- Areas of soil or bedrock that have normal uranium content but properties that promote high radon levels in houses. This group is incompletely understood at present. Relatively high soil permeability can lead to high radon, the clearest example being houses built on glacial eskers. Limestone-dolomite soils also appear to be predisposed for high radon levels in houses, perhaps because of the deep clay-rich residuum in which radium is concentrated by weathering on iron oxide or clay surfaces, coupled with moderate porosity and permeability. The importance of carbonate soils is indicated by the fact that radon contents

in 93 percent of a sample of houses built on limestone-dolomite soils near State College, Centre County, exceeded 4 pCi/L, and 21 percent exceeded 20 pCi/L, even though the uranium values in the underlying bedrock are all in the normal range of 0.5 to 5 ppm uranium.

The second factor listed above is most likely the cause of radon levels in Bucks County, although high test results may be a result of multiple factors. Figures 4.3.10-2 and 4.3.10-3 show the radon test data available for Bucks County by zip code. Many communities have average basement radon readings of over the threshold of action of 4 pCi/L, but none appear to have readings higher than 11-23 pCi/L. Communities with no data available did not have a sufficient sample size.

Figure 4.3.10-2: Bucks Average Basement Radon Test Results

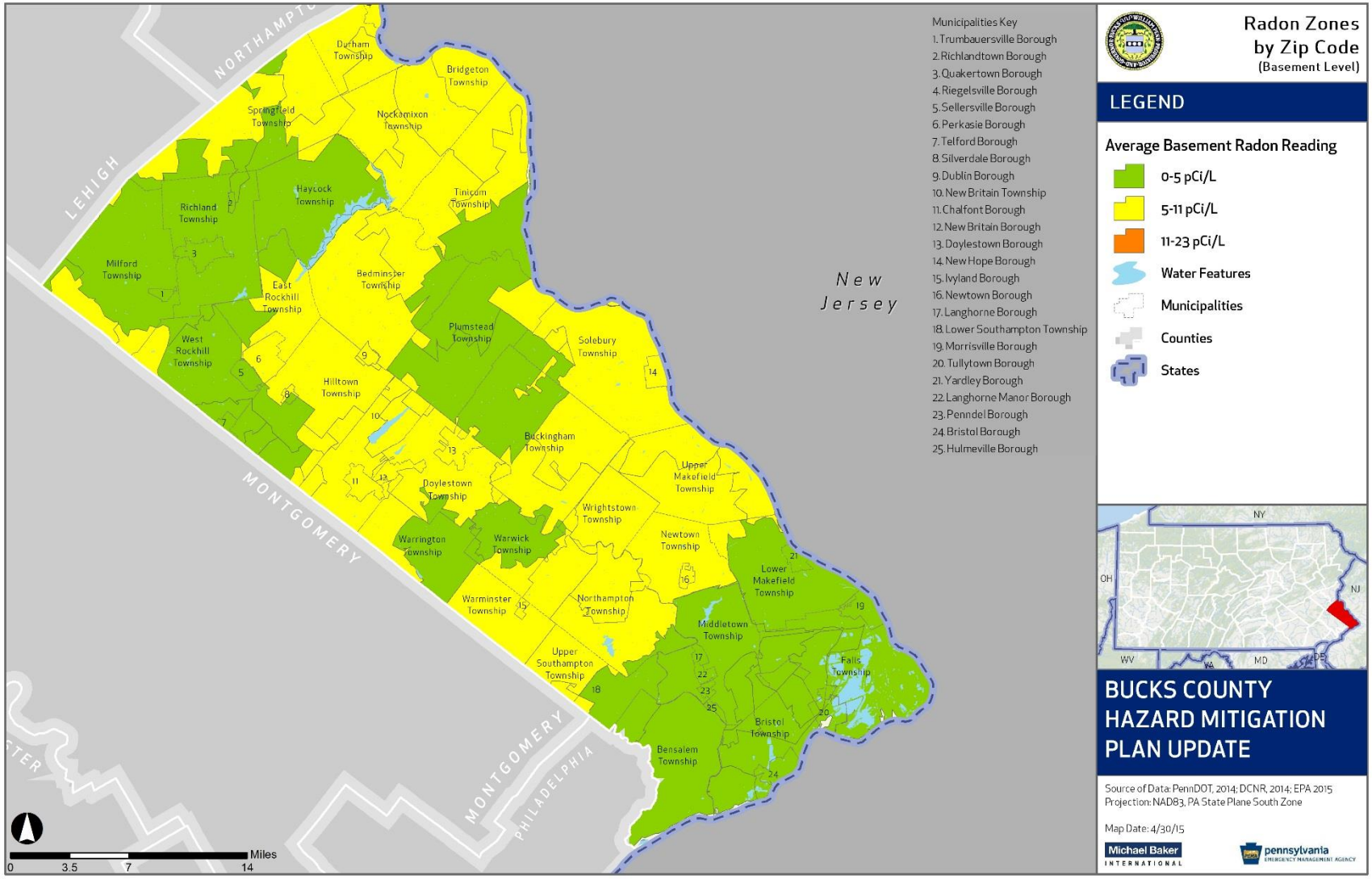
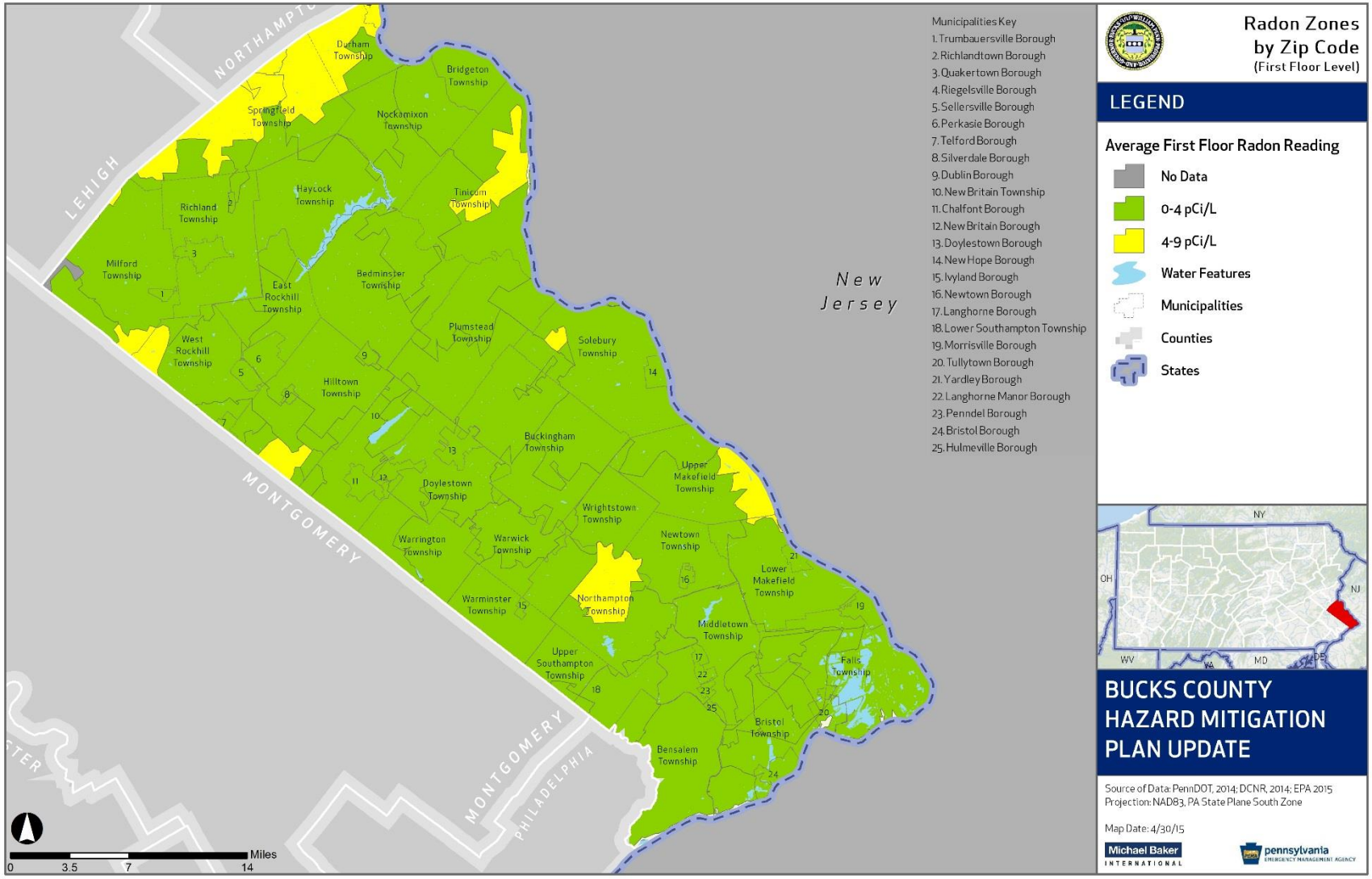


Figure 4.3.10-3: Bucks Average First Floor Radon Test Results



4.3.10.2. Range of Magnitude

Exposure to radon is the second leading cause of lung cancer after smoking. It is the number one cause of lung cancer among non-smokers. Radon is responsible for about 21,000 lung cancer deaths every year; approximately 2,900 of which occur among people who have never smoked. Lung cancer is the only known effect on human health from exposure to radon in air and thus far, there is no evidence that children are at greater risk of lung cancer than are adults (EPA, 2010). The main hazard is actually from the radon daughter products (218Po, 214Pb, 214Bi), which may become attached to lung tissue and induce lung cancer by their radioactive decay.

According to the EPA, the average radon concentration in the indoor air of homes nationwide is about 1.3 pCi/L. The EPA recommends homes be fixed if the radon level is 4 pCi/L or more. However, because there is no known safe level of exposure to radon, the EPA also recommends that Americans consider fixing their home for radon levels between 2 pCi/L and 4 pCi/L. Table 4.3.7-1 shows the relationship between various radon levels, probability of lung cancer, comparable risks from other hazards, and action thresholds. As is shown in Table 4.3.10-1, a smoker exposed to radon has a much higher risk of lung cancer.

Table 4.3.10-1: Radon risk for smokers and non-smokers (EPA, 2010).

RADON LEVEL (CCI/L)	IF 1,000 PEOPLE WERE EXPOSED TO THIS LEVEL OVER A LIFETIME…*	RISK OF CANCER FROM RADON EXPOSURE COMPARES TO…**	ACTION THRESHOLD
SMOKERS			
20	About 260 people could get lung cancer	250 times the risk of drowning	Fix Structure
10	About 150 people could get lung cancer	200 times the risk of dying in a home fire	
8	About 120 people could get lung cancer	30 times the risk of dying in a fall	
4	About 62 people could get lung cancer	5 times the risk of dying in a car crash	
2	About 32 people could get lung cancer	6 times the risk of dying from poison	Consider fixing structure between 2 and 4 pCi/L
1.3	About 20 people could get lung cancer	(Average indoor radon level)	Reducing radon levels below 2pCi/L is difficult
0.4	About 3 people could get lung cancer	(Average outdoor radon level)	
NON-SMOKERS			
20	About 36 people could get lung cancer	35 times the risk of drowning	Fix Structure
10	About 18 people could get lung cancer	20 times the risk of dying in a home fire	
8	About 15 people could get lung cancer	4 times the risk of dying in a fall	
4	About 7 people could get lung cancer	The risk of dying in a car crash	
2	About 4 people could get lung cancer	The risk of dying from poison	Consider fixing structure between 2 and 4 pCi/L

Table 4.3.10-1: Radon risk for smokers and non-smokers (EPA, 2010).			
RADON LEVEL (CCI/L)	IF 1,000 PEOPLE WERE EXPOSED TO THIS LEVEL OVER A LIFETIME…*	RISK OF CANCER FROM RADON EXPOSURE COMPARES TO…**	ACTION THRESHOLD
1.3	About 2 people could get lung cancer	(Average indoor radon level)	Reducing radon levels below 2pCi/L is difficult
0.4	-	(Average outdoor radon level)	

NOTE: Risk may be lower for former smokers.
** Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).*
*** Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.*

The worst-case scenario for radon exposure would be that a large area of tightly sealed homes in Bucks County provided residents high levels of exposure over a prolonged period of time without the resident being aware. This worst-case scenario exposure then could lead to a large number of people with cancer attributed to the radon exposure.

4.3.10.3. Past Occurrence

Current data on abundance and distribution of radon as it affects individual houses in the state of Pennsylvania in general is considered incomplete and potentially biased. Bucks County is not an exception. The EPA has estimated that the national average indoor radon concentration is 1.3 pCi/L and the level for action is 4.0 pCi/L; however they have estimated that the average indoor concentration in Pennsylvania basements is about 7.1 pCi/L and 3.6 pCi/L on the first floor (PADEP, 2011).

The Pennsylvania Department of Environmental Protection Bureau of Radiation Protection provides information for homeowners on how to test for radon in their houses. If a test results in radon concentrations over 4 pCi/L, then the Bureau works to help the homeowners make repairs to their houses to mitigate against high radon levels. The total number tests reported to the Bureau since 1990 and their results are provided by zip code on the Bureau's website. However, this information is only provided if over 30 tests total were reported in order to best approximate the average for the area.

In Bucks County, 163 zip codes had sufficient tests reported to the Bureau to list their findings, which are shown in Table 4.3.10 -2. This table includes zip codes that are located partially in Bucks County, such as Telford and Huntingdon Valley. It does not include the 5 ZIP codes for which insufficient data was collected or data did not exist.

Table 4.3.10-2: Radon level tests and results in Bucks County zip codes (PADEP, 2015).					
ZIP CODE	MUNICIPALITY	LOCATION OF TEST	NUMBER OF TESTS	MAXIMUM RESULT (PCI/L)	AVERAGE RESULT (PCI/L)
18036	Coopersburg	Basement	1319	970.2	8.6
18036	Coopersburg	First Floor	198	62.2	4.4
18041	East Greenville	Basement	346	52.3	4.8
18041	East Greenville	First Floor	101	10.3	2.1
18042	Easton	Basement	3156	607	8.5

Table 4.3.10-2: Radon level tests and results in Bucks County zip codes (PADEP, 2015).

ZIP CODE	MUNICIPALITY	LOCATION OF TEST	NUMBER OF TESTS	MAXIMUM RESULT (PCI/L)	AVERAGE RESULT (PCI/L)
18042	Easton	First Floor	589	109.1	4.1
18054	Green Lane	Basement	270	53.6	4.2
18054	Green Lane	First Floor	87	11.2	2.1
18055	Hellertown	Basement	939	529.2	8
18055	Hellertown	First Floor	162	133.2	5.4
18073	Pennsburg	Basement	594	125.5	5.2
18073	Pennsburg	First Floor	168	9.2	2.1
18077	Riegelsville	Basement	325	267.7	11.7
18077	Riegelsville	First Floor	86	23.8	4.3
18901	Doylestown	Basement	9060	243.7	6
18901	Doylestown	First Floor	3585	155.8	3.2
18902	Doylestown	Basement	465	149.1	5.7
18913	Carversville	Basement	86	502	16.5
18913	Carversville	First Floor	48	52.3	5.2
18914	Chalfont	Basement	2936	206.2	5.8
18914	Chalfont	First Floor	1037	78.1	2.9
18915	Colmar	Basement	127	79.5	4.7
18915	Colmar	First Floor	45	10.6	2.3
18917	Dublin	Basement	170	113.4	5
18917	Dublin	First Floor	82	39.1	2.3
18920	Erwinna	Basement	85	42.3	9.3
18920	Erwinna	First Floor	43	14.7	4.5
18923	Fountainville	Basement	126	39	5.2
18925	Furlong	Basement	1046	143.1	6.8
18925	Furlong	First Floor	344	62.5	3.3
18927	Hilltown	Basement	119	33.5	5.1
18927	Hilltown	First Floor	44	8.7	2.3
18929	Jamison	Basement	1571	182.4	4.6
18929	Jamison	First Floor	729	113.7	2.3
18930	Kintnersville	Basement	200	54.9	7.6
18930	Kintnersville	First Floor	67	14.6	3.2
18932	Line Lexington	Basement	34	12.9	5.1
18933	Lumberville	Basement	49	34.5	5.8
18933	Lumberville	First Floor	30	17.6	3
18934	Mechanicsville	Basement	36	87	7.7
18938	New Hope	Basement	2860	216.6	6.7
18938	New Hope	First Floor	1166	58.9	3.3
18940	Newtown	Basement	6047	162.3	5
18940	Newtown	First Floor	3323	60	2.3
18942	Ottsville	Basement	272	44.2	6.3
18942	Ottsville	First Floor	105	21.3	3

Table 4.3.10-2: Radon level tests and results in Bucks County zip codes (PADEP, 2015).

ZIP CODE	MUNICIPALITY	LOCATION OF TEST	NUMBER OF TESTS	MAXIMUM RESULT (PCI/L)	AVERAGE RESULT (PCI/L)
18944	Perkasie	Basement	2450	120.7	4.8
18944	Perkasie	First Floor	862	69.2	2.6
18947	Pipersville	Basement	885	61.2	4.5
18947	Pipersville	First Floor	344	54.2	2.4
18951	Quakertown	Basement	2388	549.5	4.9
18951	Quakertown	First Floor	779	51.7	2.1
18954	Richboro	Basement	1921	293	7.8
18954	Richboro	First Floor	757	144.3	4.2
18955	Richlandtown	Basement	106	25	3.6
18960	Sellersville	Basement	1035	364.1	4.5
18960	Sellersville	First Floor	340	28	2.1
18964	Souderton	Basement	1198	39.1	3.5
18964	Souderton	First Floor	379	42.8	1.9
18966	Southampton	Basement	5257	505	5.4
18966	Southampton	First Floor	2590	170.8	2.8
18969	Telford	Basement	1297	174.8	3.9
18969	Telford	First Floor	452	45.8	1.9
18972	Upper Black Eddy	Basement	296	56.9	5.6
18972	Upper Black Eddy	First Floor	115	14	2.7
18974	Warminster	Basement	2992	284.3	5.5
18974	Warminster	First Floor	1338	119.8	2.6
18976	Warrington	Basement	2014	97.5	4.3
18976	Warrington	First Floor	725	52.6	2.2
18977	Washington Crossing	Basement	1522	171.1	8.3
18977	Washington Crossing	First Floor	606	140.1	4.6
19002	Ambler	Basement	5849	150.1	4.4
19002	Ambler	First Floor	1961	99.1	2.3
19006	Huntingdon Valley	Basement	2752	95.3	4.8
19006	Huntingdon Valley	First Floor	989	37.5	2.6
19007	Bristol	Basement	769	29.6	2.4
19007	Bristol	First Floor	334	7.4	1.4
19020	Bensalem	Basement	2301	341.4	3.7
19020	Bensalem	First Floor	1268	94.9	2.2
19021	Croydon	Basement	323	35.9	3.4
19021	Croydon	First Floor	143	22.2	1.8
19030	Fairless Hills	Basement	405	30.1	3.6
19030	Fairless Hills	First Floor	335	24.8	2.5
19040	Hatboro	Basement	1836	193.4	4.2
19040	Hatboro	First Floor	693	32.9	2
19044	Horsham	Basement	1865	155	4.5
19044	Horsham	First Floor	849	31.1	2

Table 4.3.10-2: Radon level tests and results in Bucks County zip codes (PADEP, 2015).

ZIP CODE	MUNICIPALITY	LOCATION OF TEST	NUMBER OF TESTS	MAXIMUM RESULT (PCI/L)	AVERAGE RESULT (PCI/L)
19047	Langhorne	Basement	3453	94.3	3.9
19047	Langhorne	First Floor	1737	56.2	2.1
19053	Feasterville Trevose	Basement	1884	81.9	4.4
19053	Feasterville Trevose	First Floor	833	44.5	2.5
19054	Levittown	Basement	182	89.7	4.6
19054	Levittown	First Floor	205	31.6	2
19055	Levittown	Basement	53	68.9	5
19055	Levittown	First Floor	126	5.8	1.3
19056	Levittown	Basement	99	13.2	3.4
19056	Levittown	First Floor	207	9.1	1.6
19057	Levittown	Basement	82	38.7	3.5
19057	Levittown	First Floor	203	22.9	1.7
19067	Morrisville	Basement	8802	351.5	4.2
19067	Morrisville	First Floor	3893	79.3	2.2
19114	Philadelphia	Basement	518	31.9	1.9
19114	Philadelphia	First Floor	208	11.3	1.5
19116	Philadelphia	Basement	911	84.2	3.1
19116	Philadelphia	First Floor	398	16.3	1.7
19154	Philadelphia	Basement	571	39.1	1.7
19154	Philadelphia	First Floor	224	5.5	1.1
19440	Hatfield	Basement	1822	26.8	3.2
19440	Hatfield	First Floor	632	8.3	1.7
19454	North Wales	Basement	4003	114.2	3.7
19454	North Wales	First Floor	1486	26.9	1.8

4.3.10.4. Future Occurrence

Radon exposure in Bucks County remains a possibility given present soil, geologic, and geomorphic factors. Future occurrence of high radon level hazards can be considered *possible* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

Development in areas where previous radon levels have been significantly high will continue to be more susceptible to exposure. However, new incidents of concentrated exposure may occur with future development or deterioration of older structures. Exposure can be limited with proper testing for both past and future development and appropriate mitigation measures.

4.3.10.5. Vulnerability Assessment

Structures in Bucks County, particularly in vulnerable areas as shown in Figures 4.3.10-2 and 4.3.10-3, could be susceptible to moderate levels of radon. Smokers can be up to ten times more vulnerable to lung cancer from high levels of radon depending on the level of radon they are exposed to. Older houses that have crawl spaces or unfinished basements are more vulnerable as well because of the increased exposure to soils which could be releasing higher levels of radon gas. Additionally, houses that rely on

wells for their water may face an additional risk, although this type of exposure is low and rare in Pennsylvania.

Proper testing for radon levels should be completed throughout Bucks County, especially in the areas of higher incidence levels and for vulnerable populations that face the contributing risks described above. This testing will determine the level of vulnerability that residents face in their homes, as well as in their businesses and schools. The Pennsylvania Department of Environmental Protection Bureau of Radiation Protection provides short and long term tests to determine radon levels as well as information on how to mitigate high levels of radon in a building. According to the EPA, repairs to protect against radon can cost on average the same as routine house repairs (EPA, 2010). As seen in Figures 4.3.10-2 and 4.3.10-3, areas with the highest reported tests existed throughout the center of the county with most falling between 5-11 pCi/L. First floor radon levels were consistently low, but areas along the northern edge of the county had some higher readings.

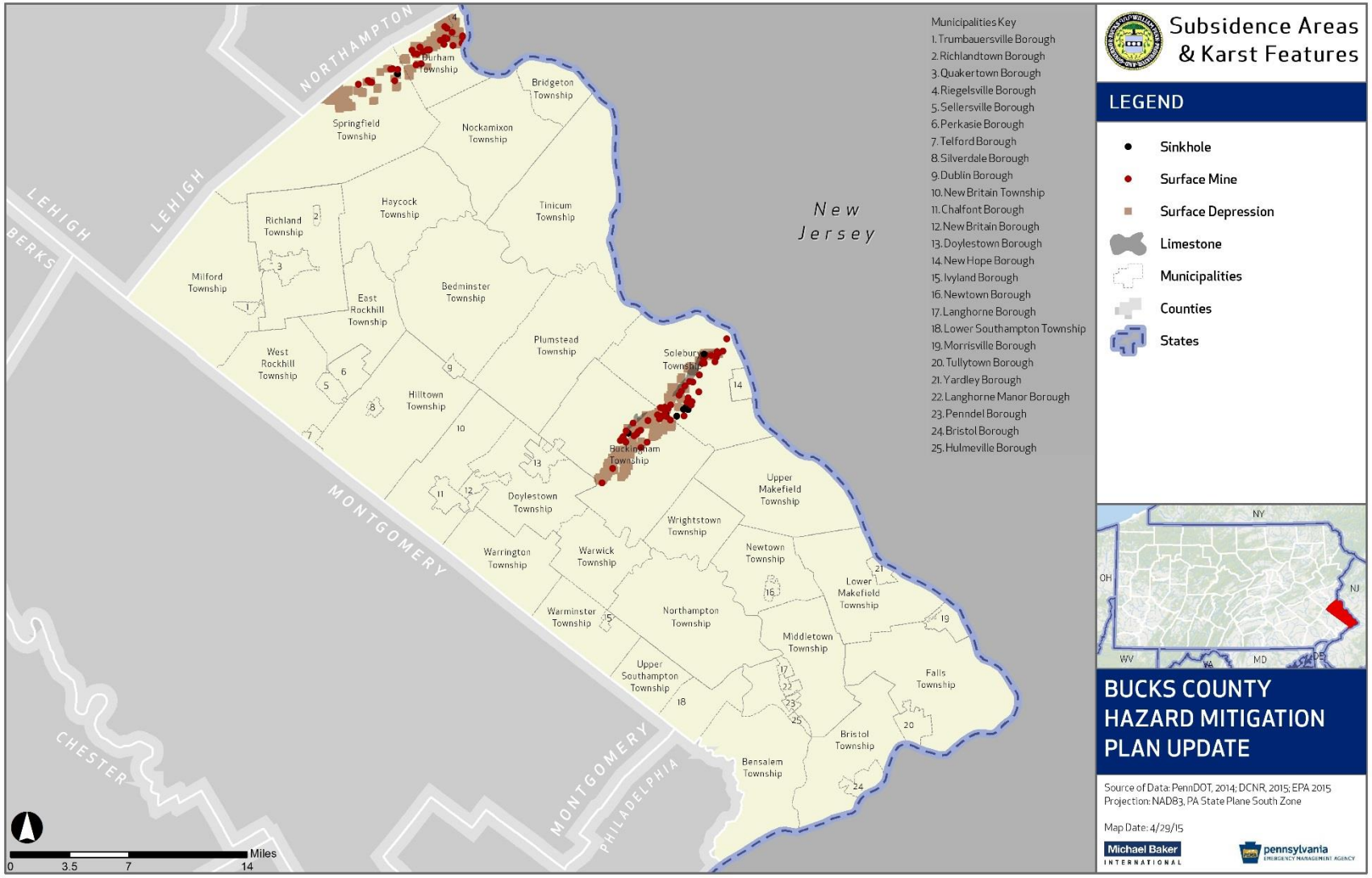
4.3.11. Subsidence, Sinkhole

4.3.11.1. Location and Extent

Subsidence is the gradual or sudden caving in or sinking of land. Subsidence is caused by a number of geological factors; human actions can exacerbate the natural causes of subsidence to increase the likelihood of an event occurrence. The potential for subsidence in Bucks County is associated with the limestone geology, sinkholes, and surface depressions. Water passing through naturally occurring fractures and bedding planes dissolve the limestone leaving voids below the surface. Eventually, overburden on top of the voids collapse leaving subsidence structures called karst features. Characteristic structures associated with karst topography include sinkholes, linear depressions, and caves. Often, sub-surface solution of limestone will not result in the immediate formation of karst features. Collapse sometimes occurs only after a large amount of activity, or when a heavy burden is placed on the overlying material. Subsidence may be exacerbated by flooding, since water flowing over the limestone may lead to erosion and collapse causing karst features. Flooding is profiled in Section 4.3.4. Additionally, human activity can accelerate the creation of subsidence or sinkhole events. Leaking water pipes or structures that convey storm-water runoff may also result in areas of subsidence as the water dissolves substantial amounts of rock over time. Poorly managed stormwater may be an exacerbating factor in subsidence events. In some cases, construction, land grading, or earthmoving activities that cause changes in stormwater flow can trigger sinkhole events.

Due to the nature of the geology in the region, karst features typically occur along southwest-to-northeast deposits of limestone. Figure 4.3.11-1 illustrates the karst feature areas including limestone as well as the noted areas of surface depressions, or areas where the land is observed to be sunken or depressed, the noted sinkholes in Bucks County, and the areas where there are surface mines. As shown in Figure 4.3.11-1, these are located along bands in Springfield and Durham townships and Riegelsville borough in Upper Bucks County, and in Buckingham and Solebury townships in Central Bucks County. The majority of limestone occurs in the band across the center of the county.

Figure 4.3.11-1: Areas Susceptible to Subsidence in Bucks County



4.3.11.2. Range of Magnitude

Subsidence and sinkhole events may occur gradually or abruptly; no two subsidence areas or sinkholes are exactly alike. Variations in size and shape, time period under which they occur (i.e. gradually or abruptly), and their proximity to development ultimately determines the magnitude of damage incurred. Events could result in a range of impacts from minor elevation changes to deep or gaping holes in the ground surface. These kinds of events can cause severe damage in populated areas, though gradual events can be addressed before large-scale damage occurs.

Primarily, problems related to subsidence include the disruption of utility services and damages to private and public property including buildings, roads, and underground infrastructure. If long-term subsidence or sinkhole formation is not recognized and mitigation measures are not implemented, fractures or complete collapse of building foundations and roadways may result. If mitigation measures are not taken, the cost to fill in and stabilize sinkholes can be significant although sinkholes are limited in extent.

A possible worst case scenario would be if a sinkhole occurred under a densely populated part of the County or under a critical facility. This would cause damage to property and building collapses, and this event has the potential to cause injury and even death.

4.3.11.3. Past Occurrence

The Pennsylvania Department of Conservation and Natural Resources conducted a partial inventory of karst features categorized as sinkholes, surface depressions, surface mines, or cave entrances that have been cataloged in Pennsylvania by the staff of the Pennsylvania Geological Survey since 1985 (DCNR, 2014b). This inventory lists nine sinkholes due to karst geology in Bucks County – one each are listed in Solebury and Springfield Townships, and the remainder are in Buckingham Township. This has not changed from the number noted in the 2011 HMP. Additionally, the DCNR database indicates that there are 910 surface depressions due to karst in Bucks County. These surface depressions are spatially concentrated; there are 227 in Springfield Township, 198 in Durham Township, 302 in Buckingham Township, 32 in Riegelsville Borough, and 151 in Solebury Township.

4.3.11.4. Future Occurrence

The exact probability of future events is difficult to predict. As a precaution, a model zoning ordinance has been developed by the County Planning Commission for jurisdictions with limestone geology due to the potential for karst subsidence. However, as mentioned above, only nine sinkholes have been identified within the County, and the area susceptible to subsidence is limited. The future occurrence of subsidence can be considered possible as defined by the Risk Factor methodology probability criteria (see Table 4.4-1).

4.3.11.5. Vulnerability Assessment

Bucks County, only Riegelsville Borough and Springfield, Durham, Buckingham, and Solebury townships can be considered vulnerable to geology-related subsidence and sinkhole events. These municipalities have ordinances and land use regulations to protect buildings from the impacts of subsidence, as described in Section 5.2.1.1.

The vulnerability of individual structures and critical facilities to subsidence and sinkhole events depend on underground site conditions related to the presence of limestone at each location. Table 4.3.11-1 details the structures and critical facilities which are placed in subsidence areas distinguished by the presence of limestone by municipality.

Table 4.3.11-1: Structures and Critical Facilities in Subsidence Areas (DCNR, 2015; EPA, 2015)

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN SUBSIDENCE AREA	% STRUCTURES IN SUBSIDENCE AREA	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES IN SUBSIDENCE AREA	% CRITICAL FACILITIES IN SUBSIDENCE AREA
Bedminster Township	3,380	0	0.00	9	0	0.00
Bensalem Township	15,196	0	0.00	59	0	0.00
Bridgeton Township	995	0	0.00	3	0	0.00
Bristol Borough	2,231	0	0.00	20	0	0.00
Bristol Township	19,210	0	0.00	57	0	0.00
Buckingham Township	7,607	37	0.49	19	0	0.00
Chalfont Borough	1,333	0	0.00	11	0	0.00
Doylestown Borough	2,810	0	0.00	20	0	0.00
Doylestown Township	5,475	0	0.00	21	0	0.00
Dublin Borough	541	0	0.00	6	0	0.00
Durham Township	967	0	0.00	1	0	0.00
East Rockhill Township	2,520	0	0.00	12	0	0.00
Falls Township	11,506	0	0.00	30	0	0.00
Haycock Township	1,783	0	0.00	2	0	0.00
Hilltown Township	6,027	0	0.00	10	0	0.00
Hulmeville Borough	409	0	0.00	3	0	0.00
Ivyland Borough	234	0	0.00	4	0	0.00
Langhorne Borough	718	0	0.00	8	0	0.00
Langhorne Manor Borough	436	0	0.00	6	0	0.00
Lower Makefield Township	9,883	0	0.00	26	0	0.00
Lower Southampton Township	7,181	0	0.00	28	0	0.00
Middletown Township	13,318	0	0.00	41	0	0.00
Milford Township	4,745	0	0.00	13	0	0.00
Morrisville Borough	3,358	0	0.00	13	0	0.00
New Britain Borough	979	0	0.00	10	0	0.00
New Britain Township	3,954	0	0.00	16	0	0.00
New Hope Borough	827	0	0.00	8	0	0.00
Newtown Borough	1,005	0	0.00	7	0	0.00
Newtown Township	4,376	0	0.00	31	0	0.00
Nockamixon Township	2,591	0	0.00	7	0	0.00
Northampton Township	12,376	0	0.00	28	0	0.00
Penndel Borough	763	0	0.00	5	0	0.00
Perkasie Borough	3,043	0	0.00	13	0	0.00

Table 4.3.11-1: Structures and Critical Facilities in Subsidence Areas (DCNR, 2015; EPA, 2015)						
MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN SUBSIDENCE AREA	% STRUCTURES IN SUBSIDENCE AREA	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES IN SUBSIDENCE AREA	% CRITICAL FACILITIES IN SUBSIDENCE AREA
Plumstead Township	5,032	0	0.00	16	0	0.00
Quakertown Borough	2,929	0	0.00	20	0	0.00
Richland Township	4,633	0	0.00	11	0	0.00
Richlandtown Borough	379	0	0.00	3	0	0.00
Riegelsville Borough	530	0	0.00	3	0	0.00
Sellersville Borough	1,307	0	0.00	9	0	0.00
Silverdale Borough	341	0	0.00	3	0	0.00
Solebury Township	4,260	84	1.97	12	1	8.33
Springfield Township	3,661	0	0.00	8	0	0.00
Telford Borough	633	0	0.00	2	0	0.00
Tinicum Township	3,306	0	0.00	12	0	0.00
Trumbauersville Borough	432	0	0.00	4	0	0.00
Tullytown Borough	836	0	0.00	9	0	0.00
Upper Makefield Township	3,509	0	0.00	5	0	0.00
Upper Southampton Township	5,421	0	0.00	20	0	0.00
Warminster Township	9,498	0	0.00	36	0	0.00
Warrington Township	5,568	0	0.00	23	0	0.00
Warwick Township	3,258	0	0.00	14	0	0.00
West Rockhill Township	2,661	0	0.00	12	0	0.00
Wrightstown Township	1,738	0	0.00	6	0	0.00
Yardley Borough	950	0	0.00	8	0	0.00
Grand Total	**212,659**	**121**	**0.06**	**783**	**1**	**0.13**

4.3.12. Tornado, Windstorm

4.3.12.1. Location and Extent

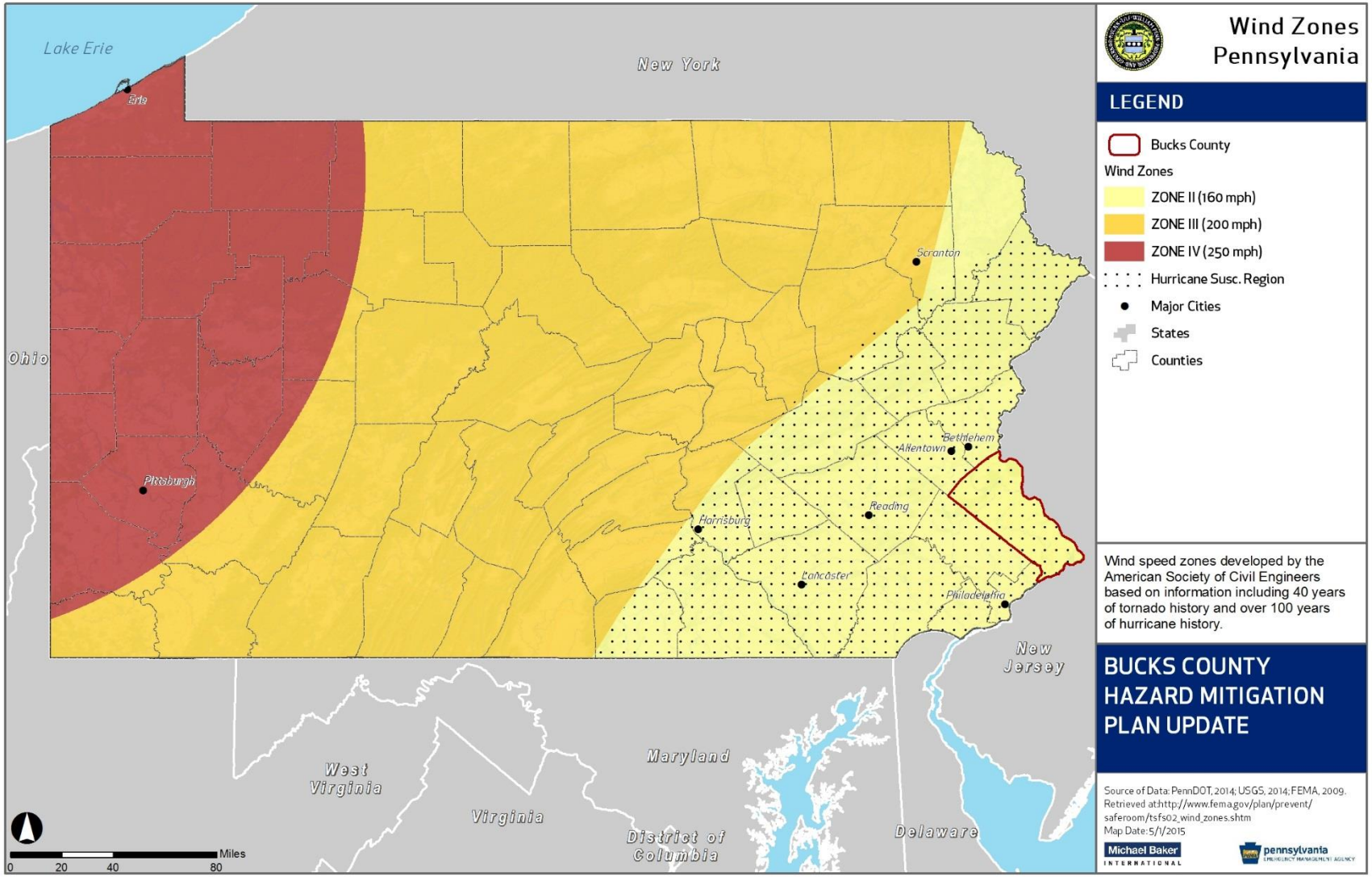
Tornadoes and wind storms can occur throughout Bucks County. While the extent of tornado damage is usually localized, the extreme winds of this vortex can be among the most destructive on earth when they move through populated, developed areas. Severe thunderstorms may result in conditions favorable to the formation of numerous or long-lived tornadoes. Tornadoes can occur at any time during the day or night, but are most frequent during late afternoon into early evening, the warmest hours of the day, and most likely to occur during the spring and early summer months of March through June.

Tornado movement is characterized in two ways: direction and speed of spinning winds, and forward movement of the tornado, also known as the storm track. The forward motion of the tornado path can

be a few hundred yards or several hundred miles in length. The width of tornadoes can vary greatly, but generally range in size from less than 100 feet to over a mile in width. Some tornadoes never touch the ground and are short-lived, while others may touch the ground several times.

Straight-line winds and windstorms are experienced on a more region-wide scale. Straight-line winds are the movement of air from areas of higher pressure to areas of lower pressure – the greater the difference in pressure, the stronger the winds. Wind storms are generally defined as sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration. Figure 4.3.12-1 shows the wind speed zones developed by the American Society of Civil Engineers based on tornado and hurricane historical events. These wind speed zones are intended to guide the design and evaluation of the structural integrity of shelters and critical facilities. The whole of Bucks County falls within Zone II, meaning the whole county is susceptible to winds up to 160 miles per hour. The hurricane susceptibility shown in the map is discussed in Section 4.3.6.

Figure 4.3.12-1: Wind Speed Zones in Bucks County.



4.3.12.2. Range of Magnitude

Each year, tornadoes account for $1.1 billion in damages and cause over 80 deaths nationally (NCAR, 2001). Rotational wind speeds can range from 100 mph to more than 250 mph. In addition, the speed of forward motion can range from 0 to 50 mph. Therefore, some estimates place the maximum velocity (combination of ground speed, wind speed, and upper winds) of tornadoes at about 300 mph. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles.

Damages and deaths can be especially significant when tornadoes move through populated, developed areas. The destruction caused by tornadoes ranges from minor to extreme damage depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damages to structures of light construction such as mobile homes. The Enhanced Fujita Scale, also known as the "EF-Scale," measures tornado strength and associated damages. The EF-Scale is an update to the earlier Fujita Scale, also known as the "F-Scale," that was published in 1971. It classifies United States tornadoes into six intensity categories, as shown in Table 4.3.12-1, based upon the estimated maximum winds occurring within the wind vortex. Since its implementation by the National Weather Service in 2007, the EF-Scale has become the definitive metric for estimating wind speeds within tornadoes based upon damage to buildings and structures. F-Scale categories with corresponding EF-Scale wind speeds are provided in Table 4.3.12-1 since the magnitude of previous tornado occurrences is based on the F-Scale.

Table 4.3.12-1: Enhanced Fujita Scale (EF-Scale) categories with associated wind speeds and description of damages

EF-SCALE NUMBER	WIND SPEED (MPH)	F-SCALE NUMBER	TYPE OF DAMAGE POSSIBLE
EF0	65–85	F0-F1	**Minor damage**: Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.
EF1	86-110	F1	**Moderate damage**: Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111–135	F1-F2	**Considerable damage**: Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136–165	F2-F3	**Severe damage**: Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166–200	F3	**Devastating damage**: Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.

Table 4.3.12-1: Enhanced Fujita Scale (EF-Scale) categories with associated wind speeds and description of damages			
EF-SCALE NUMBER	WIND SPEED (MPH)	F-SCALE NUMBER	TYPE OF DAMAGE POSSIBLE
EF5	>200	F3-F6	**Extreme damage**: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (300 ft); steel reinforced concrete structure badly damaged; high-rise buildings have significant structural deformation.

While tornado winds rotate, high winds that move in a straight line can also be damaging. Windstorms are generally defined as sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration.

As noted above, Figure 4.3.12-1 shows the wind speed zones based on tornado and hurricane historical events. The whole of Bucks County falls within Zone II, meaning that shelters and critical facilities should be able to withstand a 3-second gust of up to 160 mph, regardless of whether the gust is the result of a tornado, coastal storm, or windstorm event. Therefore, these structures should be able to withstand the wind speeds experienced in an F3 tornado event.

Since tornado and windstorm events are typically localized, environmental impacts are rarely widespread. However, where these events occur, severe damage to buildings and plant species is likely. This includes loss of trees and an increased threat of wildfire in areas where dead trees are not removed. Hazardous material facilities should meet design requirements to withstand a 3-second gust of up to 160 mph in order to prevent release of hazardous materials into the environment.

The worst case scenario for tornado events in Bucks County happened in September 1993. Trees fell down, extensive structural damage was incurred, and about 20,000 people lost power across the county. This was an F1 event without death or injury, but in total it cost the County $5.0 million in property damages (NCDC, 2015).

4.3.12.3. Past Occurrence

Tornadoes have occurred in Pennsylvania in all seasons and in all parts of the state, but the western and southeastern portions have been more frequently struck. One of the most significant in recent Bucks County history was the September 1993 tornado that touched down near Neshaminy High School and moved northeast through Langhorne to Yardley. In addition to numerous trees downed, extensive structural damage occurred as the twister swept through the County. In one instance, the tornado ripped the roof off of an orchard warehouse on Woodbourne Road in Middletown Township; the roof landed in the road over 100 feet away. About 20,000 customers lost power countywide, and three schools cancelled classes because of power outages.

A list of tornado events that have occurred in Bucks County between 1950 and 2014 is shown in Table 4.3.12-2 with an associated Fujita Tornado Scale magnitude. A map showing the approximate location of

previous events from 1950-2004 whose center of circulation were located in or tracked through Bucks County is included in Figure 4.3.12-2.

Table 4.3.12-2: Previous tornado events between 1950 and 2014 in Bucks County (NCDC, 2015).

LOCATION	DATE	MAGNITUDE	DEATHS	INJURIES	ESTIMATED PROPERTY DAMAGE ($)
Countywide	08/29/1950	F1	0	0	3K
Countywide	09/03/1961	F1	0	0	25K
Countywide	05/24/1962	F2	0	0	25K
Countywide	06/29/1973	F2	0	0	25K
Countywide	07/13/1975	F1	0	0	25K
Countywide	06/29/1982	F1	0	0	25K
Countywide	03/21/1983	F1	0	0	25K
Countywide	08/29/1983	F1	0	0	25K
Countywide	04/05/1984	F1	0	0	25K
Countywide	11/16/1989	F0	0	0	2.5M
Countywide	11/16/1989	F1	0	1	2.5M
Countywide	07/05/1990	F1	0	0	250K
Countywide	01/14/1992	F1	0	0	0K
Countywide	07/31/1992	F1	0	0	3K
Neshaminy	09/27/1993	F1	0	0	5.0M
Hilltown	06/06/1994	F1	0	0	50K
Silverdale	09/11/1997	F0	0	0	5K

Windstorm events may be the result of thunderstorms, hurricanes, tropical storms, winter storms, or nor'easters. There have been 209 events in Bucks County with wind speeds of greater than 50 knots from 1950 to 2014 (NCDC, 2015). These windstorms have caused trees and power lines to fall across the county. The worst case scenario of a windstorm happened in September 1998 when severe thunderstorms disrupted power service, blocked roads with fallen trees, damaged homes, and crushed a vehicle. Six people were injured and one child was killed during the course of the storm (NCDC, 2015). A list of events greater than 50 knots that have occurred in Bucks County since 1960 is shown in Table 4.3.12-3.

Table 4.3.12-3: Number of previous windstorm events greater than 50 knots by municipality in Bucks County between 1950 and 2014 (NCDC, 2015).

LOCATION	EVENTS WITH WIND SPEED 50-60 KT.S	EVENTS WITH WIND SPEED >60 KT.S	TOTAL DEATHS	TOTAL INJURIES	TOTAL PROPERTY DAMAGE ($)	TOTAL CROP DAMAGE ($)
County Wide	58	7	0	2	0	0
Central Portion	3	0	0	0	0	0
Eastern Portion	1	0	0	0	0	0
Bedminster Township	0	0	0	0	0	0
Northern Portion	1	0	0	0	0	0
Northwest Portion	1	0	0	0	0	0
Southeast Portion	1	0	0	0	0	0
Bensalem Township	6	0	0	0	20,000	0
Bridgeton Township	0	0	0	0	0	0
Bristol Borough	1	0	0	0	0	0
Bristol Township	9	0	0	0	0	0
Buckingham Township	5	1	0	0	0	0
Chalfont Borough	5	0	0	0	0	0
Doylestown Township	8	0	0	1	5,000	0
Dublin Borough	2	0	0	0	0	0
Durham Township	0	0	0	0	0	0
East Rockhill Township	0	0	0	0	0	0
Falls Township	1	0	0	0	0	0
Haycock Township	0	0	0	0	0	0
Hilltown Township	2	0	0	0	0	0
Hulmeville Borough	2	0	0	0	0	0
Ivyland Borough	1	0	0	0	0	0
Langhorne Borough	5	0	0	3	10,000	0
Langhorne Manor Borough	0	0	0	0	0	0
Lower Makefield Township	0	0	0	0	0	0
Lower Southampton Township	0	0	0	0	0	0
Middletown Township	9	0	0	1	100,000	0
Milford Township	2	0	0	0	0	0
Morrisville Borough	2	0	0	0	0	0
New Britain Borough	0	0	0	0	0	0
New Britain Township	2	0	0	0	0	0
New Hope Borough	3	0	0	0	0	0
Newtown Borough	0	0	0	0	0	0
Newtown Township	7	0	0	0	100,000	0
Nockamixon Township	0	1	0	0	300,000	0

Table 4.3.12-3: Number of previous windstorm events greater than 50 knots by municipality in Bucks County between 1950 and 2014 (NCDC, 2015).

LOCATION	EVENTS WITH WIND SPEED 50-60 KT.S	EVENTS WITH WIND SPEED >60 KT.S	TOTAL DEATHS	TOTAL INJURIES	TOTAL PROPERTY DAMAGE ($)	TOTAL CROP DAMAGE ($)
Northampton Township	3	0	0	0	25,000	0
Penndel Borough	0	0	0	0	0	0
Perkasie Borough	12	0	0	0	20,000	0
Plumstead Township	1	0	0	0	0	0
Quakertown Borough	10	0	0	0	260,000	0
Richland Township	0	0	0	0	0	0
Richlandtown Borough	4	1	0	0	260,000	0
Riegelsville Borough	1	0	0	0	0	0
Sellersville Borough	2	0	0	0	0	0
Silverdale Borough	1	0	0	0	0	0
Solebury Township	1	1	0	0	25,000	0
Springfield Township	4	0	0	0	50,000	0
Telford Borough	2	0	0	0	0	0
Tinicum Township	3	0	0	0	0	0
Trumbauersville Borough	3	1	0	0	5,000	0
Tullytown Borough	2	0	0	0	0	0
Upper Makefield Township	1	0	0	0	25,000	0
Upper Southampton Township	2	0	0	0	0	0
Warminster Township	6	0	0	0	0	0
Warrington Township	5	0	0	0	25,000	0
Warwick Township	1	0	0	0	0	0
West Rockhill Township	0	0	0	0	0	0
Woodside	1	0	0	0	50,000	0
Wrightstown Township	1	0	0	0	0	0
Yardley Borough	6	0	0	0	0	0
Totals	**209**	**12**	**0**	**7**	**1,280,000**	**0**

Figure 4.3.12-2: Previous tornado events between 1950 and 2015 in Bucks County (NWS, 2004).

4.3.12.4. Future Occurrence

The probability of actually being in the path of a tornado in any given year in Bucks County is quite small, on the order of 0.01 percent. While the chance of being hit by a tornado is small, the damage that results when the tornado arrives is devastating. An F4 tornado can carry wind velocities of 200 mph, resulting in a force of more than 100 pounds per square foot of surface area. This is a "wind load" that exceeds the design limits of most buildings.

Bucks County experiences windstorm events more commonly than tornadoes, which causes power failures, loss of communication networks, and residents requiring temporary shelters and provision of supplies (NCDC, 2015). The future occurrence of tornado and windstorms can be considered possible as defined by the Risk Factor methodology probability criteria (see Table 4.4-1).

4.3.12.5. Vulnerability Assessment

The frequency of tornadoes and windstorms is expected to remain constant across Bucks County. Since high wind events may affect the entire County, it is important to identify specific critical facilities and assets that are most vulnerable to the hazard. Evaluation criteria include age of the building (and what building codes may have been in effect at the time), type of construction, and condition of the structure (i.e., how well has the structure been maintained). Individual structure data was not available for this study, so it was difficult to determine the exact number and types of structures within Bucks County that have heightened vulnerability to wind hazards.

Due to their lightweight and unanchored design, mobile homes and commercial trailers are extremely vulnerable to high winds and will generally sustain the most damage. The total number of mobile home structures has grown from 4,071 to 5,922 between 2010 and 2016. Table 4.3.12-4 details the number of mobile home structures in each municipality. Falls Township has the highest concentration of mobile homes while most boroughs such as Bristol, Dublin, and Silverdale Boroughs had no mobile homes. Zoning restrictions within the boroughs are most likely the cause of this difference. Higher concentrations of mobile home structures increase the vulnerability of the area to tornadoes and wind storms.

Table 4.3.12-4: Mobile home structures in Bucks County (Bucks County GIS Dept., 2015).

MUNICIPALITY	# OF MOBILE HOME STRUCTURES
Bedminster Township	52
Bensalem Township	883
Bridgeton Township	57
Bristol Borough	0
Bristol Township	17
Buckingham Township	697
Chalfont Borough	0
Doylestown Borough	0
Doylestown Township	164
Dublin Borough	0
Durham Township	12
East Rockhill Township	42
Falls Township	1477
Haycock Township	50

Table 4.3.12-4: Mobile home structures in Bucks County (Bucks County GIS Dept., 2015).

MUNICIPALITY	# OF MOBILE HOME STRUCTURES
Hilltown Township	146
Hulmeville Borough	0
Ivyland Borough	0
Langhorne Borough	0
Langhorne Manor Borough	0
Lower Makefield Township	9
Lower Southampton Township	341
Middletown Township	11
Milford Township	143
Morrisville Borough	1
New Britain Borough	87
New Britain Township	98
New Hope Borough	0
Newtown Borough	0
Newtown Township	2
Nockamixon Township	110
Northampton Township	2
Penndel Borough	0
Perkasie Borough	0
Plumstead Township	280
Quakertown Borough	0
Richland Township	867
Richlandtown Borough	0
Riegelsville Borough	3
Sellersville Borough	0
Silverdale Borough	0
Solebury Township	2
Springfield Township	81
Telford Borough	0
Tinicum Township	110
Trumbauersville Borough	0
Tullytown Borough	7
Upper Makefield Township	0
Upper Southampton Township	0
Warminster Township	0
Warrington Township	0
Warwick Township	3
West Rockhill Township	165
Wrightstown Township	3
Yardley Borough	0
TOTAL	**5,922**

4.3.13. Wildfire

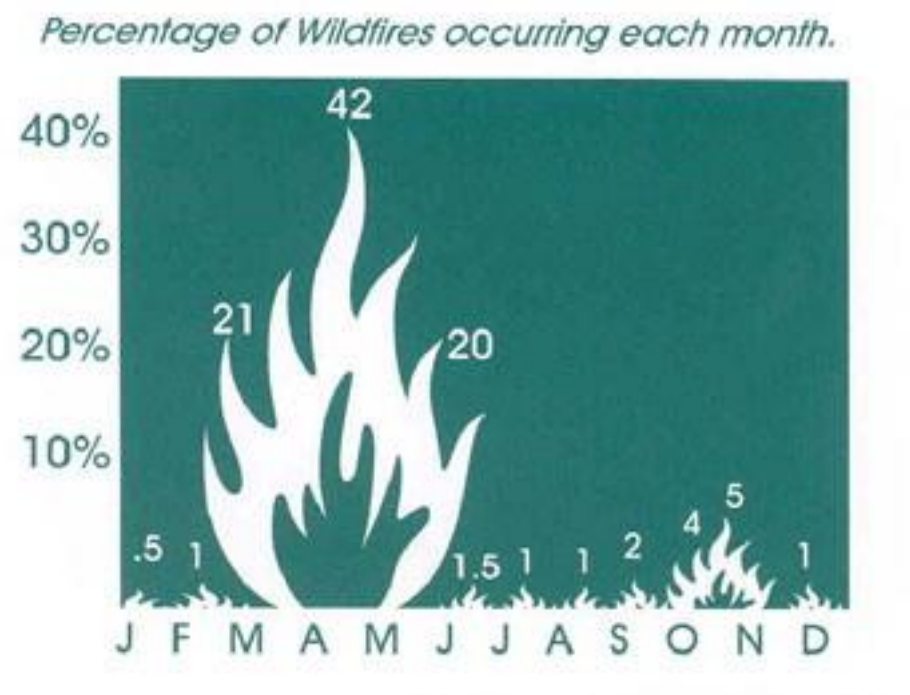
4.3.13.1. Location and Extent

While many fires can occur in Bucks County every year, the spatial extent, and impact of many residential fires is small. Assume that building codes are in place and are enforced, the risk of urban structure fires should be the same throughout the County. Wildfires, however, are more likely to occur in portions of Bucks County that consists of forests or farms.

Wildfires occur throughout wooded and open vegetation areas of Pennsylvania. They can occur any time of the year, but mostly occur during long, dry hot spells. Any small fire, if not quickly detected and suppressed, can get out of control. Wildfires can be started by human negligence, lightning strikes, and rare instances of spontaneous combustion. There have been major fires in the state and in the municipalities that are located in upper Bucks County, such as Springfield, Haycock, and Hilltown Townships.

The greatest potential for wildfires is in the spring months of March, April, and May, and, to a lesser extent, the autumn months of October and November. In the spring, bare trees allow sunlight to reach the forest floor, drying fallen leaves and other ground debris. In the fall, dried leaves are also fuel for fires. The percentage of wildfires occurring each month in Pennsylvania is shown in Figure 4.3.13-1.

Figure 4.3.13-1: Percentage of wildfires occurring each month (DCNR-BOF).



4.3.13.2. Range of Magnitude

As stated in Section 4.3.13.1, wildfires can occur at any time of the year, but mostly occur during long, dry, hot spells. Any small fire in a wooded area, if not quickly detected and suppressed, can get out of

control. Most wildfires are caused by human carelessness, negligence, and ignorance. However, some are precipitated by lightning strikes and in rare instances, spontaneous combustion.

Wildfires in the Commonwealth of Pennsylvania can occur in fields, grass, and brush as well as in the forest itself. Much of upper Bucks County includes forested areas. Under dry conditions or droughts, wildfires have the potential to burn forests as well as croplands. In the fall, dried leaves are also fuel for fires. Ninety-eight percent of wildfires in Pennsylvania are caused by people, often by debris burns. Several fires have started in a private backyard and traveled through dead grasses and weeds into bordering woodlands.

An uncontrolled wildfire is one of the most destructive fires caused by nature or man. It kills people, livestock, and wildlife. It destroys property, valuable timber, forage, and inestimable scenic and recreational value. Potential aftermath of wildfires includes severe erosion, silting of stream beds and reservoirs, and flooding due to a loss of ground cover.

Vegetation loss is often an environmental concern with wildfires, but it typically is not a serious impact since natural re-growth occurs with time. The most significant environmental impact is the potential for severe erosion, silting of stream beds and reservoirs, and flooding due to ground-cover loss following a fire event.

Wildfires also have a positive environmental impact in that they burn dead trees, leaves, and grasses to allow more open spaces for new and different types of vegetation to grow and receive sunlight. Another positive effect of a wildfire is that it stimulates the growth of new shoots on trees and shrubs and its heat can open pine cones and other seed pods.

The worst case scenario for a wildfire in Bucks County would be an uncontrolled fire that spreads from forested areas into bordering residential areas, causing significant damages to homes and other assets in addition to some natural resources.

4.3.13.3. Past Occurrence

There have been 61 wildfire events reported to the Pennsylvania Department of Conservation and Natural Resources Bureau of Forestry from 2002-2013 in Bucks County. This number does not include wildfires that were not reported to DCNR, that had no known location, or that were controlled solely by the volunteer fire departments in the County, but it is the most comprehensive list of wildfire occurrences available for Bucks County. Table 4.3.13-1 shows the list of wildfire events and location reported to the DCNR.

Of all of Bucks County's jurisdictions, wildfires have been concentrated in fifteen of the jurisdictions: Bedminster Township, Bridgeton Township, Bristol Township, Buckingham Township, Durham Township, East Rockhill Township, Haycock Township, Hilltown Township, Milford Township, Nockamixon Township, Plumstead Township, Quakertown Borough, Richland Township, Solebury Township, Springfield Township, and West Rockhill Township. Note the clustering of wildfire events in the far northern portions of the County where brush, grassland, forested land, and park land abound. The wildfires have ranged significantly in size; the largest fires burned 17 acres while the smallest only consumed 0.01 acres.

Table 4.3.13-1: List of wildfire events reported in Bucks County from 2001-2013 (DCNR, 2010).

YEAR	MUNICIPALITY	TOTAL AREA BURNED (ACRES)
2002	Bristol Township	1.300
2002	Bristol Township	14.800
2002	East Rockhill Township	0.110
2002	East Rockhill Township	0.000
2002	East Rockhill Township	0.000
2002	East Rockhill Township	0.000
2002	Milford Township	8.500
2002	Solebury Township	1.300
2002	Springfield Township	2.100
2002	Springfield Township	0.170
2003	Bedminster Township	1.200
2003	Milford Township	0.090
2003	Nockamixon Township	1.250
2003	Richland Township	0.700
2003	Springfield Township	1.500
2003	Springfield Township	0.070
2005	Bridgeton Township	1.200
2005	Durham Township	0.300
2005	Haycock Township	0.300
2005	Richland Township	0.350
2005	Richland Township	0.290
2005	Richland Township	1.000
2005	Springfield Township	2.900
2005	Springfield Township	6.300
2005	Springfield Township	0.100
2005	Springfield Township	0.150
2005	West Rockhill Township	0.350
2006	East Rockhill Township	0.700
2006	Haycock Township	0.800
2006	Haycock Township	0.800
2006	Hilltown Township	0.750
2006	Milford Township	0.570
2006	Nockamixon Township	6.000
2006	Nockamixon Township	2.500
2006	Nockamixon Township	2.000
2006	Plumstead Township	17.000
2006	Plumstead Township	17.000
2006	Richland Township	2.000

Table 4.3.13-1: List of wildfire events reported in Bucks County from 2001-2013 (DCNR, 2010).		
YEAR	MUNICIPALITY	TOTAL AREA BURNED (ACRES)
2006	Springfield Township	0.100
2006	Springfield Township	0.030
2006	Springfield Township	2.000
2006	Springfield Township	0.170
2006	Springfield Township	0.600
2007	Haycock Township	1.000
2007	Plumstead Township	6.000
2007	Quakertown Borough	0.010
2007	Richland Township	1.200
2007	Richland Township	0.010
2008	Haycock Township	1.000
2008	Springfield Township	0.250
2008	Springfield Township	1.500
2008	Springfield Township	0.120
2008	Springfield Township	0.250
2008	Springfield Township	0.950
2008	Springfield Township	0.100
2009	Richland Township	0.25
2010	Buckingham Township	1
2011	Springfield Township	1.4
2012	Milford Township	1.5
2012	Haycock Township	2.2
2013	Springfield Township	0.1

Major parks and state gamelands within Bucks County could be a significant factor for wildfires. Notable among these is Nockamixon State Park, which is over 5,000 acres in area. In addition, several of these parks include large bodies of water which have multiple uses within the community. Therefore, fires within the forest can have severe impacts on the well-being of residents and the local economy.

4.3.13.4. Future Occurrence

Weather conditions like drought can increase the likelihood of fires burning out of control and becoming a wildfire. Any fire, without the quick response or attention of firefighters, forestry personnel, or visitors to the forest, has the potential to become a wildfire. The probability of future wildfires should be considered likely according to the Risk Factor Methodology (see Table 4.4-1). However, the likelihood of one of those fires attaining significant size and intensity is unpredictable and highly dependent on environmental conditions and firefighting response. Weather conditions, particularly drought events, increase the likelihood of wildfires occurring.

It is important to note that most wildfires in Pennsylvania are human-caused. As a result, the occurrence of future wildfire events will strongly depend on patterns of human activity. Events are more likely to occur in wildfire-prone areas experiencing new or additional development. Wildfires may also be more likely after invasive species infestations or high wind events; these events would add additional potential fuel load to fire-prone locations.

4.3.13.5. Vulnerability Assessment

The Pennsylvania Bureau of Forestry has conducted an independent wildfire hazard risk assessment for the municipalities in Bucks County. Results of that assessment are shown in Figure 4.3.13-2. Wildfire hazard is defined based on conditions that affect wildfire ignition and/or behavior such as fuel, topography, and local weather. 39 of the 54 municipalities in Bucks County have a "high" hazard rating. Table 4.3.13-2 shows the total addressable structures and critical facilities in the high wildfire hazard areas, and Table 4.3.13-3 shows the number of structures by generalized land use type.

Eight municipalities have a "medium" wildfire hazard rating. These are Bristol Borough, Doylestown Borough, Ivyland Borough, Morrisville Borough, New Britain Borough, Silverdale Borough, Warminster Township, and Yardley Borough. The remaining seven communities- Dublin Borough, Newtown Borough, Penndel Borough, Quakertown Borough, Richlandtown Borough, Trumbauersville Borough, and Tullytown Borough- have a "low" wildfire hazard ranking. The individual vulnerability of communities will differ based on the design of the urban/wildland interface, the number of ingress and egress points into a community, and the availability of water to fight fires.

Table 4.3.13-2: Structures and critical facilities located in wildfire high hazard areas of Bucks County.

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN WILDFIRE HIGH HAZARD AREAS	PERCENT OF STRUCTURES IN WILDFIRE HIGH HAZARD AREAS	TOTAL CRITICAL FACILITIES	TOTAL CRITICAL FACILITIES IN WILDFIRE HIGH HAZARD AREAS	PERCENT CRITICAL FACILITIES IN WILDFIRE HIGH HAZARD AREAS
Bedminster Township	3,380	3,374	100	9	9	100
Bensalem Township	15,196	15,193	100	59	59	100
Bridgeton Township	995	995	100	3	3	100
Bristol Borough	2,231	0	0	20	0	0
Bristol Township	19,210	19,176	100	57	55	96
Buckingham Township	7,607	7,607	100	19	19	100
Chalfont Borough	1,333	1,333	100	11	11	100
Doylestown Borough	2,810	27	1	20	0	0
Doylestown Township	5,475	5,443	99	21	21	100
Dublin Borough	541	16	3	6	0	0
Durham Township	967	965	100	1	1	100
East Rockhill Township	2,520	2,520	100	12	12	100
Falls Township	11,506	11,476	100	30	30	100

Table 4.3.13-2: Structures and critical facilities located in wildfire high hazard areas of Bucks County.

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN WILDFIRE HIGH HAZARD AREAS	PERCENT OF STRUCTURES IN WILDFIRE HIGH HAZARD AREAS	TOTAL CRITICAL FACILITIES	TOTAL CRITICAL FACILITIES IN WILDFIRE HIGH HAZARD AREAS	PERCENT CRITICAL FACILITIES IN WILDFIRE HIGH HAZARD AREAS
Haycock Township	1,783	1,783	100	2	2	100
Hilltown Township	6,027	5,986	99	10	10	100
Hulmeville Borough	409	409	100	3	3	100
Ivyland Borough	234	0	0	4	0	0
Langhorne Borough	718	718	100	8	8	100
Langhorne Manor Borough	436	436	100	6	6	100
Lower Makefield Township	9,883	9,882	100	26	26	100
Lower Southampton Township	7,181	7,177	100	28	28	100
Middletown Township	13,318	13,264	100	41	40	98
Milford Township	4,745	4,727	100	13	13	100
Morrisville Borough	3,358	20	1	13	0	0
New Britain Borough	979	22	2	10	1	10
New Britain Township	3,954	3,932	99	16	16	100
New Hope Borough	827	827	100	8	8	100
Newtown Borough	1,005	10	1	7	0	0
Newtown Township	4,376	4,371	100	31	31	100
Nockamixon Township	2,591	2,591	100	7	7	100
Northampton Township	12,376	12,376	100	28	28	100
Penndel Borough	763	22	3	5	0	0
Perkasie Borough	3,043	3,043	100	13	13	100
Plumstead Township	5,032	5,032	100	16	16	100
Quakertown Borough	2,929	258	9	20	3	15
Richland Township	4,633	4,621	100	11	11	100
Richlandtown Borough	379	20	5	3	0	0
Riegelsville Borough	530	530	100	3	3	100
Sellersville Borough	1,307	1,307	100	9	9	100
Silverdale Borough	341	8	2	3	0	0
Solebury Township	4,260	4,260	100	12	12	100
Springfield Township	3,661	3,658	100	8	8	100
Telford Borough	633	633	100	2	2	100
Tinicum Township	3,306	3,306	100	12	12	100
Trumbauersville Borough	432	45	10	4	1	25
Tullytown Borough	836	77	9	9	0	0

Table 4.3.13-2: Structures and critical facilities located in wildfire high hazard areas of Bucks County.

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN WILDFIRE HIGH HAZARD AREAS	PERCENT OF STRUCTURES IN WILDFIRE HIGH HAZARD AREAS	TOTAL CRITICAL FACILITIES	TOTAL CRITICAL FACILITIES IN WILDFIRE HIGH HAZARD AREAS	PERCENT CRITICAL FACILITIES IN WILDFIRE HIGH HAZARD AREAS
Upper Makefield Township	3,509	3,509	100	5	5	100
Upper Southampton Township	5,421	5,421	100	20	20	100
Warminster Township	9,498	0	0	36	0	0
Warrington Township	5,568	5,568	100	23	23	100
Warwick Township	3,258	3,258	100	14	14	100
West Rockhill Township	2,661	2,661	100	12	12	100
Wrightstown Township	1,738	1,738	100	6	6	100
Yardley Borough	950	17	2	8	0	0
Grand Total	212,659	185,648	87	783	617	79

Table 4.3.13-3: Structures in Wildfire High Hazard Areas by Generalized Land Use Type

MUNICIPALITY	AGRIULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Bedminster Township	688	101	40	27	34	2455	8	21	3,374
Bensalem Township	22	936	212	284	90	13436	32	181	15,193
Bridgeton Township	0	23	7	8	31	910	0	16	995
Bristol Borough	0	0	0	0	0	0	0	0	0
Bristol Township	0	623	157	375	51	17826	92	52	19,176
Buckingham Township	483	342	78	41	29	6558	35	41	7,607
Chalfont Borough	0	108	9	7	6	1193	7	3	1,333
Doylestown Borough	0	1	0	0	0	14	12	0	27
Doylestown Township	18	139	235	13	26	4951	34	27	5,443
Dublin Borough	0	2	0	0	0	14	0	0	16
Durham Township	128	18	10	5	2	782	0	20	965
East Rockhill Township	112	53	47	7	34	2216	16	35	2,520
Falls Township	25	405	102	249	52	10537	64	42	11,476
Haycock Township	56	10	15	2	64	1609	0	27	1,783
Hilltown Township	312	195	62	85	14	5235	22	61	5,986

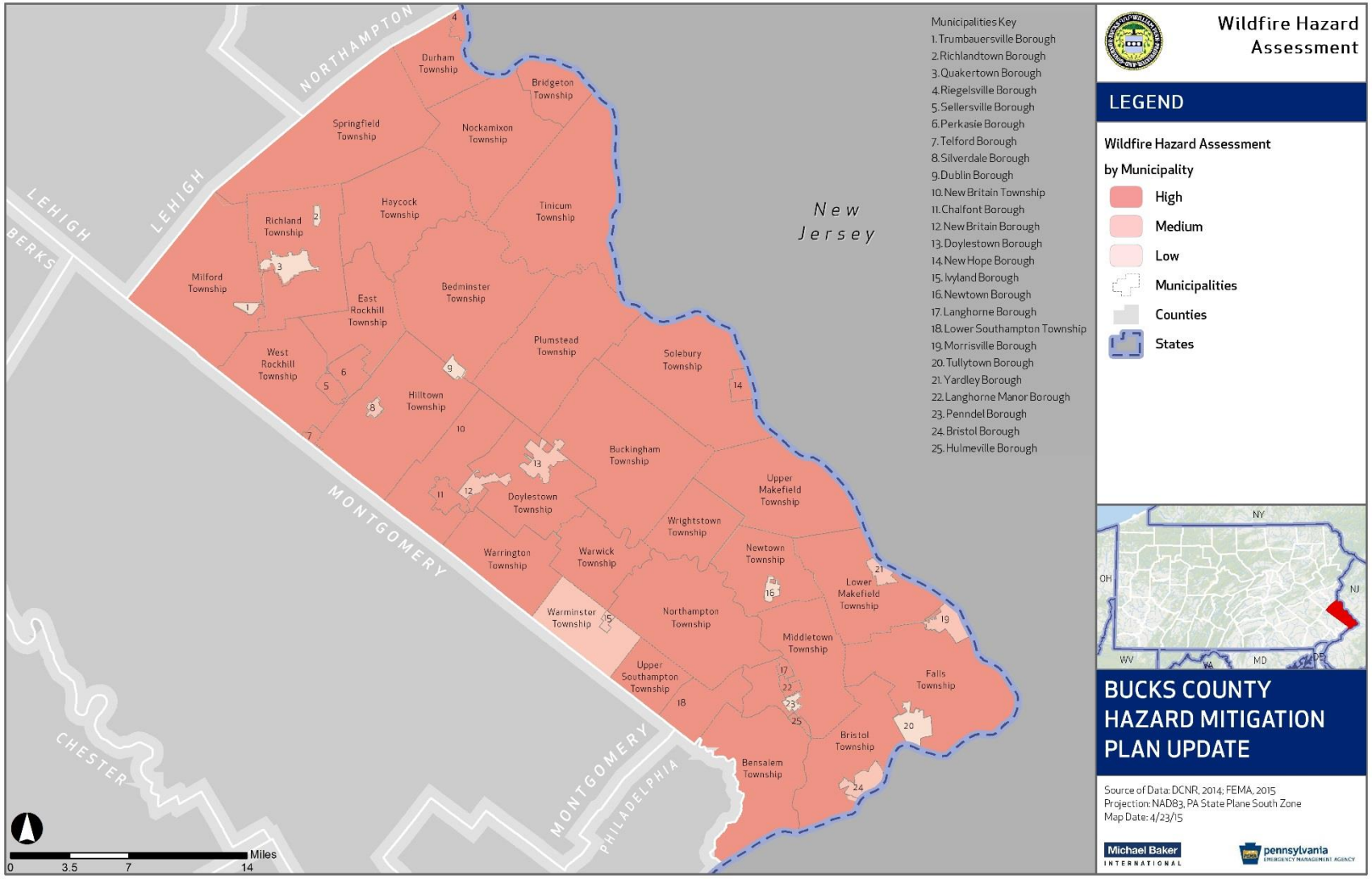
Table 4.3.13-3: Structures in Wildfire High Hazard Areas by Generalized Land Use Type

MUNICIPALITY	AGRIULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Hulmeville Borough	0	23	6	5	1	372	0	2	409
Ivyland Borough	0	0	0	0	0	0	0	0	0
Langhorne Borough	0	57	46	0	15	591	2	7	718
Langhorne Manor Borough	0	0	20	0	5	407	0	4	436
Lower Makefield Township	47	107	73	2	21	9587	18	27	9,882
Lower Southampton Township	0	329	59	121	62	6559	4	43	7,177
Middletown Township	38	397	283	50	71	12275	24	126	13,264
Milford Township	318	106	67	47	56	4029	21	83	4,727
Morrisville Borough	0	1	0	1	0	18	0	0	20
New Britain Borough	0	0	6	0	0	16	0	0	22
New Britain Township	97	118	40	22	65	3557	5	28	3,932
New Hope Borough	0	154	28	4	4	622	12	3	827
Newtown Borough	0	0	0	0	0	9	1	0	10
Newtown Township	51	147	105	40	56	3950	16	6	4,371
Nockamixon Township	177	156	25	21	22	2148	5	37	2,591
Northampton Township	121	226	112	94	87	11690	22	24	12,376
Penndel Borough	0	0	0	0	0	22	0	0	22
Perkasie Borough	0	108	96	29	21	2743	19	27	3,043
Plumstead Township	291	221	32	45	43	4341	15	44	5,032
Quakertown Borough	0	15	6	0	3	233	0	1	258
Richland Township	213	231	27	49	23	3985	40	53	4,621
Richlandtown Borough	0	1	0	0	0	19	0	0	20
Riegelsville Borough	3	27	14	0	3	463	6	14	530
Sellersville Borough	0	46	42	19	1	1178	3	18	1,307
Silverdale Borough	0	0	0	0	0	8	0	0	8
Solebury Township	236	154	65	11	48	3680	8	58	4,260
Springfield Township	369	60	42	14	26	3023	12	112	3,658
Telford Borough	0	11	38	19	0	559	1	5	633
Tinicum Township	148	92	39	9	141	2818	2	57	3,306
Trumbauersville Borough	0	0	1	1	0	43	0	0	45
Tullytown Borough	0	0	0	0	0	76	1	0	77

Table 4.3.13-3: Structures in Wildfire High Hazard Areas by Generalized Land Use Type

MUNICIPALITY	AGRIULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Upper Makefield Township	232	52	18	0	52	3109	4	42	3,509
Upper Southampton Township	0	262	75	59	15	4986	16	8	5,421
Warminster Township	0	0	0	0	0	0	0	0	0
Warrington Township	53	154	38	69	81	5156	5	12	5,568
Warwick Township	64	93	31	54	63	2924	10	19	3,258
West Rockhill Township	57	127	60	82	100	2159	29	47	2,661
Wrightstown Township	80	85	25	42	11	1483	3	9	1,738
Yardley Borough	0	1	0	0	0	16	0	0	17
TOTAL	**4,439**	**6,517**	**2,493**	**2,012**	**1,529**	**166,590**	**626**	**1,442**	**185,648**

Figure 4.3.13-2: Map showing wildfire hazard by municipality in Bucks County.



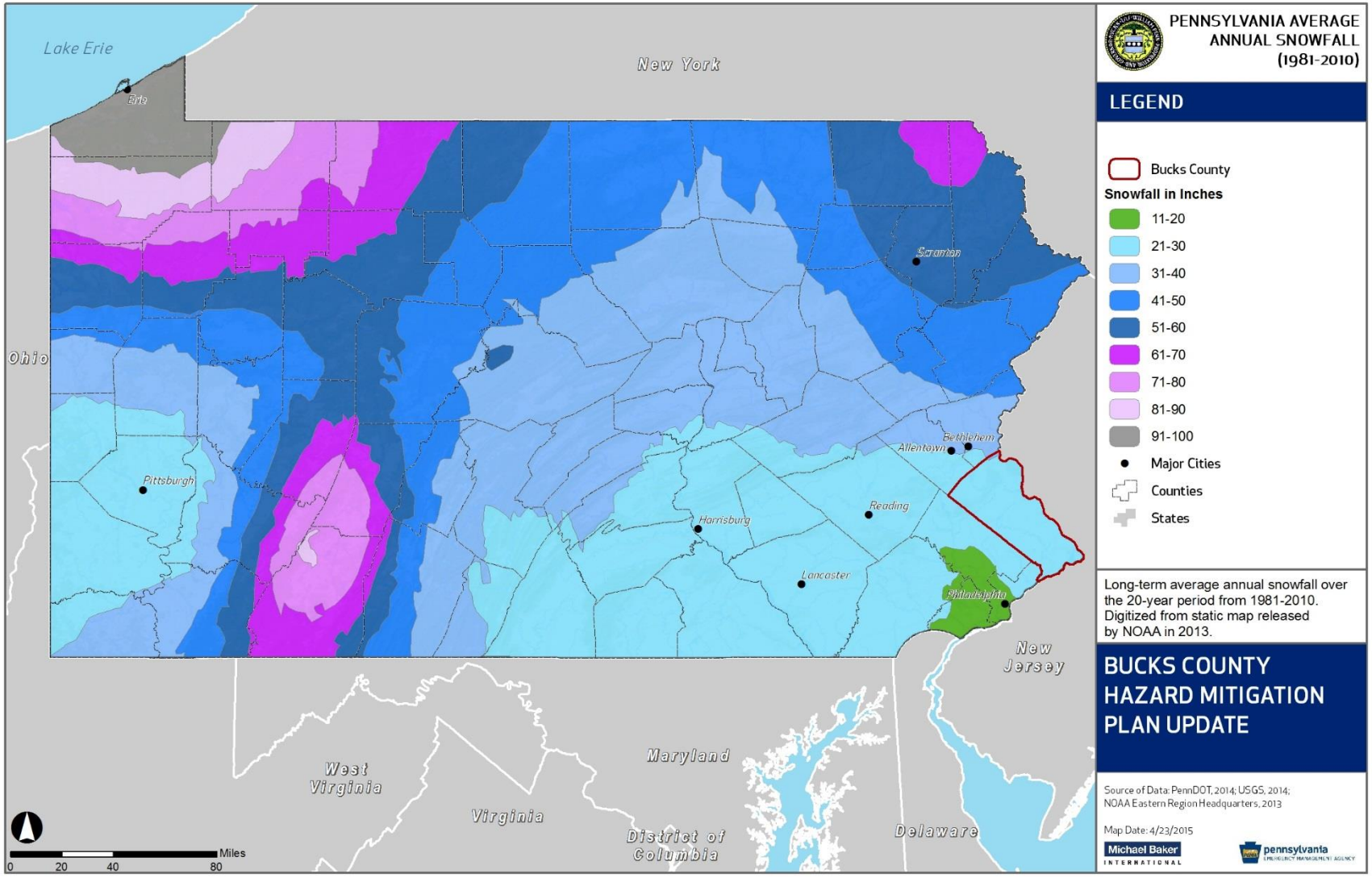
4.3.14. Winter Storm

4.3.14.1. Location and Extent

Winter storms are regional events. Every county in the Commonwealth, including Bucks, is subject to severe winter storms on an annual basis. In many cases, surrounding states, and even the larger northeaster U.S. region, are affected by severe winter storms.

As illustrated in Figure 4.3.14-1, from 1981-2010, annual snowfall in Bucks County averaged between of 21 to 30 inches of snow a year. This is a reduction in average annual snowfall in the northern part of the county from the previous thirty-year average annual snowfall observation where areas in the northern part of the county averaged between 30 and 40 inches of snowfall annually.

Figure 4.3.14-1: Mean Annual Snowfall for Pennsylvania and Bucks County.



4.3.14.2. Range of Magnitude

Winter storms begin as low-pressure systems that move through Pennsylvania either following the jet stream or developing as extra-tropical cyclonic weather systems over the Atlantic Ocean called Nor'easters. The effects of these storms can sometimes last for weeks, bringing several inches or even feet of snow, ice, and cold temperatures. Because winter storms are regular, annual occurrences in Pennsylvania, they are considered hazards only when they result in damage to specific structures and/or overwhelm local capabilities to handle disruptions to traffic, communications, electric power, or other utilities.

A winter storm can adversely affect roadways, utilities, business activities, and can cause frostbite or loss of life. These storms may include one or more of the following weather events:

- **Heavy Snowstorm:** Accumulations of four inches or more in a six-hour period, or six inches or more in a twelve-hour period.
- **Sleet Storm:** Significant accumulations of solid pellets which form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces posing hazards to pedestrians and motorists.
- **Ice Storm:** Significant accumulations of rain or drizzle freezing on objects (trees, power lines, roadways, etc.) as it strikes them, causing slippery surfaces and damage from the sheer weight of ice accumulation.
- **Blizzard:** Wind velocity of 35 miles per hour or more, temperatures below freezing, considerable blowing snow with visibility frequently below one-quarter mile prevailing over an extended period of time.
- **Severe Blizzard:** Wind velocity of 45 miles per hour, temperatures of 10 degrees Fahrenheit or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period time.

Any of the above events can result in the closing of major or secondary roads, particularly in rural locations, stranded motorists, transportation accidents, loss of utility services, and depletion of oil heating supplies. The weight of snow on building roofs can be great enough to compromise the structure and cause building collapse. The risk of building collapse is greater on older properties and ancillary builds, such as sheds, which may not be built to current building code standards. Environmental impacts often include damage to shrubbery and trees due to heavy snow loading, ice build-up and/or high winds which can break limbs or even bring down large trees. Gradual melting of snow and ice provides excellent groundwater recharge. However, high temperatures following a heavy snowfall can cause rapid surface water runoff and severe flooding.

Three of the seventeen Presidential Disaster and Emergency Declarations affecting Bucks have been in response to hazard events related to winter storms (see Table 4.2-1). Other reported winter storm events, including those associated with Disaster Declarations, are listed in Table 4.3.14-1.

Bucks County has experienced roof collapses, power failures, loss of communication networks, as well as stranded motorists requiring emergency transportation and temporary shelter as a result of these storms.

The worst case winter storm event in Bucks County occurred in on January 7, 1996. This blizzard led to an all-time record snowfall of 30.7 inches at Philadelphia International Airport; storm spotters in Perkasie reported snowfalls of 36 inches, and many locations in Southeastern Pennsylvania experienced snow totals of over 30 inches (Gelber, 2002). This record winter storm was followed on the 12th by another heavy snowfall. The compound impact of the two storms led to building and roof collapses throughout Eastern Pennsylvania. For example, in Quakertown, a woman was injured as the weight of snow collapsed four porch roofs on Juniper Street. The Atlas Roofing Company in Richland Township and the Atrium in Quakertown experienced significant structural damage as a result of the storms. Overall, across the County, Doylestown holds the record for most snowfall in one day of 22 inches, and for two days of 32 inches (NCDC, 2015).

4.3.14.3. Past Occurrence

The Commonwealth of Pennsylvania has a long history of severe winter weather. Bucks County experienced major winter storms in 1958, 1966, 1972, 1977, 1978, 1981, 1983, 1993, 1994, 1996, 2003, 2007, 2010, and 2014. There have been numerous other winter storms recorded every year; those that occurred after 2006 and were reported to the NCDC are listed in Table 4.3.14-1.

Table 4.3.14-1: Previous winter storm events impacting Bucks County since 2006 (NCDC, 2015). Events with the location "Multiple Counties" include Bucks County

LOCATION	DATE	TYPE
Bucks County & parts of New Jersey	01/14/2006	Winter Weather
Multiple Counties	02/12/2006	Winter Storm
Bucks, Berks, & Montgomery Counties	02/27/2006	Winter Weather
Multiple Counties	03/02/2006	Winter Weather
Bucks County & Philadelphia	01/18/2007	Winter Weather
Multiple Counties	01/19/2007	Winter Weather
Bucks, Montgomery, & Northampton Counties	01/29/2007	Winter Weather
Bucks, Chester, & Montgomery Counties	02/02/2007	Winter Weather
Multiple Counties	02/25/2007	Winter Storm
Bucks & Berks Counties	03/16/2007	Winter Storm
Multiple Counties	11/18/2007	Winter Weather
Multiple Counties	12/13/2007	Ice Storm
Bucks & Monroe Counties	12/15/2007	Winter Storm
Bucks & Lehigh Counties	01/17/2007	Winter Weather
Multiple Counties	02/01/2008	Winter Weather
Bucks, Chester, & Montgomery Counties	02/12/2008	Winter Storm
Multiple Counties	02/22/2008	Winter Storm
Bucks & Lehigh Counties	02/22/2008	Winter Weather
Bucks & Lehigh Counties	02/29/2008	Winter Weather
Multiple Counties	03/01/2008	Winter Weather
Bucks & Montgomery Counties	10/28/2008	Winter Weather
Multiple Counties	12/06/2008	Winter Weather
Bucks, Berks, & Montgomery Counties	12/16/2008	Winter Weather
Multiple Counties	12/21/2008	Winter Weather
Bucks & Montgomery Counties	12/23/2008	Winter Weather

Table 4.3.14-1: Previous winter storm events impacting Bucks County since 2006 (NCDC, 2015). Events with the location "Multiple Counties" include Bucks County

LOCATION	DATE	TYPE
Bucks & Montgomery Counties	01/06/2009	Winter Storm
Multiple Counties	01/10/2009	Winter Weather
Multiple Counties	01/19/2009	Winter Weather
Bucks & Montgomery Counties	01/27/2009	Winter Storm
Multiple Counties	02/02/2009	Winter Weather
Berks & Bucks Counties	02/01/2009	Winter Storm
Berks & Bucks Counties	02/01/2009	Winter Weather
Multiple Counties	12/31/2009	Winter Weather
Bucks & Berks Counties	12/31/2009	Winter Weather
Bucks, Monroe, & Montgomery Counties	01/28/2010	Winter Weather
Multiple Counties	02/05/2010	Winter Storm
Bucks & Delaware Counties	02/09/2010	Winter Storm
Multiple Counties	02/15/2010	Winter Weather
Multiple Counties	02/16/2010	Winter Weather
Bucks & Montgomery Counties	02/25/2010	Winter Storm
Multiple Counties	11/25/2010	Winter Weather
Multiple Counties	01/07/2011	Winter Weather
Bucks & Berks Counties	01/08/2011	Winter Weather
Multiple Counties	01/11/2011	Winter Storm
Bucks, Berks & Montgomery Counties	01/17/2011	Winter Storm
Bucks, Chester & Montgomery Counties	01/21/2011	Winter Weather
Bucks & Carbon Counties	01/26/2011	Heavy Snow
Bucks & Carbon Counties	01/26/2011	Winter Storm
Bucks & Carbon Counties	01/26/2011	Winter Weather
Multiple Counties	12/24/2012	Winter Weather
Multiple Counties	12/26/2012	Winter Weather
Multiple Counties	12/29/2012	Winter Weather
Multiple Counties	01/06/2013	Winter Weather
Montgomery, Chester, Berks, and Bucks Counties	01/16/2013	Winter Weather
Multiple Counties	01/21/2013	Winter Weather
Multiple Counties	01/25/2013	Winter Weather
Multiple Counties	01/28/2013	Winter Weather
Multiple Counties	02/08/2013	Winter Storm & Winter Weather
Multiple Counties	02/11/2013	Winter Weather
Multiple Counties	02/13/2013	Winter Weather
Monroe, Northampton, and Bucks Counties	03/07/2013	Winter Weather
Multiple Counties	03/16/2013	Winter Weather
Multiple Counties	03/18/2013	Winter Weather
Lower Bucks County	03/20/2013	Winter Weather
Chester, Montgomery, and Bucks Counties	03/21/2013	Winter Weather
Multiple Counties	03/25/2013	Winter Weather
Multiple Counties	11/26/2013	Winter Weather

Table 4.3.14-1: Previous winter storm events impacting Bucks County since 2006 (NCDC, 2015). Events with the location "Multiple Counties" include Bucks County

LOCATION	DATE	TYPE
Multiple Counties	12/08/2013	Winter Weather
Multiple Counties	12/10/2013	Winter Storm & Heavy Snow
Multiple Counties	12/14/2013	Winter Storm
Multiple Counties	12/17/2013	Winter Weather
Multiple Counties	12/26/2013	Winter Weather
Multiple Counties	01/02/2014	Heavy Snow
Multiple Counties	01/05/2014	Winter Weather
Multiple Counties	01/10/2014	Winter Weather
Multiple Counties	01/21/2014	Heavy Snow
Multiple Counties	01/25/2014	Winter Weather
Multiple Counties	02/03/2014	Heavy Snow
Multiple Counties	02/05/2014	Winter Storm
Multiple Counties	02/09/2014	Winter Weather
Multiple Counties	02/12/2014	Winter Storm
Multiple Counties	02/15/2014	Winter Weather
Multiple Counties	02/18/2014	Winter Weather
Multiple Counties	02/19/2014	Winter Weather
Multiple Counties	02/26/2014	Winter Weather
Bucks and Philadelphia Counties	03/03/2014	Winter Weather
Bucks and Chester Counties	03/17/2014	Winter Weather
Multiple Counties	11/13/2014	Winter Weather
Multiple Counties	11/26/2014	Winter Weather
Multiple Counties	12/02/2014	Winter Weather
Multiple Counties	12/09/2014	Winter Weather
Multiple Counties	12/11/2014	Winter Weather
Multiple Counties	01/03/2015	Winter Weather
Chester, Delaware, Montgomery, Philadelphia, and Bucks Counties	01/06/2015	Winter Weather
Multiple Counties	01/12/2015	Winter Weather
Multiple Counties	01/18/2015	Winter Weather
Multiple Counties	01/23/2015	Winter Storm & Winter Weather
Multiple Counties	01/26/2015	Winter Weather
Multiple Counties	02/01/2015	Winter Weather
Multiple Counties	02/09/2015	Winter Weather
Multiple Counties	02/14/2015	Winter Weather
Multiple Counties	02/16/2015	Winter Storm & Heavy Snow
Multiple Counties	02/21/2015	Winter Storm & Winter Weather

4.3.14.4. Future Occurrence

Winter storms are a regular, annual occurrence in Bucks County and should be considered highly likely as defined by the Risk Factor methodology probability criteria (see Table 4.4-1). Approximately thirty-five winter storm events occur across Pennsylvania and about five to ten in Bucks County annually. Table 4.3.14-2 shows the probability of receiving measureable snowfall by month in Bucks County. These probabilities are based on data collected over a minimum of 20 years. There is slight variation in the probabilities of snowfall in different locations in Bucks County.

Table 4.3.14-2: Probability of Measurable Snowfall in Bucks County by Snow Station Location (NCDC, 2011).

MONTH	PROBABILITY (%)			
	DOYLESTOWN	GEORGE SCHOOL	NESHAMINY FALLS	QUAKERTOWN 1E
January	92.8	93.9	90.3	93.8
February	94.2	92.6	87.9	96.7
March	80.9	81.2	66.7	88.5
April	26.7	36.8	14.7	22.6
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	4.9	7.3	3.9	4.8
November	29.7	39.3	14.9	36.8
December	80.6	84.8	73.9	83.3

4.3.14.5. Vulnerability Assessment

Winter storm events in Bucks County normally effect the entire County, though sometimes storms are focused on lower or upper Bucks County. Wintertime snow accumulations are expected and normal in Bucks County. Residents of the mountainous areas of the County may be more susceptible to isolation during storms if roads become impassible, especially when emergency medical assistance is required. In addition, the more rural areas of the County are susceptible to isolation caused by winter storms. Many areas are heavily wooded which make emergency response to these areas difficult when roadways are blocked by downed trees and wires.

People residing in structures lacking adequate equipment to protect against cold temperatures or significant snow and ice are more vulnerable to winter storm events. Even for communities that are prepared to respond to winter storms, severe events involving snow accumulations that exceed six or more inches in a twelve hour period can cause a large number of traffic accidents, strand motorists due to snow drifts, interrupt power supply and communications, and cause the failure of inadequately designed and/or maintained roof systems.

Similar to the discussion under tornadoes and wind storms, vulnerability of buildings to the effects of winter storms is dependent on the age of the building (and what building codes may have been in effect

at the time), type of construction, and condition of the structure (i.e., how well has the structure been maintained). Individual structure data was not available for this study so it was difficult to determine the exact number and types of structures within Bucks County that have heightened vulnerability to winter-storm snow loading.

Vulnerability to the effects of winter storms on buildings is also dependent on the age of the building type, construction material used, and condition of the structure. Table 4.3.14-3 shows that while a majority of structures in Bucks County were built since 1940, about 24,000 structures, approximately 10 percent of all structures in the county are over 70 years old. This is down from 12 percent, or about 26,000 structures, reported in the 2010 plan. Additional information on construction type and building codes enforced at time of construction would allow a more thorough assessment of the vulnerability of structures to winter storm impacts such as severe wind and heavy snow loading. Based on the available information, the three municipalities with the highest number of housing units – Bensalem Township, Bristol Township, and Middletown Township – have a lower percentage of units built prior to 1940 than the county total. A majority of the housing units in Newtown Borough, Langhorne Borough, Trumbauersville Borough, and Riegelsville Borough were built prior to 1940.

Table 4.3.14-3: Age of housing units in Bucks County (Census, 2013).

MUNICIPALITY	TOTAL HOUSING UNITS	NUMBER OF HOUSING UNITS BUILT PRIOR TO 1940	PERCENT OF TOTAL HOUSING UNITS
Bedminster Township	2,737	551	20.13%
Bensalem Township	26,020	979	3.76%
Bridgeton Township	610	231	37.87%
Bristol Borough	4,245	1,399	32.96%
Bristol Township	21,919	1,098	5.01%
Buckingham Township	7,242	630	8.70%
Chalfont Borough	1,569	179	11.41%
Doylestown Borough	4,137	1,225	29.61%
Doylestown Township	6,358	391	6.15%
Dublin Borough	908	98	10.79%
Durham Township	502	246	49.00%
East Rockhill Township	2,135	269	12.60%
Falls Township	13,844	467	3.37%
Haycock Township	902	200	22.17%
Hilltown Township	5,516	828	15.01%
Hulmeville Borough	379	139	36.68%
Ivyland Borough	354	98	27.68%
Langhorne Borough	618	330	53.40%
Langhorne Manor Borough	317	122	38.49%
Lower Makefield Township	12,090	431	3.56%
Lower Southampton Township	7,206	272	3.77%
Middletown Township	17,408	451	2.59%

Table 4.3.14-3: Age of housing units in Bucks County (Census, 2013).

MUNICIPALITY	TOTAL HOUSING UNITS	NUMBER OF HOUSING UNITS BUILT PRIOR TO 1940	PERCENT OF TOTAL HOUSING UNITS
Milford Township	3,581	723	20.19%
Morrisville Borough	3,940	1,203	30.53%
New Britain Borough	941	151	16.05%
New Britain Township	4,106	286	6.97%
New Hope Borough	1,359	314	23.11%
Newtown Borough	1,005	524	52.14%
Newtown Township	7,485	130	1.74%
Nockamixon Township	1,534	380	24.77%
Northampton Township	14,252	525	3.68%
Penndel Borough	1,021	167	16.36%
Perkasie Borough	3,395	882	25.98%
Plumstead Township	4,514	553	12.25%
Quakertown Borough	3,627	1,341	36.97%
Richland Township	5,020	576	11.47%
Richlandtown Borough	513	190	37.04%
Riegelsville Borough	396	257	64.90%
Sellersville Borough	1,737	541	31.15%
Silverdale Borough	374	83	22.19%
Solebury Township	3,995	688	17.22%
Springfield Township	2,076	576	27.75%
Telford Borough	1,042	109	10.46%
Tinicum Township	1,905	534	28.03%
Trumbauersville Borough	413	267	64.65%
Tullytown Borough	730	35	4.79%
Upper Makefield Township	3,170	236	7.44%
Upper Southampton Township	5,910	206	3.49%
Warminster Township	12,895	406	3.15%
Warrington Township	8,384	272	3.24%
Warwick Township	4,960	72	1.45%
West Rockhill Township	2,244	456	20.32%
Wrightstown Township	1,094	244	22.30%
Yardley Borough	1,177	409	34.75%
TOTAL	**245,811**	**23,970**	**9.75%**

Because of the frequency of winter storms, strategies have been developed to respond to these events. Snow removal and utility repair equipment is present to respond to typical events. The use of auxiliary heat and electricity supplies such as wood burning stoves, kerosene heaters, and gasoline power generators reduces the vulnerability of humans to extreme cold temperatures commonly associated with winter storms.

HUMAN-MADE HAZARDS

4.3.15. Structure Collapse (Infrastructure)

4.3.15.1. Location and Extent

Buildings and other engineered structures, including bridges, may collapse if their structural integrity is compromised, especially due to effects from other natural or human-made hazards. Older buildings or structures, structures that are not built to standard codes, or structures that have been weakened are more susceptible to be affected by these hazards.

When this hazard was identified in 2010, the Bucks County HMPT determined that the incidence of building collapse in the county is always linked to other hazards including Flooding, Urban Fire and Explosion, Winter Storms, Subsidence and Sinkhole. The HMPT felt that the impact of these hazards was sufficiently addressed in these associated hazard profiles. The HMPT members concern for Bucks County continues to be focused on bridge infrastructure collapse.

Bridges serve to connect both large and small roadways and communities throughout the County. Whether they span another roadway or a body of water, bridges are a crucial part of every transportation system. However, many of Pennsylvania's bridge structures are aging and in great need of repair. Inspection and maintenance are necessary to observe and mitigate the extent of the disrepair, especially on older structures.

4.3.15.2. Range of Magnitude

Disrepair can critically affect the integrity of the bridge structure. The level of disrepair depends on how much of the structure is damaged and how critical that portion of the structure is to the safety of drivers. Some structures only need deck replacement or a new superstructure, while others have substructure problems and should be entirely replaced. Bucks County has 12 closed bridges.

Structures are ranked by sufficiency rating and condition in order to classify the level of deterioration. Sufficiency ratings determine the overall capability of a bridge, help to determine funding for repair, and range from 0 to 100, worst to best. Condition ratings are determined for each of the following bridge components: bridge superstructure, bridge deck, and the bridge substructure or foundation. These ratings range from 0 to 9, worst to best. For a bridge to be structurally deficient, it must have one or more component with a condition rating equal to or less than 4 (The Patriot News, 2007).

The worst case scenario for a bridge structure collapse is for a high traffic bridge to collapse during rush hour causing many injuries and several deaths.

4.3.15.3. Past Occurrence

Structures can collapse due to deterioration of critical load bearing members, but external occurrences can also impact bridges. A notable past occurrence of a bridge collapse event was when the Geigel Hill Road Bridge was hit by a vehicle. The accident damaged one vertical member and broke another, so in 2008, the bridge was demolished (Historic Bridges, 2011).

4.3.15.4. Future Occurrence

Structures can collapse due to deterioration of bridge critical load bearing members, but as demonstrated in the Geigel Hill Road Bridge accident, external occurrences can also impact bridges. Pennsylvania has the third-largest number of bridges in the nation, but the most bridges classified as "structurally deficient" (PennDOT, 2015). Consequently, the entire state will see an increased focus on prevention of structure collapse. With almost 25 percent of its bridges marked as structurally deficient, Bucks County will continue to face deteriorating structures in the future if these are not addressed.

PennDOT is currently addressing two of projects to improve bridges in Bucks County. The projects began in April 2015 to rehabilitate the Chiquapin Road Bridge over Iron Works Creek in Northampton, a structurally deficient bridge, as well as to repair the Dark Hollow Road Bridge over Tohickon Creek in Tinicum Township (PennDOT, 2015a).

The future occurrence of structure collapse can be considered *possible* as defined by the Risk Factor methodology probability criteria (see Table 4.4-1).

4.3.15.5. Vulnerability Assessment

The most vulnerable areas of the County are those with the highest concentration of deteriorating structures. In Bucks County, the majority of bridges, about 80%, are owned and maintained by the state, the rest are owned and maintained by the County or local municipalities. Countywide, about 24% of all bridges are structurally deficient and another 24% are functionally obsolete – which is down from 30% structurally deficient and 25% functionally obsolete in 2011 (PennDOT, 2015). Table 4.3.15-1 shows the breakdown of closed, structurally deficient, and functionally obsolete bridges owned by the state and by the County or municipalities.

Table 4.3.15-1: Summary of bridge structure deterioration in Bucks County (PennDOT, 2015).

BRIDGE OWNER	TOTAL BRIDGE STRUCTURES	CLOSED BRIDGES	STRUCTURALLY DEFICIENT BRIDGE STRUCTURES	FUNCTIONALLY OBSOLETE STRUCTURES	% STRUCTURALLY DEFICIENT	% FUNCTIONALLY OBSOLETE
State Owned	659	1	118	182	17.91%	27.62%
County and Local Owned	174	11	81	27	46.55%	15.52%
TOTAL	**833**	**12**	**199**	**209**	**23.89%**	**25.09%**

Structurally deficient bridges are often still safe for vehicles to cross over, but will need work in the near future. In 2008, PennDOT initiated an Accelerated Bridge Program, in order to meet the structural problems head on. The eventual goal of the program will be to reduce the risk of structure collapse within the County by prioritizing bridge construction for the higher risk structures.

In Table 4.3.15-2, the numbers of structurally deficient and functionally obsolete structures owned by the state and by the County or local municipalities are given, broken down by municipality, along with the total number of bridges in each municipality.

Table 4.3.15-2: The state of bridge structure deterioration in Bucks County (PennDOT, 2015).

COMMUNITY	TOTAL BRIDGE STRUCTURES	TOTAL LOCAL & COUNTY OWNED	LOCAL & COUNTY FUNCTIONALLY OBSLOETE	LOCAL & COUNTY STRUCTURALLY DEFICIENT	TOTAL STATE OWNED	STATE FUNCTIONALLY OBSOLETE	STATE STRUCTURALLY DEFICIENT
Bedminster Township	32	8	1	4	24	4	3
Bensalem Township	57	4	0	4	53	24	7
Bridgeton Township	6	1	1	0	5	3	1
Bristol Borough	8	2	1	1	6	1	0
Bristol Township	20	4	0	3	16	4	1
Buckingham Township	23	9	1	3	14	3	4
Chalfont Borough	3	0	0	0	3	1	0
Doylestown Borough	21	0	0	0	21	7	4
Doylestown Township	35	11	1	1	24	4	4
Dublin Borough	0	0	0	0	0	0	0
Durham Township	8	1	1	0	7	2	2
East Rockhill Township	12	8	4	3	4	2	0
Falls Township	50	6	0	3	44	12	7
Haycock Township	15	3	0	2	12	3	2
Hilltown Township	43	10	2	6	33	8	9
Hulmeville Borough	2	0	0	0	2	1	0
Ivyland Borough	1	0	0	0	1	0	1
Langhorne Borough	0	0	0	0	0	0	0
Langhorne Manor Borough	4	0	0	0	4	2	0
Lower Makefield Township	22	0	0	0	22	4	3
Lower Southampton Township	10	2	0	1	8	2	0
Middletown Township	47	3	0	2	44	8	4
Milford Township	24	6	0	4	18	4	5
Morrisville Borough	7	0	0	0	7	1	3

Table 4.3.15-2: The state of bridge structure deterioration in Bucks County (PennDOT, 2015).

COMMUNITY	TOTAL BRIDGE STRUCTURES	TOTAL LOCAL & COUNTY OWNED	LOCAL & COUNTY FUNCTIONALLY OBSLOETE	LOCAL & COUNTY STRUCTURALLY DEFICIENT	TOTAL STATE OWNED	STATE FUNCTIONALLY OBSOLETE	STATE STRUCTURALLY DEFICIENT
New Britain Borough	6	1	1	0	5	2	1
New Britain Township	15	5	0	2	10	4	3
New Hope Borough	7	2	0	2	5	1	0
Newtown Borough	7	1	1	0	6	4	0
Newtown Township	8	1	0	0	7	2	1
Nockamixon Township	24	13	0	6	11	2	0
Northampton Township	23	5	0	2	18	3	3
Penndel Borough	0	0	0	0	0	0	0
Perkasie Borough	3	2	0	2	1	0	0
Plumstead Township	33	11	3	4	22	7	4
Quakertown Borough	8	4	1	1	4	0	1
Richland Township	25	5	0	2	20	5	8
Richlandtown Borough	1	0	0	0	1	0	0
Riegelsville Borough	1	0	0	0	1	1	0
Sellersville Borough	5	1	0	0	4	0	3
Silverdale Borough	2	0	0	0	2	0	0
Solebury Township	31	6	3	1	25	8	12
Springfield Township	22	4	2	1	18	8	4
Telford Borough	0	0	0	0	0	0	0
Tinicum Township	38	10	3	5	28	6	7
Trumbauersville Borough	0	0	0	0	0	0	0
Tullytown Borough	3	0	0	0	3	1	1
Upper Makefield Township	16	3	0	2	13	6	1
Upper Southampton Township	10	2	0	1	8	1	0
Warminster Township	10	1	0	1	9	3	1

Table 4.3.15-2: The state of bridge structure deterioration in Bucks County (PennDOT, 2015).

COMMUNITY	TOTAL BRIDGE STRUCTURES	TOTAL LOCAL & COUNTY OWNED	LOCAL & COUNTY FUNCTIONALLY OBSLOETE	LOCAL & COUNTY STRUCTURALLY DEFICIENT	TOTAL STATE OWNED	STATE FUNCTIONALLY OBSOLETE	STATE STRUCTURALLY DEFICIENT
Warrington Township	13	3	0	2	10	0	0
Warwick Township	22	9	0	5	13	3	2
West Rockhill Township	27	5	1	4	22	8	2
Wrightstown Township	13	0	0	0	13	4	3
Yardley Borough	10	2	0	1	8	3	1
TOTALS	833	174	27	81	659	182	118

4.3.16. Dam Failure

Due to sensitivity issues, the Dam Failure profile can be found in **Appendix G**.

4.3.17. Environmental Hazards

4.3.17.1. Location and Extent

HAZARDOUS MATERIALS RELEASES

Facilities that use, manufacture, or store hazardous materials in Pennsylvania must comply with both Title III of the federal Superfund Amendments and Reauthorization Act (SARA), also known as the Emergency Planning and Community Right-to-Know Act (EPCRA), and the Commonwealth's reporting requirements under the Hazardous Materials Emergency Planning and Response Act (1990-165), as amended. The community right-to-know reporting requirements keep communities abreast of the presence and release of chemicals at individual facilities. EPCRA was designed to ensure that state and local communities are prepared to respond to potential chemical accidents through Local Emergency Planning Committees (LEPCs). LEPCs are charged with developing emergency response plans for SARA Title III facilities; these plans cover the location and extent of hazardous materials, establish evacuation plans, response procedures, methods to reduce the magnitude of a materials release, and establish methods and schedules for training and exercises. There are 143 SARA Title III facilities in Bucks County (PEMA, 2011).

Because SARA Title III facilities are covered under their own unique planning process and are continually evaluated through the LEPC, this Hazard Mitigation Plan will focus on the Environmental Protection Agency (EPA)-identified hazardous materials sites. This dataset, publicly available at http://www.epa.gov/enviro/geo_data.html, includes a number of materials facilities including:

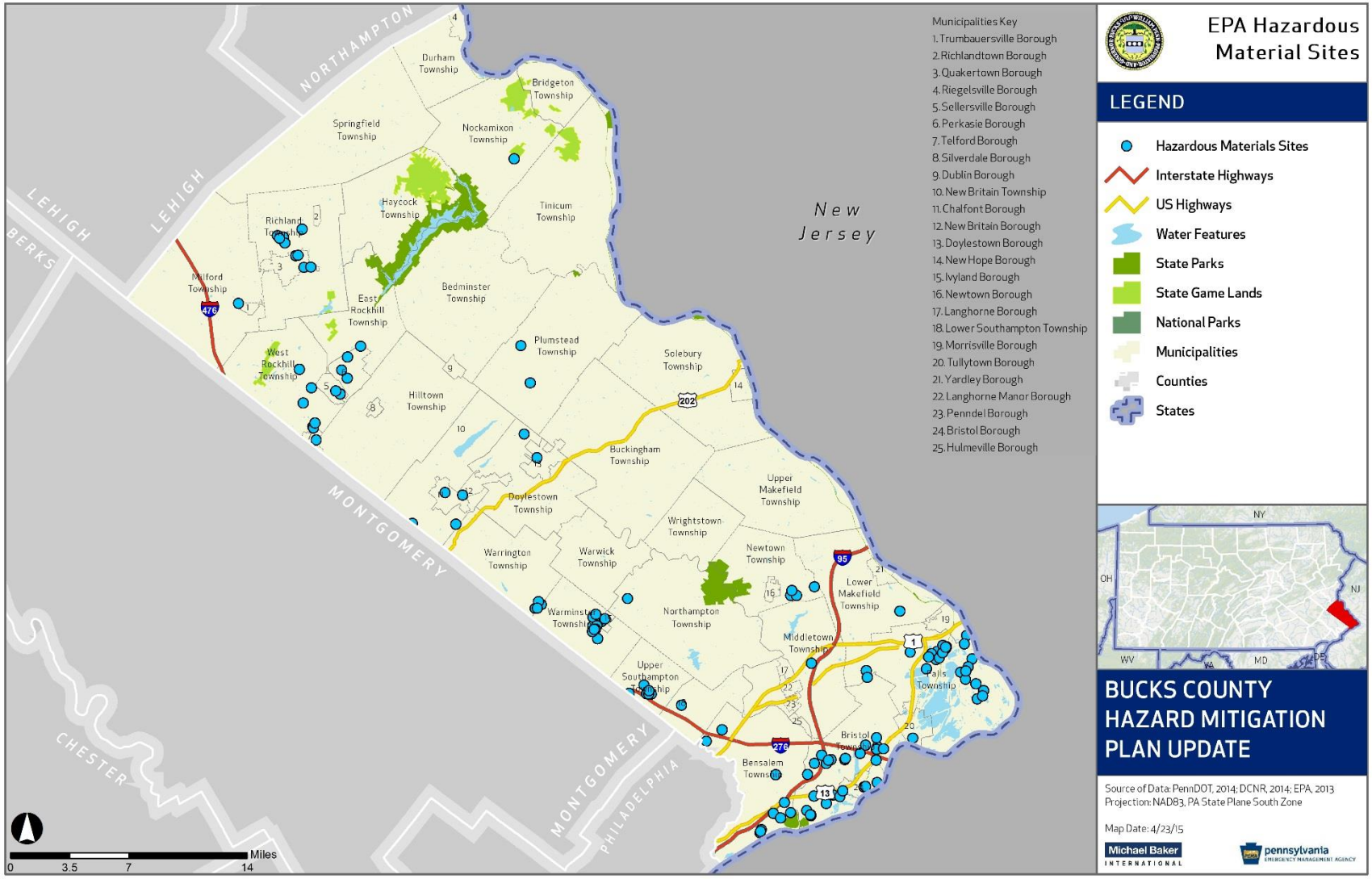
- Superfund National Priorities List (NPL) sites,
- RCRAInfo (EPA and state treatment, storage, disposal) facilities,
- Toxic Release Inventory System (TRI) sites,
- Integrated Compliance Information System (ICIS) and Permit Compliance System (PCS) - National Pollutant Discharge Elimination System (NPDES) Majors,
- RCRAInfo - Large Quantity Generators (LQG),
- Air Facility System (AFS) - Major discharges of air pollutants,
- RCRAInfo - Corrective Actions,
- Risk Management Plan,
- Section Seven Tracking System Sites (Pesticides), and
- ACRES - Brownfields Properties.

Using this dataset will help to provide a more complete picture of the risk of hazardous materials releases in the County. Bucks County has 128 EPA-identified hazardous materials sites throughout the County, shown in Figure 4.3.17-1. Fairless Hills has the most hazardous materials facilities, followed closely by Bristol Borough. Other municipalities and places hosting TRI sites include Bensalem, Chalfont, Danboro, Doylestown, Falls, Feasterville, Ivyland, Langhorne, Levittown, Morrisville, New Britain, Newton, Perkasie, Plumstead, Quakertown, Revere, Sellersville, Southampton, Telford, Trevose, Trumbauersville, Warminster, and Warrington.

Transportation of hazardous materials on highways involves tanker trucks or trailers. Unsurprisingly, large trucks are responsible for the greatest number of hazard material release incidents. Hazardous material releases from rail transport are also of concern due to collisions and derailments that result in large spills.

The development pattern in Bucks County is focused along the major transportation routes, including, for example, Interstates 476, 276, and 95. Interstate 276 is a six-lane highway in a portion of the County before it tapers down to a four-lane facility and, as it is the major east-west limited access facility through the County; it typically has large trucks transporting a variety of materials, including hazardous waste on it. Interstate 95 is the major north-south limited access facility through the County and also carries a significant amount of truck traffic. Although rail lines run through many of Bucks County's municipalities, most rail usage is by commuter trains. These major transportation routes are also shown on Figure 4.3.17-1.

Figure 4.3.17-1: Bucks County hazardous material facilities and major roadways.



4.3.17.2. Range of Magnitude

Hazardous material releases can contaminate air, water, and soils, possibly resulting in death and/or injuries. Dispersion can take place rapidly when transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events. Hazardous materials can include toxic chemicals, radioactive materials, infectious substances, and hazardous wastes. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas.

With a hazardous material release, whether accidental or intentional, there are several potentially exacerbating or mitigating circumstances that will affect its severity or impact. Mitigating conditions are precautionary measures taken in advance to reduce the impact of a release on the surrounding environment. Primary and secondary containment or shielding by sheltering-in-place protects people and property from the harmful effects of a hazardous material release. Exacerbating conditions, or characteristics that can enhance or magnify the effects of a hazardous material release, include:

- **Weather conditions:** affects how the hazard occurs and develops
- **Micro-meteorological effects of buildings and terrain:** alters dispersion of hazardous materials
- **Non-compliance with applicable codes (e.g. building or fire codes) and maintenance failures (e.g. fire protection and containment features):** can substantially increase the damage to the facility itself and to surrounding buildings.

Whether or not a hazardous materials site is contained in the SFHA is also a concern, as there could be larger-scale water contamination during a flood event should the flood compromise the production or storage of hazardous chemicals. Such a situation could be considered a worst case scenario for a hazardous materials release because it could swiftly move toxic chemicals throughout a water supply and across great distances.

The severity of a given incident is dependent not only on the circumstances described above, but also with the type of material released and the distance and related response time for emergency response teams. The areas within closest proximity to the releases are generally at greatest risk, yet depending on the agent, a release can travel great distances or remain present in the environment for a long period of time (e.g. centuries to millennia for radioactive materials), resulting in extensive impacts on people and the environment.

4.3.17.3. Past Occurrence

The EPA TRI records indicate that there have been a total of 97,175,892 pounds of chemicals released from fixed sites in Bucks County in 2013 (EPA, 2014). Beyond the TRI records, the Bucks County EMA has records of 228 hazardous materials incidents both in transit and at a fixed site location between 2002 and 2009. These events, including the type of spill, are shown in Table 4.3.17-1. The Pennsylvania Emergency Incident Reporting System (PEIRS), which was previously used to report these incidents, is no longer in use and reports stop at 2009. However, as a majority of hazardous material release incidents occur in

transit, the Pipeline and Hazardous Materials Safety Administration (PHMSA) of the U.S. Department of Transportation tracks hazardous materials releases as a result of transportation accidents. Table 4.3.17-2 lists the reported incidents from PHMSA in Bucks County as of June 2015.

Table 4.3.17-1: Previous hazardous materials incidents in Bucks County between 2002 and 2009 (PIERS, 2002-2009).

INCIDENT TYPE	2002	2003	2004	2005	2006	2007	2008	2009	TOTAL INCIDENTS
ASPHALT SPILL	1	0	0	1	4	0	0	0	**6**
BIO-HAZARDOUS WASTE	1	0	0	0	2	0	0	0	**3**
CHEMICAL RELEASE	4	2	4	1	2	1	1	0	**15**
CHEMICAL SPILL	2	6	4	2	7	4	2	2	**29**
DIESEL FUEL SPILL	7	3	4	7	6	2	2	0	**31**
FISH KILL	0	0	1	0	0	0	1	0	**2**
GASOLINE SPILL	1	2	4	4	0	1	0	1	**13**
HAZARDOUS WASTE MATERIALS	2	0	0	0	0	0	1	2	**5**
HEATING OIL SPILL	7	8	17	9	9	6	4	2	**62**
HYDRAULIC OIL SPILL	1	1	1	1	0	2	0	0	**6**
KEROSENE SPILL	1	0	0	0	0	1	1	0	**3**
MISCELLANEOUS OILS	0	0	1	4	1	1	2	1	**10**
NATURAL GAS RELEASE	1	0	0	2	0	1	1	3	**8**
OIL SHEEN	0	0	3	4	1	0	1	1	**10**
OIL SPILL	0	5	2	2	8	2	2	1	**22**
PESTICIDE SPILL	1	1	0	0	0	0	0	0	**2**
PROPANE RELEASE	0	0	0	0	0	0	1	0	**1**
Total	**29**	**28**	**41**	**37**	**40**	**21**	**19**	**13**	**228**

Table 4.3.17-2: Previous Hazardous Materials Incidents in Transit in Bucks County between 2010-Present (as of June 2015) (PHMSA, 2015).

MATERIAL RELEASED	2010	2011	2012	2013	2014	2015	TOTAL INCIDENTS
COMBUSTIBLE LIQUID	1			1			**2**
CORROSIVE MATERIAL	6	7	6	10	13	2	**44**
FLAMMABLE - COMBUSTIBLE LIQUID	17	19	7	29	48	6	**126**
FLAMMABLE GAS			3	1	1	1	**6**
MISCELLANEOUS HAZARDOUS MATERIAL	2	4		3	4		**13**
NONFLAMMABLE COMPRESSED GAS		1			2	1	**4**
ORGANIC PEROXIDE		1					**1**
OXIDIZER		2	2	5	3		**12**
POISONOUS MATERIALS	2	1	1		2		**6**
Total	**28**	**35**	**19**	**49**	**73**	**10**	**214**

4.3.17.4. Future Occurrence

While many incidents involving hazardous materials releases have occurred in Bucks County in the past, they are generally difficult to predict. Any occurrence is largely dependent upon the accidental or intentional actions of a person or group. At the same time, though, the County cites increases in truck-based shipping as a potential source for expanding numbers of hazardous materials releases in Bucks County. The future occurrence of environmental hazards can be considered *highly likely* as defined by the Risk Factor methodology probability criteria (see Table 4.4-1).

4.3.17.5. Vulnerability Assessment

Jurisdictions that are home to one or more hazardous materials facilities should be considered vulnerable to hazardous materials releases from fixed facilities. Table 4.3.17-3 illustrates the number of hazardous material sites by municipality in Bucks County. Falls Township has the highest concentration of hazardous materials facilities with 25, but Bristol Township follows closely behind with a total of 24 facilities. Bensalem and Warminster Townships follow with seven facilities each. The jurisdictions without TRI facilities have much lower relative vulnerability to fixed hazardous materials incidents.

Populations in and around the communities that are home to TRI sites are more vulnerable to facility releases, particularly those within 1.5 miles of the facility. Table 4.3.17-3 also shows the number of addressable structures and critical facilities within 1.5 miles of hazardous materials sites. Bristol Township has the highest number of addressable structures within 1.5 miles with 18,910 and the highest number of critical facilities vulnerable to fixed hazardous materials incidents with 56. Bensalem, Falls, and Warminster Townships each have 35 or more structures each that are vulnerable to fixed hazardous materials releases. Other municipalities that are home to critical facilities vulnerable to fixed hazardous materials incidents include Lower Southampton, Lower Makefield, and Middletown Townships. Jurisdictions without fixed hazardous materials facilities in general do not have vulnerable structures or critical facilities. However, it is important to note that even if a jurisdiction houses no hazardous materials sites, it may be vulnerable to a release event occurring in an adjacent municipality. This is the case particularly for East Rockhill Township, Milford Township, Newtown Borough, Langhorne Borough, and several others.

Table 4.3.17-3: Hazardous Material Sites by Municipality (EPA, 2013)

MUNICIPALITY	NUMBER OF HAZARDOUS MATERIAL FACILITIES	TOTAL ADDRESSABLE STRUCTURES WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES	TOTAL CRITICAL FACILITIES WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES
Bedminster Township	0	202	0
Bensalem Township	10	12,017	44
Bridgeton Township	0	0	0
Bristol Borough	3	2,231	21
Bristol Township	24	18,910	56
Buckingham Township	0	279	1

Table 4.3.17-3: Hazardous Material Sites by Municipality (EPA, 2013)

MUNICIPALITY	NUMBER OF HAZARDOUS MATERIAL FACILITIES	TOTAL ADDRESSABLE STRUCTURES WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES	TOTAL CRITICAL FACILITIES WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES
Chalfont Borough	1	1,333	11
Doylestown Borough	1	2,810	20
Doylestown Township	1	2,339	9
Dublin Borough	0	0	0
Durham Township	0	0	0
East Rockhill Township	0	1,384	9
Falls Township	25	10,546	30
Haycock Township	0	0	0
Hilltown Township	4	2,379	2
Hulmeville Borough	0	84	0
Ivyland Borough	2	234	4
Langhorne Borough	0	661	8
Langhorne Manor Borough	0	254	4
Lower Makefield Township	3	5,350	20
Lower Southampton Township	1	5,465	24
Middletown Township	1	5,218	24
Milford Township	0	1,270	5
Morrisville Borough	1	3,224	13
New Britain Borough	1	631	7
New Britain Township	2	3,133	14
New Hope Borough	0	0	0
Newtown Borough	0	1,005	7
Newtown Township	4	1,735	17
Nockamixon Township	1	656	1
Northampton Township	1	1,149	1
Penndel Borough	0	2	0
Perkasie Borough	4	3,043	13
Plumstead Township	2	2,704	14
Quakertown Borough	4	2,908	20
Richland Township	5	3,234	10
Richlandtown Borough	0	379	3
Riegelsville Borough	0	0	0
Sellersville Borough	2	1,307	9
Silverdale Borough	0	7	1

Table 4.3.17-3: Hazardous Material Sites by Municipality (EPA, 2013)			
MUNICIPALITY	NUMBER OF HAZARDOUS MATERIAL FACILITIES	TOTAL ADDRESSABLE STRUCTURES WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES	TOTAL CRITICAL FACILITIES WITHIN 1.5 MILE BUFFER OF HAZARDOUS MATERIAL SITES
Solebury Township	0	0	0
Springfield Township	0	0	0
Telford Borough	3	633	2
Tinicum Township	0	121	0
Trumbauersville Borough	1	432	4
Tullytown Borough	1	759	7
Upper Makefield Township	0	0	0
Upper Southampton Township	7	4,446	18
Warminster Township	10	9,106	35
Warrington Township	4	2,638	11
Warwick Township	0	387	0
West Rockhill Township	4	1,730	12
Wrightstown Township	0	0	0
Yardley Borough	0	39	2
TOTAL	133	118,374	513

4.3.18. Terrorism

4.3.18.1. Location and Extent

The term "terrorism" refers to intentional, criminal, malicious acts, but the functional definition of terrorism can be interpreted in many ways. Officially, terrorism is defined in the Code of Federal Regulations as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" (28 CFR §0.85).

The Federal Bureau of Investigation (FBI) characterizes terrorism as either domestic or international, depending on the origin, base, and objectives of the terrorist organization. However, the origin of the terrorist or person causing the hazard is far less relevant to mitigation planning than the hazard itself and its consequences.

Terrorism refers to the use of weapons of mass destruction (WMD), including, biological, chemical, nuclear, and radiological weapons; arson, incendiary, explosive, and armed attacks; industrial sabotage and intentional hazardous materials releases; and "cyber-terrorism." Within these general categories, however, there are many variations, including:

- Agriterrorism,

- Arson/incendiary attack,
- Armed attack (including active shooter attacks),
- Biological agent,
- Chemical agent,
- Cyberterrorism,
- Conventional bomb,
- Intentional hazardous materials or radiological releases, or
- Nuclear bombs.

The HMPT identified active shooter attacks as being relevant to Bucks County. The probability of terrorism cannot be quantified with as great a level of accuracy as that of many natural hazards. Furthermore, these incidents generally occur at a specific location, such as a government building, rather than encompassing an area such as a floodplain. This type of attack could take place at any facility or public or private location in the County. Thus, planning and mitigation strategies should be training specific to ensure the public is aware of what to do during an attack, and responders know how to best respond during an attack.

4.3.18.2. Range of Magnitude

The severity of terrorist incidents depends upon the type of method used, the proximity of the attack to people, animals, or other assets, and the duration of exposure to the incident or to a device (in the case of chemical, radiological, or biological agent attacks). A worst-case scenario of an active shooter incident would be if an active shooter attacked a public event in Bucks County. There would be potential casualties and fatalities across all demographics.

4.3.18.3. Past Occurrence

There has been a high consciousness of terrorist activity in the press with few catastrophic events. The most significant terrorist attack on US soil occurred on September 11, 2001; Flight 93, the fourth hijacked aircraft in the attack, crashed in Somerset County, Pennsylvania. There has been no reported terrorist incidents in Bucks County in the past.

4.3.18.4. Future Occurrence

An important consideration in estimating the likelihood of a terrorist incident is the existence of facilities, landmarks, or other buildings of national importance. Bucks County does not contain sites with national symbolism (e.g., the Statue of Liberty); however, terrorism takes many forms, and terrorists have a wide range of local, state, and national political interests or personal agendas, making the identification of potential targets especially difficult. The likelihood of a terrorist attack is considered *possible,* as defined by the Risk Factor Methodology (see Table 4.4-1).

4.3.18.5. Vulnerability Assessment

Since the probability of terrorism occurring cannot be quantified in the same way as that of many natural hazards, it is not possible to assess vulnerability in terms of likelihood of occurrence. Instead, vulnerability is assessed in terms of specific assets. By identifying potentially at-risk terrorist targets in Pennsylvania, planning efforts can be put in place to reduce the risk of attack. FEMA's Integrating Manmade Hazards into Mitigation Planning (2003) encourages site-specific assessments that should be based on the relative

importance of a particular site to the surrounding community or population, threats that are known to exist, and vulnerabilities including:

- Inherent vulnerability:
    - Visibility – How aware is the public of the existence of the facility?
    - Utility – How valuable might the place be in meeting the objectives of a potential terrorist?
    - Accessibility – How accessible is the place to the public?
    - Asset mobility – is the asset's location fixed or mobile?
    - Presence of hazardous materials – Are flammable, explosive, biological, chemical and/or radiological materials present on site? If so, are they well secured?
    - Potential for collateral damage – What are the potential consequences for the surrounding area if the asset is attacked or damaged?
    - Occupancy – What is the potential for mass casualties based on the maximum number of individuals on site at a given time?
    - Tactical vulnerability:
- Site Perimeter
    - Site planning and Landscape Design – Is the facility designed with security in mind – both site-specific and with regard to adjacent land uses?
    - Parking Security – Are vehicle access and parking managed in a way that separates vehicles and structures?
- Building Envelope
    - Structural Engineering – Is the building's envelope designed to be blast-resistant? Does it provide collective protection against chemical, biological, and radiological contaminants?
- Facility Interior
    - Architectural and Interior Space Planning – Does security screening cover all public and private areas?
    - Mechanical Engineering – Are utilities and Heating, Ventilating and Air Conditioning (HVAC) systems protected and/or backed up with redundant systems?
    - Electrical Engineering – Are emergency power and telecommunications available? Are alarm systems operational? Is lightning sufficient?
    - Fire Protection Engineering – Are the building's water supply and fire suppression systems adequate, code-compliant, and protected? Are on-site personnel trained appropriately? Are local first responders aware of the nature of the operations at the facility?
    - Electronic and Organized Security – Are systems and personnel in place to monitor and protect the facility?

4.3.19. Transportation Accident

4.3.19.1. Location and Extent

For the purposes of this plan, transportation accidents are defined as incidents involving highway, air, and rail travel. Within Bucks County, there are a total of 3,507 linear miles of roads, including 2,500 miles of local municipal road, 20 miles of turnpike, and approximately 965 miles of state roads. Bucks County is crossed by several major road networks, and transportation accidents involving those networks can have impacts on secondary roads. Major roads in the county include the I-476 Northeast Extension, the Pennsylvania Turnpike, I-95, and limited access highways including Route 1 and Route 202. Figure 4.3.19-1 shows the road network in Bucks County and the average annual daily traffic that can be expected on those roads.

In addition, there are several other important components to the county transportation infrastructure, as shown in Figure 4.3.19-2. These include numerous airports, heliports, and railroad lines.

Figure 4.3.19-1: Average Annual Daily Traffic in Bucks County

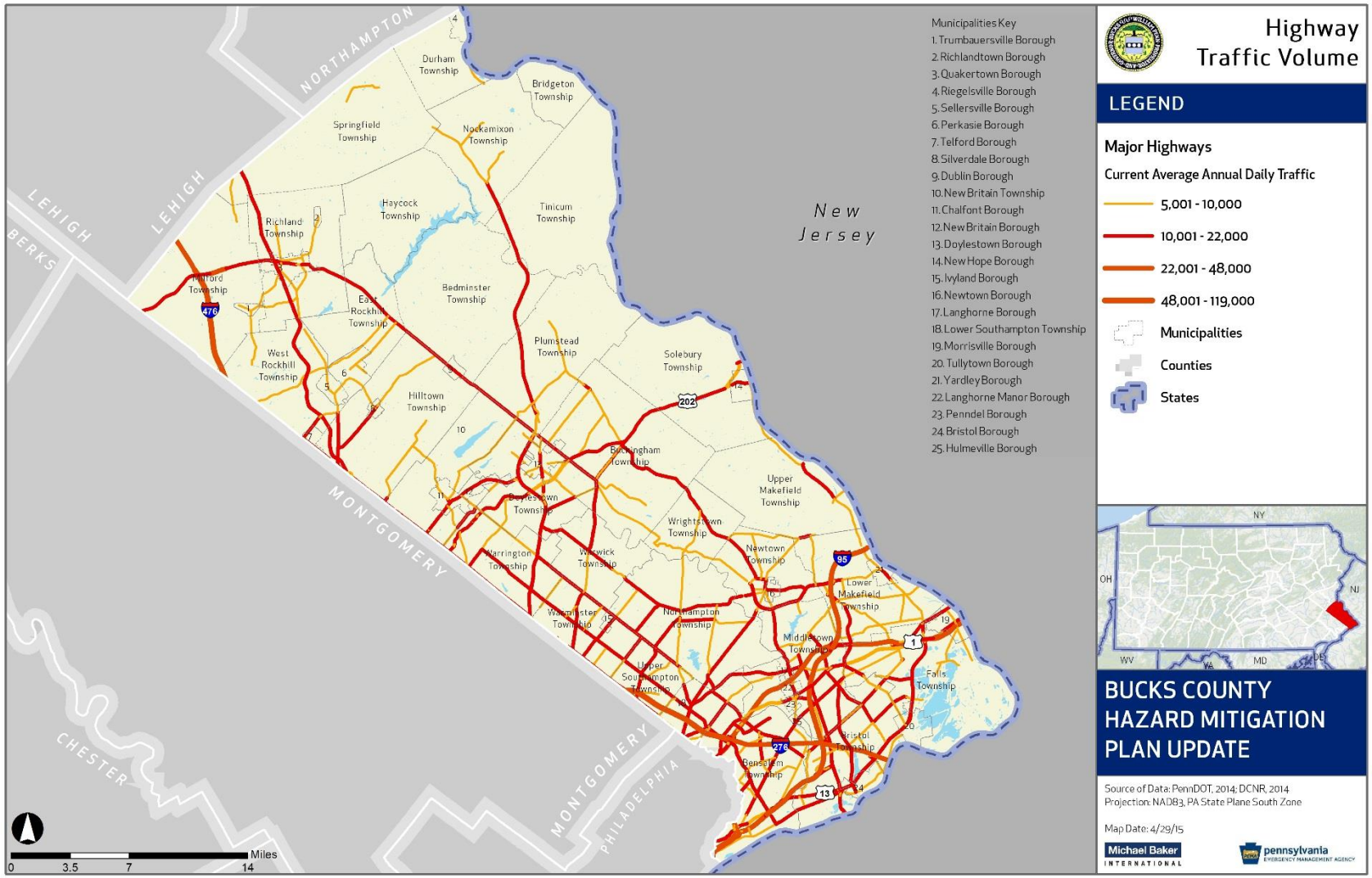


Figure 4.3.19-2: Transportation Infrastructure in Bucks County

Major transportation corridors are more vulnerable to transportation accidents, especially in areas where the daily traffic count may be between 48,001 and 119,000. A large number of secondary roads means that the population is in conflict with vehicle traffic.

4.3.19.2. Range of Magnitude

At a minimum, transportation accidents can result in damage to the vehicles and minor injuries to passengers and drivers. At worst, significant transportation accidents can result in death or serious injury or extensive property loss or damage coupled with business interruptions and hours of congestion. Road and railway accidents in particular have the potential to result in hazardous materials releases if the vehicle involved in an accident is hauling hazardous materials. The expected impacts of transportation accidents are amplified by the fact that there is often little warning of accidents.

The worst case scenario for a transportation accident impacting Bucks County would be a road accident which results in a hazardous material spill leading to immediate health hazard to the university population and requiring an evacuation of campus.

4.3.19.3. Past Occurrence

The most common transportation accidents in the County are highway accidents involving motor vehicles. The County's most serious road transportation concerns involve the Pennsylvania Turnpike and I-95. These routes have the highest annual average traffic counts in the county. Additionally, there is a temporal aspect to highway transportation accidents; in the spring and early summer, when construction and narrowed lanes are commonplace, the incidence of large-scale transportation accidents increases. On a smaller time scale, rush hour periods will see much higher volume of traffic than other times of the day depending on the location.

Overall, though, over the five-year period from 2010-2014, total crashes have remained largely the same. Table 4.3.19-1 summarizes the overall vehicular crash data from 2010-2014 for Bucks County. The data was gathered through the PennDOT Crash Statistics Reports.

Table 4.3.19-1: Total number of crashes, traffic deaths, and pedestrian deaths for Bucks County from 2010-2014 (PennDOT, 2010).

YEAR	TOTAL CRASHES	TOTAL TRAFFIC DEATHS	TOTAL PEDESTRIAN DEATHS
2010	6,094	45	8
2011	6,174	61	10
2012	5,900	65	10
2013	5,891	44	6
2014	5,779	44	8

There do not appear to be comparable records available of rail or air traffic accidents that have affected Bucks County.

4.3.19.4. Future Occurrence

Bucks County has experienced up to 5% population growth over the past decade, which could indicate that traffic volumes have risen accordingly. New residents have limited knowledge of detour routes and alternate routes around accidents, contributing to the possibility of accident-related congestion. The

Continued or elevated numbers of tractor-trailers on the County's road system could also contribute to incidences of transportation accidents. While air and rail-related transportation accidents are not as likely to impact the County because of their lower frequency, it is possible that highway accidents may increase slightly without proper mitigation strategies in place.

Overall, the probability of future transportation accidents in Bucks County can be considered *likely* according to the Risk Factor Methodology (see Table 4.4-1).

4.3.19.5. Vulnerability Assessment

A transportation-related incident can occur on any stretch of road in Bucks County. However, severe accidents are more likely on the County's highways, which experience heavier traffic volumes including heavy freight vehicles. The combination of high traffic volume, severe winter weather in the County and large numbers of hazardous materials haulers increase the chances of traffic accidents occurring.

Because of the widespread transportation network in Bucks County, a large number of structures are exposed to the threat of transportation accidents. Table 4.3.19-2 shows the structures in hazard zone for roads, railroads, and airports in Bucks County.

Table 4.3.19-3 lists structures by land use in the road accident zone, Table 4.3.19-4 structures in the rail accident zone, and Table 4.3.19-5 the air accident zone.

In addition to the airports and heliports shown in Figure 4.3.19-2 and included in the analysis in Table 4.3.19-5, there may be additional airports and heliports in New Jersey that the municipalities along the border could be vulnerable to. While the locations of these facilities were not available for this analysis, these municipalities should be aware that they may have additional structures or critical facilities that are vulnerable to accidents from these facilities.

Table 4.3.19-2: Transportation Accident Vulnerability

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN ROAD ZONE	PERCENT STRUCTURES	TOTAL CFS	CFS IN ROAD ZONE	PERCENT CFS	STRUCTURES IN RAIL ZONE	PERCENT STRUCTURES	CFS IN RAIL ZONE	PERCENT CFS	STRUCTURES IN AIR ZONE	PERCENT STRUCTURES	CFS IN AIR ZONE	PERCENT CFS
Bedminster Township	3,380	0	0	9	0	0	0	0	0	0	3,380	100	9	100
Bensalem Township	15,196	8,696	57.23	59	29	49.15	5,438	35.79	20	33.9	15,196	100	59	100
Bridgeton Township	995	0	0	3	0	0	0	0	0	0	995	100	3	100
Bristol Borough	2,231	1,147	51.41	20	9	45	2,084	93.41	19	95	1,821	81.62	16	80
Bristol Township	19,210	9,089	47.31	57	26	45.61	7,588	39.5	26	45.6	19,210	100	57	100
Buckingham Township	7,607	1,362	17.9	19	9	47.37	1,132	14.88	2	10.5	7,607	100	19	100
Chalfont Borough	1,333	0	0	11	0	0	971	72.84	11	100	1,333	100	11	100
Doylestown Borough	2,810	503	17.9	20	3	15	1,576	56.09	13	65	2,810	100	20	100
Doylestown Township	5,475	1,306	23.85	21	3	14.29	1,058	19.32	5	23.8	5,475	100	21	100
Dublin Borough	541	0	0	6	0	0	0	0	0	0	541	100	6	100
Durham Township	967	0	0	1	0	0	0	0	0	0	967	100	1	100
East Rockhill Township	2,520	0	0	12	0	0	540	21.43	5	41.7	2520	100	12	100
Falls Township	11,506	5,444	47.31	30	18	60	3,979	34.58	10	33.3	11,506	100	30	100
Haycock Township	1,783	0	0	2	0	0	23	1.29	0	0	1,783	100	2	100
Hilltown Township	6,027	0	0	10	0	0	316	5.24	0	0	6,027	100	10	100
Hulmeville Borough	409	123	30.07	3	0	0	0	0	0	0	409	100	3	100
Ivyland Borough	234	0	0	4	0	0	234	100	4	100	234	100	4	100
Langhorne Borough	718	346	48.19	8	7	87.5	376	52.37	1	12.5	718	100	8	100
Langhorne Manor Borough	436	436	100	6	6	100	281	64.45	6	100	436	100	6	100
Lower Makefield Township	9,883	1,954	19.77	26	6	23.08	1,750	17.71	8	30.8	9,623	97.37	26	100
Lower Southampton Township	7,181	1,769	24.63	28	7	25	2,939	40.93	8	28.6	7,181	100	28	100
Middletown Township	13,318	5,947	44.65	41	22	53.66	4,433	33.29	17	41.5	13,318	100	41	100
Milford Township	4,745	877	18.48	13	3	23.08	0	0	0	0	4,745	100	13	100

Table 4.3.19-2: Transportation Accident Vulnerability

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN ROAD ZONE	PERCENT STRUCTURES	TOTAL CFS	CFS IN ROAD ZONE	PERCENT CFS	STRUCTURES IN RAIL ZONE	PERCENT STRUCTURES	CFS IN RAIL ZONE	PERCENT CFS	STRUCTURES IN AIR ZONE	PERCENT STRUCTURES	CFS IN AIR ZONE	PERCENT CFS
Morrisville Borough	3,358	1,906	56.76	13	8	61.54	2,048	60.99	8	61.5	3,358	100	13	100
New Britain Borough	979	5	0.51	10	0	0	923	94.28	9	90	979	100	10	100
New Britain Township	3,954	230	5.82	16	0	0	646	16.34	2	12.5	3,954	100	16	100
New Hope Borough	827	227	27.45	8	5	62.5	759	91.78	8	100	827	100	8	100
Newtown Borough	1,005	0	0	7	0	0	920	91.54	7	100	1,005	100	7	100
Newtown Township	4,376	0	0	31	0	0	502	11.47	7	22.6	4,376	100	31	100
Nockamixon Township	2,591	0	0	7	0	0	0	0	0	0	2,591	100	7	100
Northampton Township	12,376	0	0	28	0	0	4,188	33.84	6	21.4	12,376	100	28	100
Penndel Borough	763	723	94.76	5	5	100	594	77.85	6	120	763	100	5	100
Perkasie Borough	3,043	0	0	13	0	0	1,843	60.57	10	76.9	3,043	100	13	100
Plumstead Township	5,032	0	0	16	0	0	0	0	0	0	5,032	100	16	100
Quakertown Borough	2,929	0	0	20	0	0	1612	55.04	9	45	2,929	100	20	100
Richland Township	4,633	0	0	11	0	0	1464	31.6	5	45.5	4,633	100	11	100
Richlandtown Borough	379	0	0	3	0	0	0	0	0	0	379	100	3	100
Riegelsville Borough	530	0	0	3	0	0	0	0	0	0	530	100	3	100
Sellersville Borough	1,307	0	0	9	0	0	1,146	87.68	9	100	1,307	100	9	100
Silverdale Borough	341	0	0	3	0	0	2	0.59	0	0	341	100	3	100
Solebury Township	4,260	991	23.26	12	0	0	539	12.65	0	0	4,260	100	12	100
Springfield Township	3,661	0	0	8	0	0	227	6.2	0	0	3,661	100	8	100
Telford Borough	633	0	0	2	0	0	569	89.89	2	100	633	100	2	100
Tinicum Township	3,306	0	0	12	0	0	0	0	0	0	3,306	100	12	100
Trumbauersville Borough	432	0	0	4	0	0	0	0	0	0	432	100	4	100
Tullytown Borough	836	732	87.56	9	9	100	549	65.67	0	0	836	100	9	100

Table 4.3.19-2: Transportation Accident Vulnerability

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN ROAD ZONE	PERCENT STRUCTURES	TOTAL CFS	CFS IN ROAD ZONE	PERCENT CFS	STRUCTURES IN RAIL ZONE	PERCENT STRUCTURES	CFS IN RAIL ZONE	PERCENT CFS	STRUCTURES IN AIR ZONE	PERCENT STRUCTURES	CFS IN AIR ZONE	PERCENT CFS
Upper Makefield Township	3,509	0	0	5	0	0	2,974	84.75	0	0	1,799	51.27	3	60
Upper Southampton Township	5,421	1,262	23.28	20	3	15	1,359	25.07	15	75	5,421	100	20	100
Warminster Township	9,498	0	0	36	0	0	12	0.13	7	19.4	9,498	100	36	100
Warrington Township	5,568	598	10.74	23	0	0	139	2.5	0	0	5,568	100	23	100
Warwick Township	3,258	0	0	14	0	0	415	12.74	0	0	3,258	100	14	100
West Rockhill Township	2,661	72	2.71	12	0	0	364	13.68	4	33.3	2,661	100	12	100
Wrightstown Township	1,738	0	0	6	0	0	367	21.12	1	16.7	1,738	100	6	100
Yardley Borough	950	0	0	8	0	0	0	0	4	50	882	92.84	8	100
Total	212,659	45,745	21.5	783	178	22.73	58,879	27.69	274	34.99	210,211	98.85	777	99.2

Table 4.3.19-3: Structures in Road Accident Zones by Type per Municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Bedminster Township	0	0	0	0	0	0	0	0	**0**
Bensalem Township	22	625	100	166	36	7,584	26	137	**8,696**
Bridgeton Township	0	0	0	0	0	0	0	0	**0**
Bristol Borough	0	133	24	21	10	936	11	12	**1,147**
Bristol Township	0	433	73	302	17	8,175	54	35	**9,089**
Buckingham Township	47	168	42	1	8	1,091	3	2	**1,362**
Chalfont Borough	0	0	0	0	0	0	0	0	**0**
Doylestown Borough	0	42	10	1	3	430	15	2	**503**
Doylestown Township	5	22	75	0	5	1,168	20	11	**1,306**
Dublin Borough	0	0	0	0	0	0	0	0	**0**
Durham Township	0	0	0	0	0	0	0	0	**0**
East Rockhill Township	0	0	0	0	0	0	0	0	**0**
Falls Township	25	258	47	65	15	4,987	25	22	**5,444**
Haycock Township	0	0	0	0	0	0	0	0	**0**
Hilltown Township	0	0	0	0	0	0	0	0	**0**
Hulmeville Borough	0	5	0	4	1	113	0	0	**123**
Ivyland Borough	0	0	0	0	0	0	0	0	**0**
Langhorne Borough	0	48	42	0	0	253	0	3	**346**
Langhorne Manor Borough	0	0	20	0	5	407	0	4	**436**
Lower Makefield Township	33	84	10	0	11	1,802	3	11	**1,954**
Lower Southampton Township	0	138	14	70	1	1,537	1	8	**1,769**
Middletown Township	19	297	116	47	5	5,334	17	112	**5,947**

Table 4.3.19-3: Structures in Road Accident Zones by Type per Municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Milford Township	53	30	2	14	24	726	10	18	**877**
Morrisville Borough	0	117	29	18	1	1,694	36	11	**1,906**
New Britain Borough	0	0	5	0	0	0	0	0	**5**
New Britain Township	2	7	0	0	0	220	0	1	**230**
New Hope Borough	0	29	14	4	0	179	1	0	**227**
Newtown Borough	0	0	0	0	0	0	0	0	**0**
Newtown Township	0	0	0	0	0	0	0	0	**0**
Nockamixon Township	0	0	0	0	0	0	0	0	**0**
Northampton Township	0	0	0	0	0	0	0	0	**0**
Penndel Borough	0	86	14	12	4	599	2	6	**723**
Perkasie Borough	0	0	0	0	0	0	0	0	**0**
Plumstead Township	0	0	0	0	0	0	0	0	**0**
Quakertown Borough	0	0	0	0	0	0	0	0	**0**
Richland Township	0	0	0	0	0	0	0	0	**0**
Richlandtown Borough	0	0	0	0	0	0	0	0	**0**
Riegelsville Borough	0	0	0	0	0	0	0	0	**0**
Sellersville Borough	0	0	0	0	0	0	0	0	**0**
Silverdale Borough	0	0	0	0	0	0	0	0	**0**
Solebury Township	24	96	24	2	12	813	6	14	**991**
Springfield Township	0	0	0	0	0	0	0	0	**0**
Telford Borough	0	0	0	0	0	0	0	0	**0**
Tinicum Township	0	0	0	0	0	0	0	0	**0**

Table 4.3.19-3: Structures in Road Accident Zones by Type per Municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Trumbauersville Borough	0	0	0	0	0	0	0	0	**0**
Tullytown Borough	0	74	14	42	3	565	20	14	**732**
Upper Makefield Township	0	0	0	0	0	0	0	0	**0**
Upper Southampton Township	0	79	2	55	0	1,118	8	0	**1,262**
Warminster Township	0	0	0	0	0	0	0	0	**0**
Warrington Township	1	0	2	0	1	593	0	1	**598**
Warwick Township	0	0	0	0	0	0	0	0	**0**
West Rockhill Township	0	0	0	0	4	67	0	1	**72**
Wrightstown Township	0	0	0	0	0	0	0	0	**0**
Yardley Borough	0	0	0	0	0	0	0	0	**0**
Total	**231**	**2,771**	**679**	**824**	**166**	**40,391**	**258**	**425**	**45,745**

Table 4.3.19-4: Structures in Rail Accident Zones by Type per Municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Bedminster Township	0	0	0	0	0	0	0	0	0
Bensalem Township	0	516	77	190	37	4,496	24	98	5,438
Bridgeton Township	0	0	0	0	0	0	0	0	**0**
Bristol Borough	0	233	52	25	11	1,726	12	25	**2,084**
Bristol Township	0	320	75	259	15	6,831	60	28	**7,588**
Buckingham Township	85	55	13	0	9	955	5	10	**1,132**
Chalfont Borough	0	108	9	7	3	834	7	3	**971**
Doylestown Borough	0	244	62	17	4	1,211	28	10	**1,576**
Doylestown Township	8	24	88	0	6	897	28	7	**1,058**
Dublin Borough	0	0	0	0	0	0	0	0	**0**
Durham Township	0	0	0	0	0	0	0	0	**0**
East Rockhill Township	0	7	7	5	5	503	10	3	**540**
Falls Township	25	256	25	243	6	3,357	44	23	**3,979**
Haycock Township	3	0	0	0	0	20	0	0	**23**
Hilltown Township	10	7	0	8	1	287	2	1	**316**
Hulmeville Borough	0	0	0	0	0	0	0	0	**0**
Ivyland Borough	0	12	5	8	0	209	0	0	**234**
Langhorne Borough	0	11	4	0	15	341	2	3	**376**
Langhorne Manor Borough	0	0	20	0	5	252	0	4	**281**
Lower Makefield Township	6	33	23	0	9	1,666	7	6	**1,750**
Lower Southampton Township	0	144	10	56	19	2,686	3	21	**2,939**
Middletown Township	14	218	171	46	22	3,879	17	66	**4,433**
Milford Township	0	0	0	0	0	0	0	0	**0**

Table 4.3.19-4: Structures in Rail Accident Zones by Type per Municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Morrisville Borough	0	122	32	39	1	1,803	36	15	**2,048**
New Britain Borough	0	84	27	32	0	775	2	3	**923**
New Britain Township	19	2	2	15	5	602	1	0	**646**
New Hope Borough	0	151	27	4	4	559	11	3	**759**
Newtown Borough	0	91	25	3	2	792	3	4	**920**
Newtown Township	0	49	14	0	7	422	5	5	**502**
Nockamixon Township	0	0	0	0	0	0	0	0	**0**
Northampton Township	9	68	36	72	18	3,963	10	12	**4,188**
Penndel Borough	0	84	14	11	0	477	2	6	**594**
Perkasie Borough	0	92	94	27	21	1,569	18	22	**1,843**
Plumstead Township	0	0	0	0	0	0	0	0	**0**
Quakertown Borough	0	102	40	22	12	1,408	3	25	**1,612**
Richland Township	16	78	14	44	4	1,278	8	22	**1,464**
Richlandtown Borough	0	0	0	0	0	0	0	0	**0**
Riegelsville Borough	0	0	0	0	0	0	0	0	**0**
Sellersville Borough	0	46	34	13	1	1,033	3	16	**1,146**
Silverdale Borough	0	0	0	0	0	2	0	0	**2**
Solebury Township	18	67	27	2	5	410	2	8	**539**
Springfield Township	21	22	5	13	0	159	1	6	**227**
Telford Borough	0	10	38	19	0	496	1	5	**569**
Tinicum Township	0	0	0	0	0	0	0	0	**0**
Trumbauersville Borough	0	0	0	0	0	0	0	0	**0**
Tullytown Borough	0	74	13	42	3	381	22	14	**549**

Table 4.3.19-4: Structures in Rail Accident Zones by Type per Municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Upper Makefield Township	0	0	0	0	0	0	0	0	**0**
Upper Southampton Township	0	237	51	59	15	2,596	11	5	**2,974**
Warminster Township	0	108	21	111	5	1,093	14	7	**1,359**
Warrington Township	0	0	0	0	0	12	0	0	**12**
Warwick Township	9	23	0	51	0	46	1	9	**139**
West Rockhill Township	10	37	14	30	18	280	23	3	**415**
Wrightstown Township	14	13	1	12	1	320	1	2	**364**
Yardley Borough	0	17	7	4	7	326	4	2	**367**
Total	**267**	**3,765**	**1,177**	**1,489**	**296**	**50,952**	**431**	**502**	**58,879**

Table 4.3.19-5: Structures in Air Accident Zone by Land Use per Municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Bedminster Township	688	104	40	27	34	2,458	8	21	**3,380**
Bensalem Township	22	936	212	284	90	13,439	32	181	**15,196**
Bridgeton Township	0	23	7	8	31	910	0	16	**995**
Bristol Borough	0	213	52	22	11	1,488	14	21	**1,821**
Bristol Township	0	625	158	388	51	17,831	105	52	**19,210**
Buckingham Township	483	342	78	41	29	6,558	35	41	**7,607**
Chalfont Borough	0	108	9	7	6	1,193	7	3	**1,333**
Doylestown Borough	0	279	81	17	8	2,371	41	13	**2,810**
Doylestown Township	18	141	235	13	26	4,981	34	27	**5,475**
Dublin Borough	11	55	9	18	2	440	4	2	**541**
Durham Township	128	18	10	5	2	784	0	20	**967**
East Rockhill Township	112	53	47	7	34	2,216	16	35	**2,520**
Falls Township	25	407	102	249	52	10,565	64	42	**11,506**
Haycock Township	56	10	15	2	64	1,609	0	27	**1,783**
Hilltown Township	314	195	62	85	14	5,274	22	61	**6,027**
Hulmeville Borough	0	23	6	5	1	372	0	2	**409**
Ivyland Borough	0	12	5	8	0	209	0	0	**234**
Langhorne Borough	0	57	46	0	15	591	2	7	**718**
Langhorne Manor Borough	0	0	20	0	5	407	0	4	**436**
Lower Makefield Township	47	106	73	2	20	9,333	18	24	**9,623**
Lower Southampton Township	0	329	59	121	62	6,563	4	43	**7,181**
Middletown Township	38	399	285	50	71	12,324	25	126	**13,318**
Milford Township	318	106	68	47	56	4,034	21	95	**4,745**

Table 4.3.19-5: Structures in Air Accident Zone by Land Use per Municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Morrisville Borough	0	150	48	43	4	3,060	36	17	**3,358**
New Britain Borough	0	84	27	32	0	831	2	3	**979**
New Britain Township	97	118	40	22	65	3,579	5	28	**3,954**
New Hope Borough	0	154	28	4	4	622	12	3	**827**
Newtown Borough	0	91	26	3	2	876	3	4	**1,005**
Newtown Township	51	151	105	40	56	3,951	16	6	**4,376**
Nockamixon Township	177	156	25	21	22	2,148	5	37	**2,591**
Northampton Township	121	226	112	94	87	11,690	22	24	**12,376**
Penndel Borough	0	86	14	12	6	637	2	6	**763**
Perkasie Borough	0	108	96	29	21	2,743	19	27	**3,043**
Plumstead Township	291	221	32	45	43	4,341	15	44	**5,032**
Quakertown Borough	0	234	78	26	16	2,537	3	35	**2,929**
Richland Township	213	233	27	49	23	3,994	40	54	**4,633**
Richlandtown Borough	0	25	10	0	0	342	1	1	**379**
Riegelsville Borough	3	27	14	0	3	463	6	14	**530**
Sellersville Borough	0	46	42	19	1	1,178	3	18	**1,307**
Silverdale Borough	0	22	12	1	0	306	0	0	**341**
Solebury Township	236	154	65	11	48	3,680	8	58	**4,260**
Springfield Township	369	60	42	14	26	3,025	12	113	**3,661**
Telford Borough	0	11	38	19	0	559	1	5	**633**
Tinicum Township	148	92	39	9	141	2,818	2	57	**3,306**
Trumbauersville Borough	0	23	17	5	1	378	1	7	**432**
Tullytown Borough	0	74	14	42	3	655	34	14	**836**

Table 4.3.19-5: Structures in Air Accident Zone by Land Use per Municipality

MUNICIPALITY	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Upper Makefield Township	206	5	12	0	11	1,549	0	16	**1,799**
Upper Southampton Township	0	262	75	59	15	4,986	16	8	**5,421**
Warminster Township	6	275	192	112	28	8,808	60	17	**9,498**
Warrington Township	53	154	38	69	81	5,156	5	12	**5,568**
Warwick Township	64	93	31	54	63	2,924	10	19	**3,258**
West Rockhill Township	57	127	60	82	100	2,159	29	47	**2,661**
Wrightstown Township	80	85	25	42	11	1,483	3	9	**1,738**
Yardley Borough	0	68	19	5	7	766	8	9	**882**
Grand Total	**4,432**	**8,156**	**3,082**	**2,369**	**1,572**	**188,194**	**831**	**1,575**	**210,211**

4.3.20. Urban Fire and Explosion

4.3.20.1. Location and Extent

Urban fire and explosion hazards encapsulate events ranging from appliance fires and gas leak incidents to brush fires and building fire (BCEMA, 2011). Fires and explosions can be caused by any number of sources – human-made or natural – and can cause minor to significant property damage, loss of life, and residential or business displacement. Fires can be triggered or exacerbated by other disaster events such as floods, storms, drought, transportation accidents, hazardous materials incidents, or criminal activity such as arson, and terrorism. Thus, fire as a secondary event may result in a very complex situation.

An urban fire in particular involves a structure or property within an urban or developed area. For hazard mitigation purposes, major urban fires involving large buildings and/or multiple properties are of primary concern. Statewide, this hazard occurs in the denser, more urbanized areas and occurs most often in residential structures (US Fire Administration, 2009). Urban fires can more easily spread from building to building in these denser areas. Explosion hazards tend to generate high temperatures and act as catalysts for fire.

4.3.20.2. Range of Magnitude

Severe urban fires result in extensive damage to residential, commercial, and/or public property. Damages ranges from minor smoke and/or water damage to the destruction of buildings. Fire can compromise buildings to the point of collapse or to the point where the building is no longer safe to occupy and must be demolished. People are often displaced for several months to years depending on the magnitude of the fire or explosion event. Urban fires and explosions can also cause injuries and death; from 1985-2010, the latest set of data available, there were an average of 6.4 fire-related deaths per year (BCEMA, 2011). Anecdotally, there has not been a significant increase or decrease in this rate. Although most instances of fire do not reach disaster proportions, the sum of the impact of all small fires is often much greater than the impact of the few major fire and explosion hazards that occur.

There are additional economic consequences related to this hazard. Urban fires and explosions may result in lost wages due to temporarily or permanently closed businesses, destruction and damage involving business and personal assets, loss of tax base, recovery costs, and lost investments on destroyed property. The secondary effects of urban fire and explosion events relate to the ability of public, private, and non-profit entities to provide post-incident relief. Human services agencies (community support programs, health and medical services, public assistance programs, and social services) can be effected by urban fire and explosion events as well. Effects may consist of physical damage to facilities and equipment, disruption of emergency communications, loss of health and medical facilities and supplies, and an overwhelming load of victims who are suffering from the effects of the urban fire, including loss of their home or place of business.

One of the worst case urban fire event occurred in Falls Township in 1982, when a fire leveled an entire 1.2 million square-foot K-Mart Distribution Center, causing more than $200 million in damages (National Fire Protection Association, 1983). Another notable fire occurred at the Bristol Township School in September 2013. During the course of the response a fire hydrant failed and blew up, causing injury to one of the responding firefighters. A second firefighter was also injured during the response. The fire

was later ruled an arson (Philly Fire News, 2013). The worst explosion event on record occurred in 2005 when construction caused a gas explosion at an apartment home in New Hope. The three-unit apartment building was destroyed, one resident was injured, and five people were left homeless as a result (The Digital Inquirer, 2005).

4.3.20.3. Past Occurrence

Table 4.3.20-1 details the number of fires between 2001 and 2014 as reported to the Bucks County 911 Center. According to this data, urban fire and explosion events are a fairly common occurrence in Bucks County communities. Every jurisdiction has had at least one fire incident per year for the ten years in this dataset except for Telford Borough, which reported no fire events in 2008. Figure 4.3.20-1 shows the incidence of fire events averaged over the past fourteen years of records and normalized by the number of structures in each municipality. Higher levels of incidence demonstrate an increased number of events for each structure in the municipality, and not an increased number of events because the municipality has more structures. For example, Bristol Township has almost as high of a fire incident average as Bensalem Township, but a lower normalized incidence because there are more total structures in Bristol Township. According to this analysis, New Hope Borough, Bristol Borough, Penndel Borough, Bensalem Township, and Tullytown Borough have experienced more urban fire incidents per structure in the past than other municipalities in Bucks County.

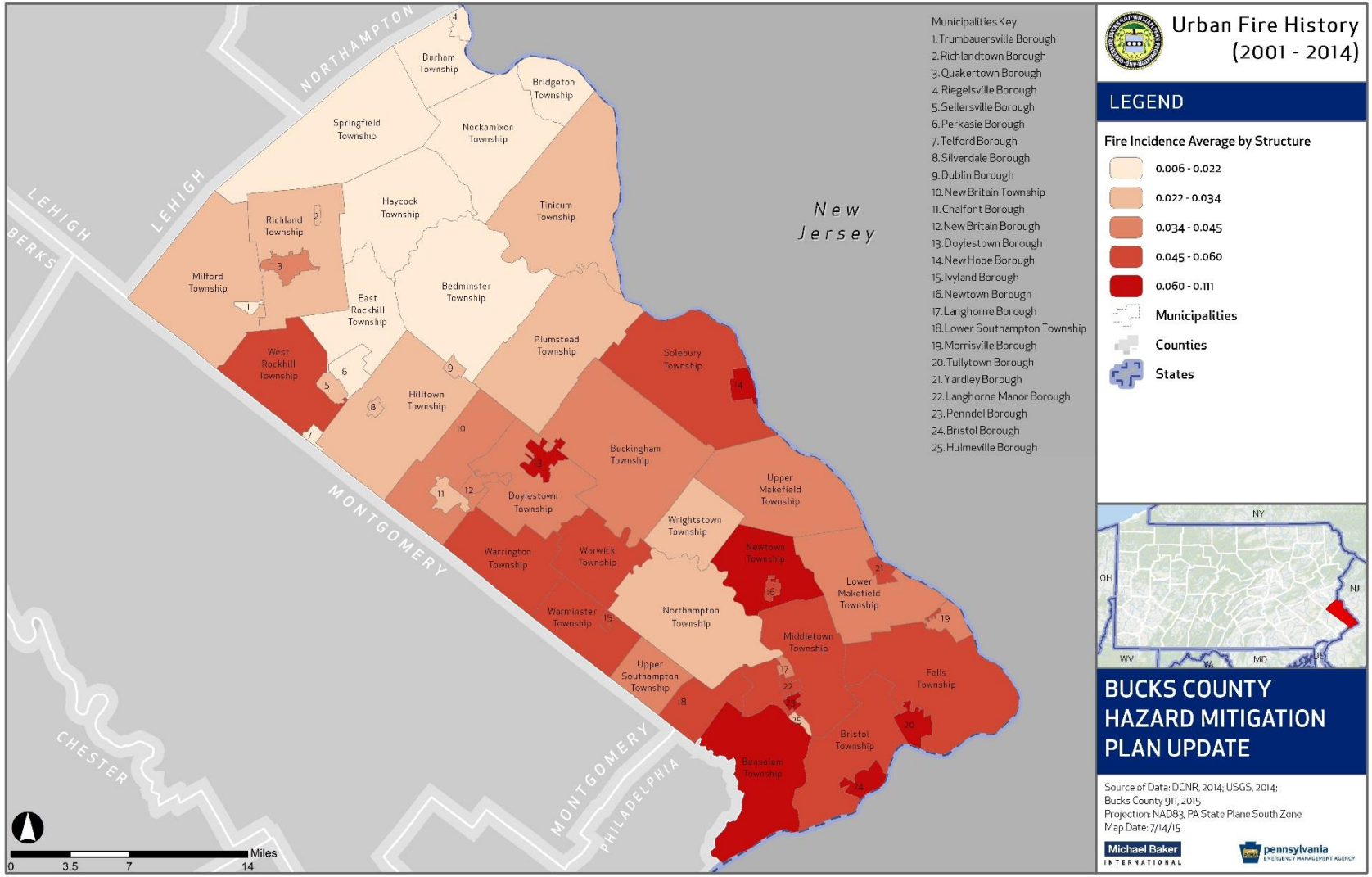
Table 4.3.20-1: Annual Fire Incident Counts for Bucks County by Municipality from 2001-2014 (Bucks County 911 Center, 2015)

COMMUNITY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL INCIDENTS 2005-14	AVERAGE
Bedminster Township	50	60	47	36	33	44	47	62	54	53	141	102	147	168	851	85.1
Bensalem Township	806	683	742	708	863	961	989	1,019	913	976	1,759	1,608	2,175	2,166	13,429	1,342.9
Bridgeton Township	14	10	7	12	9	9	5	7	7	6	40	37	36	43	199	19.9
Bristol Borough	160	158	177	119	118	149	135	141	134	146	285	251	330	324	2013	201.3
Bristol Township	931	915	1038	830	883	951	890	836	754	757	,1396	1,587	1,852	1,961	11,867	1,186.7
Buckingham Township	168	154	157	124	163	180	182	191	156	182	348	274	783	799	3,258	325.8
Chalfont Borough	31	30	30	36	28	40	45	33	29	37	69	47	83	104	515	51.5
Doylestown Borough	142	145	143	141	151	163	170	172	159	133	222	230	292	405	2,097	209.7
Doylestown Township	219	181	179	156	183	138	176	180	122	158	277	253	293	322	2,102	210.2
Dublin Borough	21	22	11	9	6	10	8	9	12	9	22	16	29	27	148	14.8
Durham Township	17	11	15	8	10	4	8	13	6	8	35	21	44	25	174	17.4
East Rockhill Township	35	34	28	26	25	38	43	46	33	46	106	76	110	119	642	64.2
Falls Township	557	561	540	497	484	432	437	468	424	452	787	826	979	1,018	6,307	630.7
Haycock Township	18	12	13	13	10	12	12	8	13	7	43	46	47	48	246	24.6
Hilltown Township	117	112	99	82	117	110	104	94	82	109	241	216	411	426	1,910	191
Hulmeville Borough	9	7	7	3	2	5	8	9	7	13	29	18	35	23	149	14.9
Ivyland Borough	11	14	8	5	9	8	8	7	12	7	15	13	23	45	147	14.7
Langhorne Borough	18	16	19	21	15	23	18	16	12	11	58	41	43	42	279	27.9
Langhorne Manor Borough	18	24	22	24	22	30	21	11	13	26	51	29	31	45	279	27.9
Lower Makefield Township	304	353	312	305	301	301	294	283	266	307	540	539	532	695	4,058	405.8
Lower Southampton Township	295	295	269	299	266	305	258	236	214	269	548	516	499	628	3,739	373.9
Middletown Township	568	512	515	544	627	568	609	588	542	565	1,142	1,081	1,526	1,692	8,940	894
Milford Township	96	95	79	90	68	96	66	74	62	79	212	244	259	350	1,510	151
Morrisville Borough	163	156	106	117	126	128	92	111	95	96	234	191	226	232	1,531	153.1
New Britain Borough	29	26	21	25	23	16	23	25	43	18	40	38	62	106	394	39.4
New Britain Township	138	143	138	145	139	139	118	130	113	128	172	165	309	361	1,774	177.4
New Hope Borough	38	54	55	77	93	70	80	90	48	95	126	138	153	176	1,069	106.9
Newtown Borough	59	70	34	64	66	38	51	43	52	62	49	79	83	85	608	60.8
Newtown Township	286	278	235	269	264	243	237	261	256	271	404	419	454	445	3,254	325.4
Nockamixon Township	21	41	34	34	21	28	34	20	27	33	110	90	169	137	669	66.9

Table 4.3.20-1: Annual Fire Incident Counts for Bucks County by Municipality from 2001-2014 (Bucks County 911 Center, 2015)

COMMUNITY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL INCIDENTS 2005-14	AVERAGE
Northampton Township	369	341	320	314	327	353	321	321	286	312	563	525	534	794	4,336	433.6
Penndel Borough	37	34	35	29	41	27	28	43	46	59	113	85	122	126	690	69
Perkasie Borough	47	39	56	45	40	47	38	39	39	32	87	86	117	138	663	66.3
Plumstead Township	106	133	124	112	126	119	111	142	96	120	293	212	303	316	1,838	183.8
Quakertown Borough	105	100	80	86	105	82	88	93	86	80	185	187	265	292	1,463	146.3
Richland Township	85	98	95	74	86	103	98	110	76	92	241	241	316	310	1,673	167.3
Richlandtown Borough	5	5	10	7	8	9	10	8	6	8	17	16	24	25	131	13.1
Riegelsville Borough	8	10	7	5	2	8	6	5	2	3	13	11	20	15	85	8.5
Sellersville Borough	19	24	19	17	24	10	18	15	25	16	51	55	99	69	382	38.2
Silverdale Borough	5	10	6	7	9	2	4	8	12	7	7	16	14	13	92	9.2
Solebury Township	151	134	130	141	128	147	175	171	148	173	318	262	440	433	2,395	239.5
Springfield Township	52	49	40	47	53	57	32	53	39	38	143	119	184	158	876	87.6
Telford Borough	2	2	1	1	5	1	1	0	2	4	6	3	13	16	51	5.1
Tinicum Township	53	61	54	46	42	48	33	30	49	46	136	120	298	223	1,025	102.5
Trumbauersville Borough	4	5	1	8	2	3	4	6	9	7	21	23	12	12	99	9.9
Tullytown Borough	33	28	31	20	43	41	34	28	34	84	112	116	132	97	721	72.1
Upper Makefield Township	107	96	135	130	108	125	113	120	129	111	206	191	217	255	1,575	157.5
Upper Southampton Township	235	192	195	191	216	214	184	185	181	205	336	333	334	488	2,676	267.6
Warminster Township	446	419	408	373	362	383	386	364	355	322	689	584	740	869	5,054	505.4
Warrington Township	214	185	191	191	227	202	223	247	221	188	320	342	523	636	3,129	312.9
Warwick Township	148	123	144	127	134	134	139	160	143	101	282	195	295	312	1,895	189.5
West Rockhill Township	86	78	93	78	69	68	68	84	67	65	186	153	386	386	1,532	153.2
Wrightstown Township	38	36	33	23	29	35	32	27	24	39	82	70	119	131	588	58.8
Yardley Borough	40	42	37	47	29	29	48	41	26	43	72	70	67	82	507	50.7
TOTAL PER YEAR	**7,734**	**7,416**	**7,325**	**6,938**	**7,340**	**7,486**	**7,362**	**7,483**	**6,761**	**7,214**	**13,980**	**13,206**	**17,589**	**19,213**	**107,634**	**10,763.4**

Figure 4.3.20-1: Urban fire events in Bucks County (Bucks County 911, 2015).



4.3.20.4. Future Occurrence

The future occurrence of urban fire and explosion events can be considered likely as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1). Minor events are likely to happen more frequently than major fires or explosions in the future. The greatest urban fire and explosion threats in Bucks County are industrial or hazardous materials fires. While residential fires are more common, industrial fires have a potentially higher risk because of the possibility of there being flammable chemicals and a sustained fuel source at industrial sites. Areas with greater population density are at greater risk for fires.

4.3.20.5. Vulnerability Assessment

Areas where large buildings are located or development is closely spaced are more vulnerable to urban fire and explosion events. In Bucks County, the jurisdictions with the highest population densities (greater than 5,000 persons per square mile) include Penndel, Richlandtown, and Bristol Boroughs. Additionally, the Bucks County Fire Marshall previously identified areas to work with that have an increased vulnerability due to an above average area of people and families that were living below the poverty level. The Fire Marshall noted that these areas were more vulnerable to the effects of urban fire because there was a decreased use of proper smoke alarms. The Fire Marshall currently runs the Bucks County Fire Safe Homes project to ensure that all houses and residences have properly functioning fire alarms placed around the residence (Bucks County, 2013).

In order to adequately assess vulnerability to urban fires and explosions, detailed information on the design specifications, specifically fire codes, used for the construction of individual buildings is required. As of December 31, 2006, all communities in Pennsylvania are required to comply with the Uniform Construction Codes. This includes requirements to comply with both the International Fire Code and the International Wildland Urban Interface Code. The adoption and enforcement of these codes will hopefully decrease the overall vulnerability of structures in Bucks County. However, these regulations will only affect new construction, as well as additions and renovations to existing structures. Older buildings that do not meet the criteria established in these modern fire codes will continue to remain vulnerable to urban fire and explosion events.

4.3.21. Utility Interruption

4.3.21.1. Location and Extent

The focus of utility interruptions as a hazard in Bucks County include fuel, electric, or utility failure, though utility failure can also include water, waste, and telecommunications networks. This hazard is often secondary to other hazard events, particularly transportation accidents, lightning strikes, floods, wind storms, extreme heat or cold events, coastal storms, and winter storms. Severe thunderstorms, lightning, tornados, and winter storms typically lead to more regional utility interruptions, while localized outages can be caused by traffic accidents or wind damage. Heat waves may also result in rolling blackouts where power may not be available for an extended period of time. Finally, national and international current events can impact the supply of fuels to the County. Utility interruptions have the potential to take place throughout the County in any location where a utility is present, including along any of its 248 miles of gas pipeline and 49 miles of liquid pipeline.

4.3.21.2. Range of Magnitude

Most severe utility interruptions and power failures are regional events. A loss of utilities can have numerous impacts including, but not limited to, food spoilage, loss of water supply (either because of a damaged pipeline or well pump failure), loss of heating or air conditioning, basement flooding (sump pump failure), lack of indoor lighting, and lack of telephone and internet service. These issues range from a minor nuisance to a full hazard event, but the degree of damage or harm depends on the population affected and the severity of the outage. For example, loss of heating and cooling capability is more dangerous in the winter and summer months, when heat sensitive populations like the elderly and very young count on utilities to maintain a safe temperature.

At a minimum, utility interruptions can cause small outages that last a few hours and doesn't even spoil food. A possible worst case scenario for a utility interruption would be if an earthquake occurred at the New Madrid fault along the Missouri/Tennessee border, having a crippling effect on the power supply of the entire East Coast and creating the potential for multiple pipeline breaks all along the East Coast. This event would likely result in long term interruptions in fuel, electricity, gas, and telecommunications in Bucks County and across Pennsylvania and the region, resulting in little aide being available to alleviate the effects of this outage and help restore utilities.

4.3.21.3. Past Occurrence

No complete or comprehensive list of utility interruption events is available for Bucks County. However, the County HVA indicates that Bucks County experienced the same challenges facing communities across the nation during the fuel crises of 1972-1973 and 1976-1977. Additionally, the County reports the occurrence of minor outages, as well as a notable ice storm event in January 2004 which led to widespread power outages.

4.3.21.4. Future Occurrence

Minor, short-term utility interruptions may occur several times a year for any given area in the County, while major, long-term events may take place once every few years, but utility interruptions are difficult to predict. Power failures are likely occurrences during severe weather and therefore should be expected during those events. The future occurrence of utility interruptions in Bucks County is considered *highly likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4-1).

4.3.21.5. Vulnerability Assessment

Resources such as electricity, communications, gas, and water supply are critical to ensure the health, safety, and general welfare of the citizenry. All critical infrastructure is vulnerable to the effects of a power outage. Facilities that provide care to vulnerable populations, including hospitals, medical facilities, retirement homes, and senior centers, are particularly vulnerable to power outages because of the populations they provide services to. While back-up power generators are often used at these facilities, loss of electricity may result in hot or cold temperatures for which these populations are particularly vulnerable.

4.4. Hazard Vulnerability Summary

4.4.1. Methodology

Ranking hazards helps communities set goals and priorities for mitigation based on their vulnerabilities. A Risk Factor (RF) is a tool used to measure the degree of risk for identified hazards in a particular planning area. The RF can also be used to assist local community officials in ranking and prioritizing those hazards that pose the most significant threat to their area based on a variety of factors deemed important by the planning team and other stakeholders involved in the hazard mitigation planning process. The RF system relies mainly on historical data, local knowledge, general consensus opinions from the planning team and information collected through development of the hazard profiles included in Section 4.3. The RF approach produces numerical values that allow identified hazards to be ranked against one another; the higher the RF value, the greater the hazard risk.

RF values were obtained by assigning varying degrees of risk to five categories for each of the twenty-one hazards profiled in the 2016 HMP. Those categories include: *probability*, *impact*, *spatial extent*, *warning time,* and *duration*. Each degree of risk was assigned a value ranging from 1 to 4. The weighting factor is shown in Table 4.4-1. To calculate the RF value for a given hazard, the assigned risk value for each category was multiplied by the weighting factor. The sum of all five categories equals the final RF value, as demonstrated in the example equation:

Risk Factor Value = [(Probability x .30) + (Impact x .30) +
(Spatial Extent x .20) + (Warning Time x .10) + (Duration x .10)]

Table 4.4-1 summarizes each of the five categories used for calculating a RF for each hazard. According to the weighting scheme applied, the highest possible RF value is 4.0.

Table 4.4-1: Summary of Risk Factor approach used to rank hazard risk.

RISK ASSESSMENT CATEGORY	DEGREE OF RISK			WEIGHT VALUE
	LEVEL	CRITERIA	INDEX	
PROBABILITY *What is the likelihood of a hazard event occurring in a given year?*	**UNLIKELY**	LESS THAN 1% ANNUAL PROBABILITY	**1**	**30%**
	POSSIBLE	BETWEEN 1% & 49.9% ANNUAL PROBABILITY	**2**	
	LIKELY	BETWEEN 50% & 90% ANNUAL PROBABILITY	**3**	
	HIGHLY LIKELY	GREATER THAN 90% ANNUAL PROBABILTY	**4**	
IMPACT *In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?*	**MINOR**	VERY FEW INJURIES, IF ANY. ONLY MINOR PROPERTY DAMAGE & MINIMAL DISRUPTION ON QUALITY OF LIFE. TEMPORARY SHUTDOWN OF CRITICAL FACILITIES.	**1**	**30%**
	LIMITED	MINOR INJURIES ONLY. MORE THAN 10% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR MORE THAN ONE DAY.	**2**	
	CRITICAL	MULTIPLE DEATHS/INJURIES POSSIBLE. MORE THAN 25% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR MORE THAN ONE WEEK.	**3**	
	CATASTROPHIC	HIGH NUMBER OF DEATHS/INJURIES POSSIBLE. MORE THAN 50% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR 30 DAYS OR MORE.	**4**	
SPATIAL EXTENT *How large of an area could be impacted by a hazard event? Are impacts localized or regional?*	**NEGLIGIBLE**	LESS THAN 1% OF AREA AFFECTED	**1**	**20%**
	SMALL	BETWEEN 1 & 10.9% OF AREA AFFECTED	**2**	
	MODERATE	BETWEEN 11 & 25% OF AREA AFFECTED	**3**	
	LARGE	GREATER THAN 25% OF AREA AFFECTED	**4**	
WARNING TIME *Is there usually some lead time associated with the hazard event? Have warning measures been implemented?*	**MORE THAN 24 HRS**	SELF-DEFINED	**1**	**10%**
	12 TO 24 HRS	SELF-DEFINED	**2**	
	6 TO 12 HRS	SELF-DEFINED	**3**	
	LESS THAN 6 HRS	SELF-DEFINED	**4**	
DURATION *How long does the hazard event usually last?*	**LESS THAN 6 HRS**	SELF-DEFINED	**1**	**10%**
	LESS THAN 24 HRS	SELF-DEFINED	**2**	
	LESS THAN 1 WEEK	SELF-DEFINED	**3**	
	MORE THAN 1 WEEK	SELF-DEFINED	**4**	

(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)

(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)

4.4.2. Ranking Results

Using the methodology described in Section 4.4.1, Table 4.4-2 lists the Risk Factor calculated for each of the twenty-one potential hazards identified in the 2011 HMP. Hazards identified as high risk have risk factors greater than 2.5. Risk Factors ranging from 2.0 to 2.4 were deemed moderate risk hazards. Hazards with Risk Factors 1.9 and less are considered *low* risk.

Table 4.4-2: Countywide ranking of hazard types based on Risk Factor methodology.

HAZARD RISK	HAZARD NATURAL (N) OR MAN-MADE (M)	RISK ASSESSMENT CATEGORY					RISK FACTOR
		PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	
HIGH	Flood, Flash Flood, Ice Jam (N)	4	3	3	3	3	3.3
	Winter Storm (N)	4	2	4	2	3	3.1
	Environmental Hazards (M)	4	2	2	4	2	2.8
	Hurricane, Tropical Storm, Nor'easter (N)	2	3	4	1	3	2.7
	Utility Interruption (M)	3	2	3	3	1	2.5
MODERATE	Transportation Accidents (M)	3	2	1	4	2	2.3
	Urban Fire and Explosion (M)	3	2	1	4	2	2.3
	Pandemic (N)	2	3	1	1	4	2.2
	Drought (N)	2	1	4	1	4	2.2
	Extreme Temperature (N)	2	2	4	1	1	2.2
	Terrorism (M)	1	4	1	4	1	2.2
	Wildfire (N)	3	2	1	4	1	2.2
	Lightning Strike (N)	4	1	1	3	1	2.1
	Tornado, Wind Storm (N)	2	2	2	4	1	2.1
	Landslide (N)	3	1	2	1	3	2
LOW	Structure Collapse (Infrastructure) (M)	2	2	1	3	2	1.9
	Dam Failure (M)	2	2	1	3	2	1.9
	Earthquake (N)	1	2	2	2	2	1.7
	Radon (N)	2	1	1	1	4	1.6
	Hailstorm (N)	2	1	1	1	2	1.4
	Subsidence, Sinkhole (N)	2	1	1	1	2	1.4

Based on these results, there are five high risk hazards, ten moderate risk hazards, and six low risk hazards in Bucks County. Mitigation actions were developed for all high, moderate, and low risk hazards (see

Section 6.4). Mitigation actions related to future public outreach and emergency service activities are identified to address low risk hazard events.

A risk assessment result for the entire county does not mean that each municipality is at the same amount of risk to each hazard. Tables 4.4-3, 4.4-4, and 4.4-5 show the different municipalities in Bucks County and whether their risk is greater than (>), less than (<), or equal to (=) the risk factor assigned to the County as a whole. This table was developed by the consultant team based on the findings in the hazard profiles of Section 4.3. Municipal officials had the opportunity to review the findings and make changes at the Risk Assessment Workshop. Those changes are reflected in the table.

Table 4.4-3: Comparative Jurisdictional Risk Factor for High Hazards

MUNICIPALITY	FLOOD, FLASH FLOOD, ICE JAM (N)	WINTER STORM (N)	ENVIRONMENTAL HAZARDS (M)	HURRICANE, TROPICAL STORM, NOR'EASTER (N)	UTILITY INTERRUPTION (M)
	3.2	3	2.8	2.7	2.5
Bedminster Township	<	=	=	=	=
Bensalem Township	=	=	<	>	<
Bridgeton Township	>	=	<	>	=
Bristol Borough	=	>	>	>	=
Bristol Township	>	=	>	>	=
Buckingham Township	<	=	<	>	=
Chalfont Borough	=	>	=	>	=
Doylestown Borough	=	>	<	>	<
Doylestown Township	<	=	>	=	=
Dublin Borough	<	=	<	=	<
Durham Township	>	>	<	>	=
East Rockhill Township	<	=	<	=	<
Falls Township	>	=	>	>	=
Haycock Township	<	>	=	=	>
Hilltown Township	>	>	<	=	=
Hulmeville Borough	=	=	=	=	=
Ivyland Borough	<	=	>	=	=
Langhorne Borough	>	=	=	>	=
Langhorne Manor Borough	=	=	=	=	=
Lower Makefield Township	>	=	>	>	>
Lower Southampton Township	=	=	<	=	=
Middletown Township	=	=	>	=	=

Table 4.4-3: Comparative Jurisdictional Risk Factor for High Hazards

MUNICIPALITY	FLOOD, FLASH FLOOD, ICE JAM (N)	WINTER STORM (N)	ENVIRONMENTAL HAZARDS (M)	HURRICANE, TROPICAL STORM, NOR'EASTER (N)	UTILITY INTERRUPTION (M)
	3.2	3	2.8	2.7	2.5
Milford Township	<	=	=	=	=
Morrisville Borough	=	=	=	=	=
New Britain Borough	=	>	=	>	=
New Britain Township	=	=	>	=	=
New Hope Borough	>	=	<	>	=
Newtown Borough	<	=	=	=	=
Newtown Township	<	=	>	=	=
Nockamixon Township	>	=	>	>	=
Northampton Township	>	<	<	=	=
Penndel Borough	>	>	>	>	=
Perkasie Borough	>	>	<	>	<
Plumstead Township	>	>	>	>	=
Quakertown Borough	=	=	>	=	=
Richland Township	=	=	>	=	=
Richlandtown Borough	<	=	=	=	=
Riegelsville Borough	>	>	>	=	>
Sellersville Borough	>	>	>	>	<
Silverdale Borough	=	=	=	=	=
Solebury Township	>	=	<	>	=
Springfield Township	>	=	<	>	=
Telford Borough	<	=	<	=	<
Tinicum Township	>	>	=	>	=
Trumbauersville Borough	<	<	<	=	=
Tullytown Borough	=	=	>	=	=
Upper Makefield Township	=	=	<	=	=
Upper Southampton Township	>	>	=	=	=
Warminster Township	=	>	=	>	=
Warrington Township	=	=	>	=	=
Warwick Township	=	>	=	>	=
West Rockhill Township	=	=	>	=	=
Wrightstown Township	=	=	<	>	=
Yardley Borough	>	>	=	>	=

Table 4.4-4: Comparative Jurisdictional Risk Factor for Moderate Hazards

MUNICIPALITY	TRANSPORTATION ACCIDENTS (M)	URBAN FIRE AND EXPLOSION (M)	PANDEMIC (N)	DROUGHT (N)	EXTREME TEMPERATURE (N)	TERRORISM (M)	WILDFIRE (N)	LIGHTNING STRIKE (N)	TORNADO, WIND STORM (N)	LANDSLIDE (N)
	2.3	2.3	2.2	2.1	2.2	2.2	2.2	2.1	2.1	2.0
Bedminster Township	=	=	=	>	=	=	>	=	>	=
Bensalem Township	<	<	=	<	<	=	<	<	=	<
Bridgeton Township	=	=	=	<	=	=	>	=	<	=
Bristol Borough	=	>	=	=	>	=	<	>	>	<
Bristol Township	>	=	=	<	=	=	>	>	>	=
Buckingham Township	<	<	=	=	<	=	<	<	<	<
Chalfont Borough	=	=	=	<	=	=	<	<	>	<
Doylestown Borough	<	>	=	<	<	=	<	=	<	<
Doylestown Township	>	=	=	>	=	=	>	>	<	=
Dublin Borough	=	<	=	<	=	=	<	=	<	<
Durham Township	=	=	=	>	=	=	>	=	<	=
East Rockhill Township	<	<	=	<	<	=	<	<	<	<
Falls Township	>	=	=	>	=	=	>	=	>	=
Haycock Township	>	=	=	>	=	=	>	=	<	=
Hilltown Township	=	=	=	<	<	=	=	=	<	<
Hulmeville Borough	=	>	=	<	<	=	<	<	=	<
Ivyland Borough	>	=	=	<	=	=	=	=	<	<
Langhorne Borough	>	=	=	<	=	=	>	>	<	=
Langhorne Manor Borough	>	=	=	<	=	=	>	=	<	=
Lower Makefield Township	>	=	=	>	=	=	>	=	>	=
Lower Southampton Township	>	<	=	=	=	>	<	=	=	<
Middletown Township	>	=	=	>	=	=	>	=	<	=
Milford Township	>	=	=	>	=	=	>	=	<	=

Table 4.4-4: Comparative Jurisdictional Risk Factor for Moderate Hazards

MUNICIPALITY	TRANSPORTATION ACCIDENTS (M)	URBAN FIRE AND EXPLOSION (M)	PANDEMIC (N)	DROUGHT (N)	EXTREME TEMPERATURE (N)	TERRORISM (M)	WILDFIRE (N)	LIGHTNING STRIKE (N)	TORNADO, WIND STORM (N)	LANDSLIDE (N)
	2.3	2.3	2.2	2.1	2.2	2.2	2.2	2.1	2.1	2.0
Morrisville Borough	=	=	=	>	=	=	=	=	=	=
New Britain Borough	=	=	=	=	=	=	<	<	>	<
New Britain Township	>	>	=	>	<	=	<	<	<	<
New Hope Borough	<	=	=	<	<	=	<	<	<	<
Newtown Borough	>	=	=	<	=	=	<	=	<	<
Newtown Township	>	=	=	>	=	=	>	=	=	=
Nockamixon Township	=	=	=	>	=	=	>	=	<	=
Northampton Township	<	<	=	=	<	=	<	<	=	<
Penndel Borough	>	=	>	=	>	>	<	=	<	<
Perkasie Borough	<	<	=	<	=	=	<	>	>	<
Plumstead Township	=	=	>	>	=	=	>	>	=	=
Quakertown Borough	>	=	=	<	=	=	<	>	<	<
Richland Township	>	=	=	>	=	=	>	=	<	=
Richlandtown Borough	=	=	=	>	=	=	<	=	<	<
Riegelsville Borough	>	=	=	>	=	=	>	=	<	=
Sellersville Borough	>	>	=	=	=	=	<	<	>	<
Silverdale Borough	>	=	=	>	=	=	=	>	<	<
Solebury Township	>	=	=	>	=	=	>	=	>	=
Springfield Township	>	=	=	>	=	=	>	=	<	=
Telford Borough	<	<	=	<	<	=	<	<	<	<
Tinicum Township	=	<	=	>	=	=	>	>	=	=
Trumbauersville Borough	=	<	=	<	<	=	<	<	<	<
Tullytown Borough	>	=	=	<	=	=	<	=	<	<
Upper Makefield Township	<	<	=	<	<	=	<	<	=	<

Table 4.4-4: Comparative Jurisdictional Risk Factor for Moderate Hazards

MUNICIPALITY	TRANSPORTATION ACCIDENTS (M)	URBAN FIRE AND EXPLOSION (M)	PANDEMIC (N)	DROUGHT (N)	EXTREME TEMPERATURE (N)	TERRORISM (M)	WILDFIRE (N)	LIGHTNING STRIKE (N)	TORNADO, WIND STORM (N)	LANDSLIDE (N)
	2.3	2.3	2.2	2.1	2.2	2.2	2.2	2.1	2.1	2.0
Upper Southampton Township	=	>	=	=	=	=	<	<	=	<
Warminster Township	=	=	=	=	>	=	<	>	=	<
Warrington Township	>	=	=	>	=	=	>	>	>	=
Warwick Township	>	<	=	>	>	=	<	<	=	<
West Rockhill Township	>	=	=	>	=	=	>	=	<	=
Wrightstown Township	<	=	=	=	<	=	<	=	=	<
Yardley Borough	>	>	=	<	<	=	<	=	>	<

Table 4.4-5: Comparative Jurisdictional Risk Factor for Low Hazards

MUNICIPALITY	STRUCTURE COLLAPSE (INFRASTRUCTURE) (M)	DAM FAILURE (M)	EARTH-QUAKE (N)	RADON (N)	HAILSTORM (N)	SUBSIDENCE, SINKHOLE (N)
	1.9	1.9	1.7	1.6	1.4	1.4
Bedminster Township	>	>	=	=	=	=
Bensalem Township	<	<	<	>	<	<
Bridgeton Township	>	=	=	=	=	=
Bristol Borough	=	<	<	=	<	<
Bristol Township	>	>	=	=	=	=
Buckingham Township	<	<	<	=	<	>
Chalfont Borough	<	<	<	>	=	<
Doylestown Borough	>	<	<	>	<	<
Doylestown Township	>	=	=	=	>	=
Dublin Borough	<	<	<	>	<	<
Durham Township	>	=	=	=	=	>
East Rockhill Township	<	<	<	=	<	<

Table 4.4-5: Comparative Jurisdictional Risk Factor for Low Hazards

MUNICIPALITY	STRUCTURE COLLAPSE (INFRASTRUCTURE) (M)	DAM FAILURE (M)	EARTH-QUAKE (N)	RADON (N)	HAILSTORM (N)	SUBSIDENCE, SINKHOLE (N)
	1.9	1.9	1.7	1.6	1.4	1.4
Falls Township	>	>	=	=	=	=
Haycock Township	>	>	=	=	=	=
Hilltown Township	<	=	<	=	<	<
Hulmeville Borough	<	<	<	=	=	<
Ivyland Borough	=	<	=	=	=	=
Langhorne Borough	<	=	=	=	>	=
Langhorne Manor Borough	>	=	=	=	=	=
Lower Makefield Township	>	=	=	=	=	=
Lower Southampton Township	=	<	<	=	<	<
Middletown Township	>	>	=	=	=	=
Milford Township	>	=	=	=	>	=
Morrisville Borough	>	=	=	>	>	=
New Britain Borough	<	<	<	=	=	<
New Britain Township	<	=	<	=	<	<
New Hope Borough	<	=	<	>	<	<
Newtown Borough	>	=	=	>	>	=
Newtown Township	>	=	=	>	>	=
Nockamixon Township	>	>	=	=	=	=
Northampton Township	<	<	<	=	<	<
Penndel Borough	=	<	<	=	<	<
Perkasie Borough	<	<	<	>	<	<
Plumstead Township	>	>	=	=	>	=
Quakertown Borough	>	=	=	>	>	=
Richland Township	>	=	=	=	=	=
Richlandtown Borough	<	<	=	=	=	=
Riegelsville Borough	>	=	=	>	=	=
Sellersville Borough	=	<	<	=	=	<
Silverdale Borough	<	=	=	=	=	=
Solebury Township	>	>	=	=	=	>
Springfield Township	>	=	=	=	=	=
Telford Borough	<	<	<	>	<	<

Table 4.4-5: Comparative Jurisdictional Risk Factor for Low Hazards						
MUNICIPALITY	STRUCTURE COLLAPSE (INFRASTRUCTURE) (M)	DAM FAILURE (M)	EARTH-QUAKE (N)	RADON (N)	HAILSTORM (N)	SUBSIDENCE, SINKHOLE (N)
	1.9	1.9	1.7	1.6	1.4	1.4
Tinicum Township	=	=	<	=	=	<
Trumbauersville Borough	=	<	<	=	<	<
Tullytown Borough	>	=	=	=	=	=
Upper Makefield Township	<	<	<	=	<	<
Upper Southampton Township	<	<	<	=	<	<
Warminster Township	<	<	<	>	<	<
Warrington Township	=	=	=	=	>	=
Warwick Township	<	=	<	=	<	<
West Rockhill Township	>	=	=	=	=	=
Wrightstown Township	<	<	=	=	<	<
Yardley Borough	<	<	<	=	=	>

4.4.3. Potential Loss Estimates

Potential loss estimates for hazard events help a community understand the monetary value of the losses they face from the impacts of a natural or human-made hazard. Estimates are considered *potential* in that they general represent losses that could occur in a countywide hazard scenario. In events that are localized, losses may be lower, while regional events will generally yield higher losses.

Potential loss estimates have four basic components, including:

- Replacement Value: Current cost of returning an asset to its pre-damaged condition, using present-day cost of labor and materials.
- Content Loss: Value of building's contents, typically measured as a percentage of the building replacement value.
- Functional Loss: The value of a building's use or function that would be lost if it were damaged or closed.
- Displacement Cost: The dollar amount required for relocation of the function (business or service) to another structure following a hazard event.

Loss estimates in this section fall into three categories: historical losses, current condition losses, and predictive losses. Historical loss estimates provide insight into what future losses may be; these estimates are based on data from the NCDC storm events database, the NFIP, and the USDA's Risk Management Agency annual crop indemnity data. Current condition losses are based on assessment land values.

Predictive losses are based on a modeling system that looks at all four potential loss estimate components. These losses were generated using FEMA's HAZUS-MH Version 2.2.

Historical Losses

Historical losses were determined for drought, flooding, hailstorms, coastal storms (hurricanes/tropical storms/tropical depressions), lightning, extreme temperatures, and winter storms from NCDC, USDA RMA, and the NFIP.

NCDC reports include property and crop damage estimates with their incident reports. As noted in many of the hazard profiles, there were many events where damage reports were not collected. This does not mean that there were no damage; rather, it indicates that no damages were reported to NCDC. As a result, these should be considered low-end estimates of losses. The flood and flash flood events reported in NCDC list $77.91 million in property damage, 15 casualties, and three fatalities over the history of flooding in the county. There were over $1.28 million of property damages and 11 casualties reported under tornado, high wind, and thunderstorm wind events. There were about $3.54 million of property damage and 11 casualties reported from lightning strike events. There were no losses, casualties, or fatalities reported for hailstorms, winter storm (including ice storms, winter weather, blizzard, sleet, and heavy snow), hurricanes or tropical storms, or wildfire events in NCDC; however, this does not mean that there were no losses, just that they were not reported to NCDC.

Agriculture is an integral part of Bucks County's economy, and agricultural production is highly vulnerable to natural hazard events. As previously mentioned, losses are available from the USDA RMA. The RMA operates and manages the Federal Crop Insurance Corporation, which provides crop insurance to American farmers. While not all crops are insured through RMA, their records provide strong insight into agricultural losses nationwide and, for the purposes of this analysis, in Bucks County. Table 4.4-6 illustrates the total amount of indemnities paid through RMA since 1948 in Carbon County by type of crop failure. Only crop failures related to the hazards discussed in this plan are listed. There has been about $1.55 million in indemnity paid out due to crop loss between 1948 and 2014 in Bucks County. The greatest amount of indemnity paid out was due to crop loss from drought, which accounts for about 37 percent of the loss, followed by loss due to rain or excess moisture, which accounted for about 31 percent of the loss.

Table 4.4-6: Historic Insured Crop Losses, 1989-2014 (USDA RMA, 2015)

REASON FOR LOSS	INDEMNITY AMOUNT
Cold Wet Weather	$78,259.61
Cold Winter	$7,167.00
Drought	$566,970.95
Excess Moisture/Precipitation/Rain	$487,767.49
Freeze	$8,516.00
Hail	$11,500.00
Heat	$139,037.30
Hurricane/Tropical Depression	$7,522.00
Other	$243,805.65
Total	**$1,550,546.00**

The final set of historic losses focuses on solely on prior flooding events using data on NFIP claims paid. Table 4.4-7 shows the total amount of claims paid in each municipality according to CIS. There has been almost $130 million paid to all municipalities in Bucks County; the most was paid to Yardley Borough, a total of $24.9 million in 760 claims.

Table 4.4-7: Total NFIP Claims Paid by Municipality (FEMA CIS, 2015).

COMMUNITY	PARTICIPATION STATUS	TOTAL CLAIMS SINCE 1978	TOTAL AMOUNT OF CLAIMS PAID SINCE 1978
Bedminster Township	Participating	7	$ 53,199
Bensalem Township	Participating	254	$ 4,172,591
Bridgeton Township	Participating	206	$ 7,000,865
Bristol Borough	Participating	48	$ 590,243
Bristol Township	Participating	288	$ 6,740,360
Buckingham Township	Participating	24	$ 488,704
Chalfont Borough	Participating	11	$ 168,297
Doylestown Borough	Participating	14	$ 233,147
Doylestown Township	Participating	36	$ 199,087
Dublin Borough	Not Participating	N/A	N/A
Durham Township	Participating	79	$ 2,801,224
East Rockhill Township	Participating	5	$ 19,279
Falls Township	Participating	108	$ 951,716
Haycock Township	Participating	8	$ 84,754
Hilltown Township	Participating	6	$ 9,555
Hulmeville Borough	Participating	112	$ 1,834,602
Ivyland Borough	Not Participating	N/A	N/A
Langhorne Manor Borough	Participating	13	$ 136,957
Langhorne Borough	Participating	72	$ 1,664,732
Lower Makefield Township	Participating	202	$ 4,769,217
Lower Southampton Township	Participating	149	$ 2,389,967
Middletown Township	Participating	266	$ 5,318,516
Milford Township	Participating	19	$ 106,809
Morrisville Borough	Participating	17	$ 142,352
New Britain Borough	Participating	0	$ 0
New Britain Township	Participating	9	$ 113,165
New Hope Borough	Participating	373	$ 15,182,133
Newtown Borough	Participating	9	$ 14,883
Newtown Township	Participating	10	$ 119,920
Nockamixon Township	Participating	21	$ 892,602
Northampton Township	Participating	93	$ 1,346,572
Penndel Borough	Participating	0	$ 0
Perkasie Borough	Participating	24	$ 1,393,432

Table 4.4-7: Total NFIP Claims Paid by Municipality (FEMA CIS, 2015).			
COMMUNITY	PARTICIPATION STATUS	TOTAL CLAIMS SINCE 1978	TOTAL AMOUNT OF CLAIMS PAID SINCE 1978
Plumstead Township	Participating	72	$ 2,691,682
Quakertown Borough	Participating	35	$ 494,013
Richland Township	Participating	17	$ 173,554
Richlandtown Borough	Not Participating	N/A	N/A
Riegelsville Borough	Participating	119	$ 2,306,537
Sellersville Borough	Participating	53	$ 1,165,804
Silverdale Borough	Participating	0	$0
Solebury Township	Participating	221	$ 7,762,342
Springfield Township	Participating	21	$ 380,632
Telford Borough	Not Participating	N/A	N/A
Tinicum Township	Participating	281	$ 11,212,561
Trumbauersville Borough	Not Participating	N/A	N/A
Tullytown Borough	Participating	2	$ 6,887
Upper Makefield Township	Participating	333	$ 13,677,561
Upper Southampton Township	Participating	83	$ 1,647,569
Warminster Township	Participating	58	$ 682,044
Warrington Township	Participating	105	$ 2,112,551
Warwick Township	Participating	20	$ 319,826
West Rockhill Township	Participating	8	$ 41,511
Wrightstown Township	Participating	11	$ 339,421
Yardley Borough	Participating	760	$ 24,920,397
TOTAL		**4,682**	**$128,873,772**

Current Condition Losses

The current condition losses were derived using the total assessed value, including land and building values, from the Bucks County Tax Assessment Database. Table 4.4-8 details the total assessed values by municipality and type of land. Please note, the data received from Bucks County attributed values for buildings and land by parcels. If there was more than one structure on one parcel, then the values would be increased by the number of structures on the parcel; this may inflate the total assessed value, though this was not a common occurrence.

Table 4.4-8: Total Assessed Value by Land Use and Municipality (Bucks GIS Department, 2015).

COMMUNITY	LAND USE								
	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Bedminster Township	$51,916,330	$6,228,270	$34,854,760	$3,825,450	$5,513,390	$102,070,630	$2,908,160	$178,560	$207,495,550
Bensalem Township	$2,564,990	$3,951,917,710	$259,626,300	$79,922,610	$30,637,250	$1,514,065,910	$3,604,910	$2,410,970	$5,844,750,650
Bridgeton Township	$0	$1,033,500	$466,200	$401,280	$1,871,100	$30,051,920	$0	$181,880	$34,005,880
Bristol Borough	$0	$24,822,120	$22,459,950	$6,927,730	$531,280	$40,182,090	$1,529,180	$178,360	$96,630,710
Bristol Township	$0	$61,187,210	$132,858,650	$172,347,690	$6,580,150	$551,638,470	$88,668,960	$864,290	$1,014,145,420
Buckingham Township	$68,471,600	$64,631,380	$72,917,770	$5,903,150	$5,536,040	$1,539,707,720	$15,361,920	$954,970	$1,773,484,550
Chalfont Borough	$0	$8,506,690	$7,221,720	$2,059,940	$205,520	$36,588,120	$289,240	$173,200	$55,044,430
Doylestown Borough	$0	$41,807,960	$64,140,300	$1,704,260	$1,351,320	$100,134,600	$5,823,960	$391,660	$215,354,060
Doylestown Township	$3,307,160	$42,088,430	$938,010,340	$1,938,260	$6,258,020	$345,615,640	$28,776,440	$683,370	$1,366,677,660
Dublin Borough	$814,880	$4,144,120	$1,477,630	$2,321,290	$11,200	$24,153,080	$132,360	$4,600	$33,059,160
Durham Township	$14,494,160	$1,834,240	$540,320	$439,400	$44,360	$32,496,590	$0	$234,680	$50,083,750
East Rockhill Township	$10,945,080	$5,260,020	$23,397,520	$683,880	$2,950,780	$78,456,240	$1,943,510	$644,520	$124,281,550
Falls Township	$18,617,080	$72,826,860	$102,481,780	$253,594,380	$10,532,120	$1,064,650,190	$21,312,750	$947,320	$1,544,962,480
Haycock Township	$4,452,910	$374,790	$1,152,880	$44,700	$14,527,460	$134,739,010	$0	$322,410	$155,614,160
Hilltown Township	$22,346,130	$41,711,130	$24,148,850	$20,046,920	$713,340	$250,202,280	$3,587,360	$663,190	$363,419,200

Table 4.4-8: Total Assessed Value by Land Use and Municipality (Bucks GIS Department, 2015).

COMMUNITY	LAND USE								
	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Hulmeville Borough	$0	$762,980	$396,220	$547,760	$2,350	$9,438,210	$0	$1,480	$11,149,000
Ivyland Borough	$0	$496,870	$319,260	$3,441,860	$0	$6,366,320	$0	$0	$10,624,310
Langhorne Manor Borough	$0	$4,186,410	$18,765,360	$0	$2,134,560	$16,914,320	$124,080	$132,650	$42,257,380
Langhorne Borough	$0	$0	$19,791,040	$0	$646,000	$13,589,830	$0	$320	$34,027,190
Lower Makefield Township	$9,189,820	$25,966,580	$84,751,100	$248,800	$2,653,130	$556,460,360	$4,718,500	$442,880	$684,431,170
Lower Southampton Township	$0	$34,381,310	$30,306,550	$11,297,380	$12,555,900	$417,487,380	$305,880	$493,260	$506,827,660
Middletown Township	$22,045,650	$168,683,840	$1,088,118,310	$14,882,990	$12,672,620	$593,421,490	$7,840,100	$5,364,190	$1,913,029,190
Milford Township	$24,306,300	$8,716,920	$21,815,440	$9,433,180	$3,803,700	$132,593,220	$12,301,400	$1,109,780	$214,079,940
Morrisville Borough	$0	$8,341,490	$25,243,920	$11,426,000	$141,560	$75,881,260	$6,606,600	$498,310	$128,139,140
New Britain Borough	$0	$7,018,000	$48,202,630	$3,333,760	$0	$57,913,520	$38,800	$33,470	$116,540,180
New Britain Township	$9,736,760	$28,499,360	$60,210,060	$11,438,120	$34,299,320	$166,200,580	$1,278,100	$461,630	$312,123,930
New Hope Borough	$0	$11,864,740	$44,384,840	$431,840	$0	$31,720,250	$455,960	$23,520	$88,881,150
Newtown Borough	$0	$8,880,400	$4,310,120	$49,830	$88,880	$38,213,960	$464,400	$41,120	$52,048,710

Table 4.4-8: Total Assessed Value by Land Use and Municipality (Bucks GIS Department, 2015).

COMMUNITY	LAND USE								
	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Newtown Township	$5,998,400	$47,562,510	$134,151,240	$15,563,330	$3,176,480	$200,093,620	$3,708,800	$139,960	$410,394,340
Nockamixon Township	$17,361,680	$13,986,640	$36,989,990	$3,196,950	$2,894,510	$79,828,240	$77,240	$562,510	$154,897,760
Northampton Township	$33,546,000	$32,857,090	$153,232,860	$14,084,250	$99,040,180	$491,012,050	$2,423,050	$399,320	$826,594,800
Penndel Borough	$0	$4,964,470	$3,621,040	$1,146,840	$136,800	$20,390,720	$91,600	$49,650	$30,401,120
Perkasie Borough	$0	$8,833,250	$17,334,020	$2,923,750	$8,451,730	$102,674,670	$537,950	$178,900	$140,934,270
Plumstead Township	$32,128,960	$39,360,720	$13,393,740	$13,104,680	$2,318,800	$336,407,620	$520,620	$721,440	$437,956,580
Quakertown Borough	$0	$33,044,580	$57,825,440	$3,948,960	$2,575,410	$65,381,390	$211,380	$148,720	$163,135,880
Richland Township	$16,057,090	$29,960,980	$5,831,040	$13,214,090	$1,455,830	$1,320,480,040	$2,791,820	$756,980	$1,390,547,870
Richlandtown Borough	$0	$1,562,400	$2,443,120	$0	$0	$8,350,640	$122,940	$3,200	$12,482,300
Riegelsville Borough	$49,800	$1,094,800	$900,470	$0	$13,280	$11,148,220	$217,520	$120,750	$13,544,840
Sellersville Borough	$0	$1,917,130	$12,808,200	$2,243,010	$160,320	$29,011,810	$94,400	$174,820	$46,409,690
Silverdale Borough	$0	$1,168,470	$587,960	$61,200	$0	$8,711,480	$0	$0	$10,529,110
Solebury Township	$53,740,540	$16,176,240	$47,981,050	$2,870,560	$5,750,460	$304,861,270	$637,680	$1,697,750	$433,715,550
Springfield Township	$35,520,160	$4,087,020	$7,881,260	$1,758,110	$1,617,230	$123,905,290	$454,640	$1,849,220	$177,072,930

Table 4.4-8: Total Assessed Value by Land Use and Municipality (Bucks GIS Department, 2015).

COMMUNITY	LAND USE								
	AGRICULTURAL	COMMERCIAL	GOVERNMENT AND INSTITUTIONAL	INDUSTRIAL	PARKS, RECREATION, AND PROTECTED OPEN SPACE	RESIDENTIAL	TRANSPORTATION AND UTILITIES	UNKNOWN	GRAND TOTAL
Telford Borough	$0	$519,100	$45,308,250	$3,158,970	$0	$15,329,500	$16,400	$6,200	$64,338,420
Tinicum Township	$16,812,540	$7,168,020	$3,505,980	$993,400	$19,810,660	$148,081,130	$20,220	$926,610	$197,318,560
Trumbauersville Borough	$0	$757,810	$1,729,040	$465,050	$0	$8,858,970	$10,400	$171,000	$11,992,270
Tullytown Borough	$0	$11,749,230	$13,729,600	$16,917,230	$18,000	$20,299,790	$22,510,570	$170,920	$85,395,340
Upper Makefield Township	$41,258,810	$5,103,000	$7,112,300	$0	$9,870,800	$229,479,480	$59,160	$1,585,310	$294,468,860
Upper Southampton Township	$0	$55,632,850	$128,900,520	$12,477,690	$864,440	$170,655,520	$926,900	$365,500	$369,823,420
Warminster Township	$1,084,800	$68,269,770	$279,341,300	$45,548,600	$8,688,550	$429,839,140	$57,150,660	$3,370,270	$893,293,090
Warrington Township	$8,599,700	$23,725,280	$30,946,690	$27,798,800	$7,464,460	$229,088,200	$164,360	$258,540	$328,046,030
Warwick Township	$7,126,480	$9,348,560	$71,745,790	$9,698,920	$8,035,040	$121,088,220	$348,880	$933,200	$228,325,090
West Rockhill Township	$5,834,680	$19,147,180	$157,657,270	$28,324,110	$14,761,360	$91,068,300	$4,369,100	$453,830	$321,615,830
Wrightstown Township	$10,234,990	$10,425,460	$5,597,120	$15,567,120	$271,030	$84,336,390	$12,240	$124,530	$126,568,880
Yardley Borough	$0	$4,405,410	$2,790,250	$1,468,040	$4,239,120	$22,951,870	$457,080	$27,950	$36,339,720
TOTAL	$548,563,480	$5,089,001,300	$4,375,715,360	$855,226,120	$357,875,840	$12,634,286,760	$306,008,180	$32,633,670	$24,199,310,710

Predictive Losses

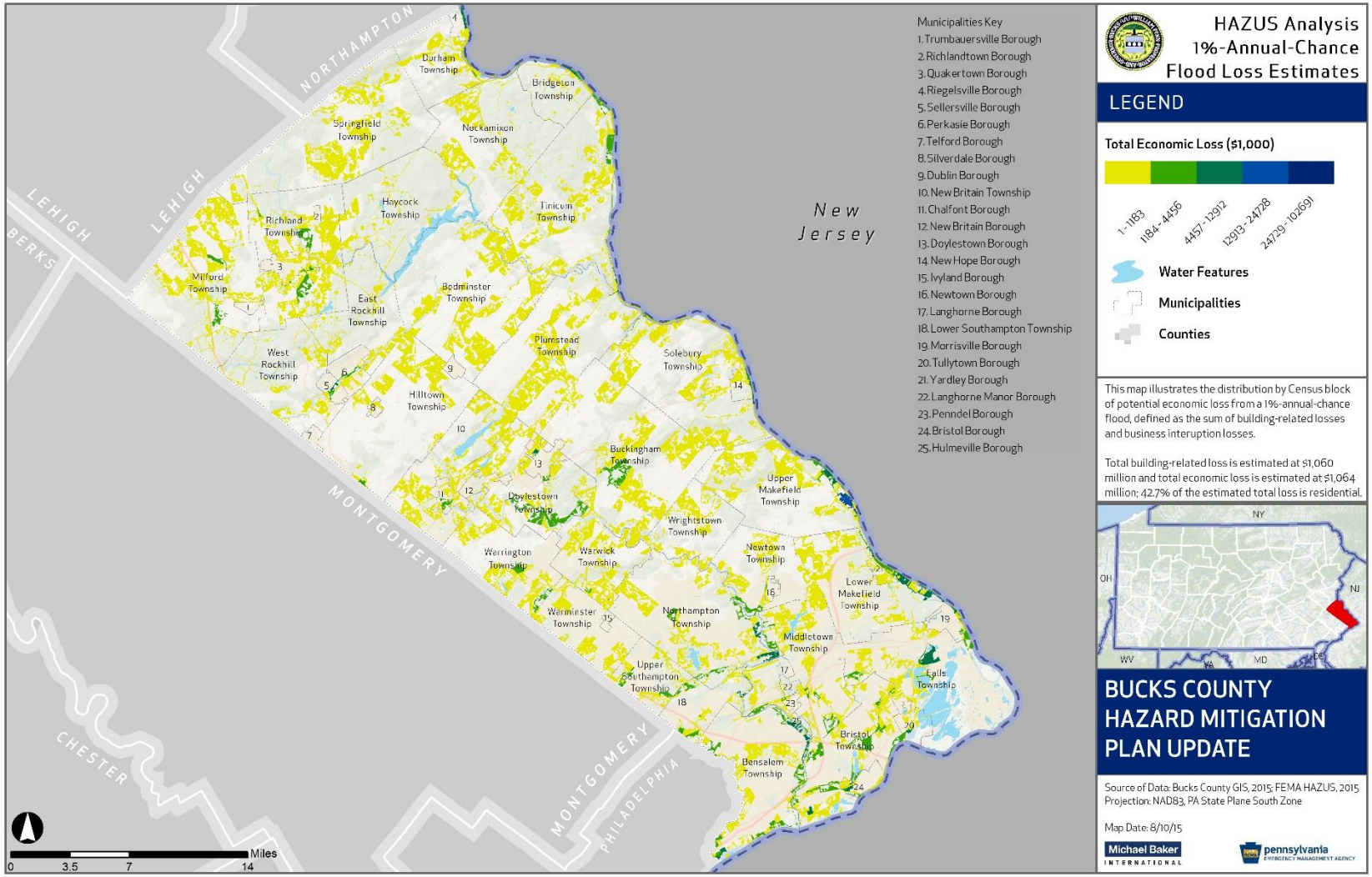
This plan employed an enhanced HAZUS analysis for floods. As opposed to basic analysis using only default data, enhanced analysis incorporates both up-to-date and specific data for inclusion in the hazard models. The enhanced data incorporated into this HMP update include:

- Updated demographic data from the 2010 Census,
- Collected critical facility information from Bucks County and used county information to updated essential facilities layer in HAZUS CDMS by adding or confirming Facility Type, Latitude and Longitude, Census Tract, Zip, City, Address, and the HazusID. The methodology from the 2013 Pennsylvania Standard State All-Hazard Mitigation Plan was used for Replacement Cost, since this data was not available in the county data.
- Dasymetric Census blocks to better attribute areas of population geographically within the block, and
- A user-delineated 100-year depth grid derived for Bucks County from the effective DFIRM data.

For more details on the HAZUS methodology used and additional results reports, see **Appendix F – HAZUS Reports**.

Using these datasets in HAZUS-MH Version 2.1, total economic losses from a 1%-annual-chance flood in Bucks County are estimated at $1.06 billion. Residential occupancies make up 42.8 percent of the total estimated building-related losses, and commercial buildings make up a further 38.0 percent of the losses. According to the model, six fire stations, one police station, and five schools would not be able to be used due to the flooding, while an additional fourteen of these facilities would suffer moderate or substantial damage. Figure 4.4-1 shows a distribution of building-related losses by census block across Bucks County. The highest losses are concentrated in the southern part of the county, and especially along the Delaware River in the municipalities in southeast Bucks County. The full HAZUS results report can be found in **Appendix F**.

Figure 4.4-1: Bucks County potential economic loss calculated with HAZUS-MH.



4.4.4. Future Development and Vulnerability

Risk and vulnerability to natural and human-made hazard events are not static. Risk will increase or decrease as counties and municipalities see changes in land use and development as well as changes in population. Bucks County is expected to experience a variety of factors that will, in some areas, increase vulnerability to hazards while in other areas, vulnerability may even be reduced.

Population change is perhaps the most significant indicator of changes in vulnerability and risk in the future. A rise or decrease in population not only impacts the level of risk (as to how many individuals could be affected), but also foreshadows development and land use changes for the County and its municipalities. The population in Bucks County grew by about 5 percent between 2000 and 2010. Table 4.4-9 compares growth trends in the different regions in the county.

Table 4.4-9: Population Change in Bucks County by Region from 1990 – 2000 and 2000 – 2010 (BCPC, 2011).

REGION	1990 – 2000		2000 – 2010	
	AMOUNT	PERCENTAGE	AMOUNT	PERCENTAGE
Upper Bucks	7,810	9.1%	9,291	9.9%
Central Bucks	40,541	21.6%	18,569	8.1%
Lower Bucks	8,060	3.0%	-246	-0.1%
Bucks County	**56,411**	**10.4%**	**27,614**	**4.6%**

Tables 4.4-10 and 4.4-11 show the municipalities in Bucks County with the highest population gains and losses between 2000 and 2010. This range of population percent change should be considered in comparison to the number of people living in each municipality.

Table 4.4-10: Population Change by Municipality, Highest Gains from 2000 – 2010 (BCPC, 2011).

MUNICIPALITY	AMOUNT OF CHANGE	PERCENTAGE OF CHANGE
Warrington Township	5,838	33.2%
Buckingham Town	3,633	22.1%
Richland Township	3,132	31.6%
Hilltown Township	2,927	24.2%
Warwick Township	2,460	20.5%

Table 4.4-11: Population Change by Municipality, Highest Losses from 2000 – 2010 (BCPC, 2011).

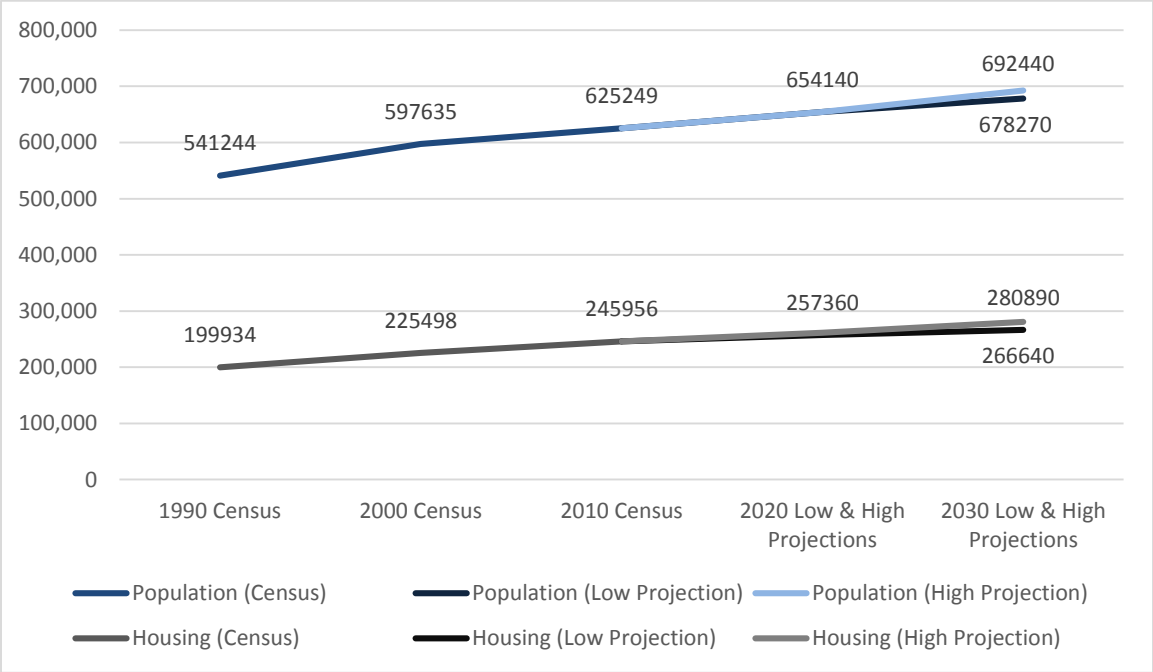
MUNICIPALITY	AMOUNT OF CHANGE	PERCENTAGE OF CHANGE
Morrisville Borough	-1,295	-12.9%
Bristol Township	-939	-1.7%
Upper Southampton Township	-612	-3.9%
Falls Township	-565	-1.7%
Lower Southampton Township	-367	-1.9%

One of the most notable demographic changes in this time period was an increase in older residents, including both baby boomers and older seniors, and a decrease in the number of younger residents. If this trend continues, Bucks County will see an increase in the population who are vulnerable to the

impacts of a number of the profiled hazards, including extreme temperatures, tornados, and utility interruptions.

During the "Bucks County Comprehensive Plan" update process in 2011, the Bucks County Planning Commission (BCPC) ran and compared the results of a number of population and housing growth forecasts from 2010 to 2020 and from 2020 to 2030. The BCPC used a continuous growth rate shown between 2000 and 2010, 4.6 percent, to project the growth from 2010 to 2020, as well as rates projected for 2020 and 2030 from Penn State Data Center, and the Delaware Valley Regional Planning Commission. These rates were turned into "high" and "low" projections to show the range of growth potential in Bucks County, illustrated in Figure 4.4-2.

Figure 4.4-2: Bucks County Population and Housing Projections, 2020 and 2030

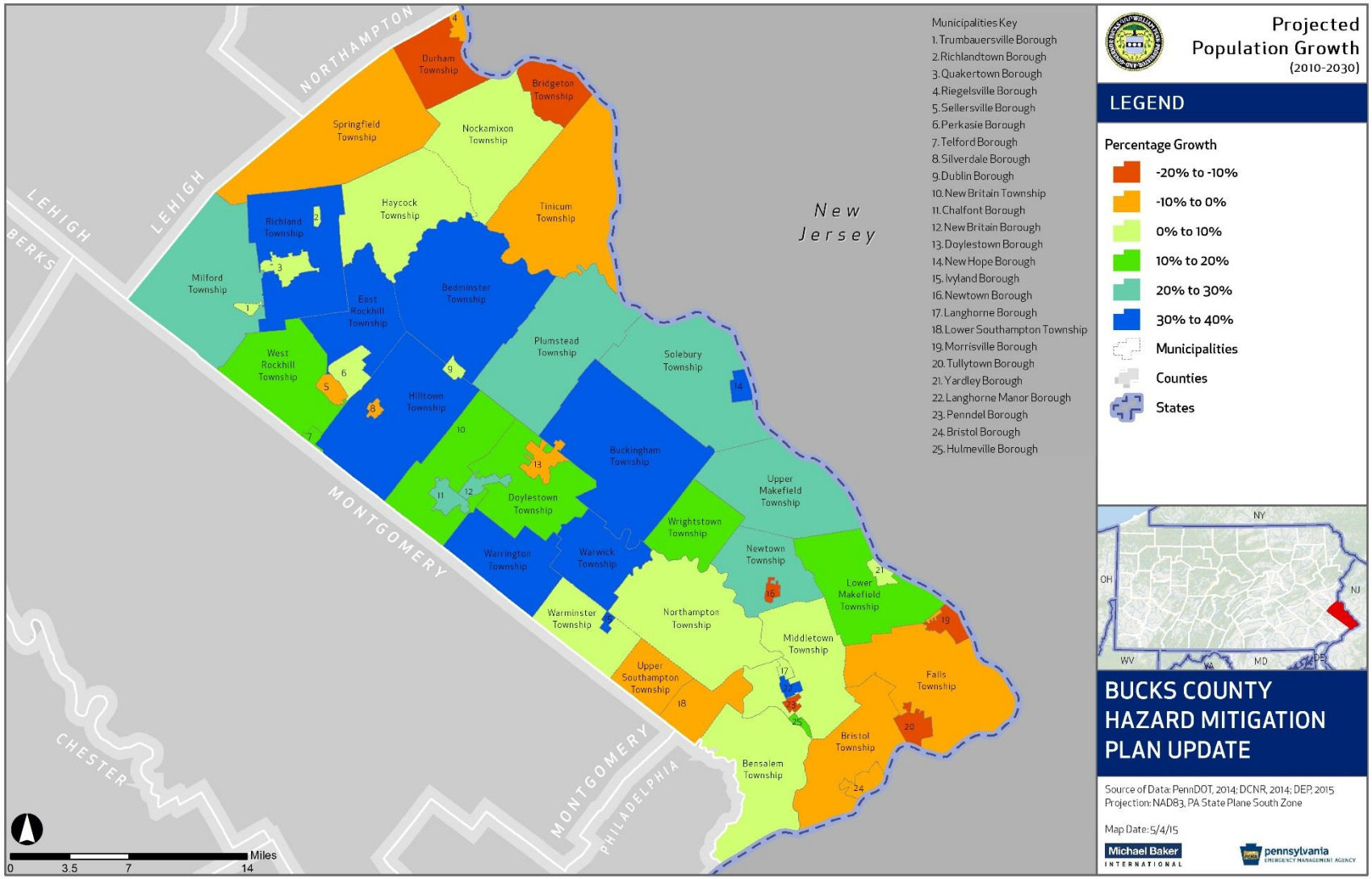


Making use of the analysis of Bucks County's current and population and demographics along with future population trends, it is important to explore how these projected changes may influence the County's future vulnerability to the profiled hazards. Hazard vulnerability and loss potential will be higher in the places of higher density throughout the County, so as areas continue to grow and densify, these communities might become more vulnerable to hazards. For example, population growth and its associated development is likely to create increases in loss potential, as more people may be living in areas prone to hazards, especially flooding, winter storms, and wildfires. The Pennsylvania Department of Environmental Protection completed a population projection for each municipality in Bucks County by 2030, shown in Figure 4.4-3.

According to these projections, the municipalities listed below will have the highest population growth. The municipalities are listed with the high or moderate hazards that they experience a higher risk for than the county as a whole, as reported in Section 4.4.2:

- Bedminster Township: Wildfire, Drought, Tornado/Windstorm
- Buckingham Township: Hurricane/Tropical Storm/Nor'easter
- East Rockhill Township: N/A
- Hilltown Township: Flood/Flash Flood/Ice Jam, Winter Storm
- Ivyland Borough: Environmental Hazards, Transportation Accidents
- Langhorne Manor Borough: Transportation Accidents
- New Hope Borough: Flood/Flash Flood/Ice Jam, Hurricane/Tropical Storm/Nor'easter
- Richland Township: Environmental Hazards, Wildfire, Drought
- Warrington Township: Environmental Hazards, Transportation Accidents, Wildfire, Drought
- Warwick Township: Winter Storm, Hurricane/Tropical Storm/Nor'easter, Transportation Accidents, Extreme Temperatures, Drought

Figure 4.4-3: Map of Projected Population Growth in Bucks County (PA DEP, 2015).



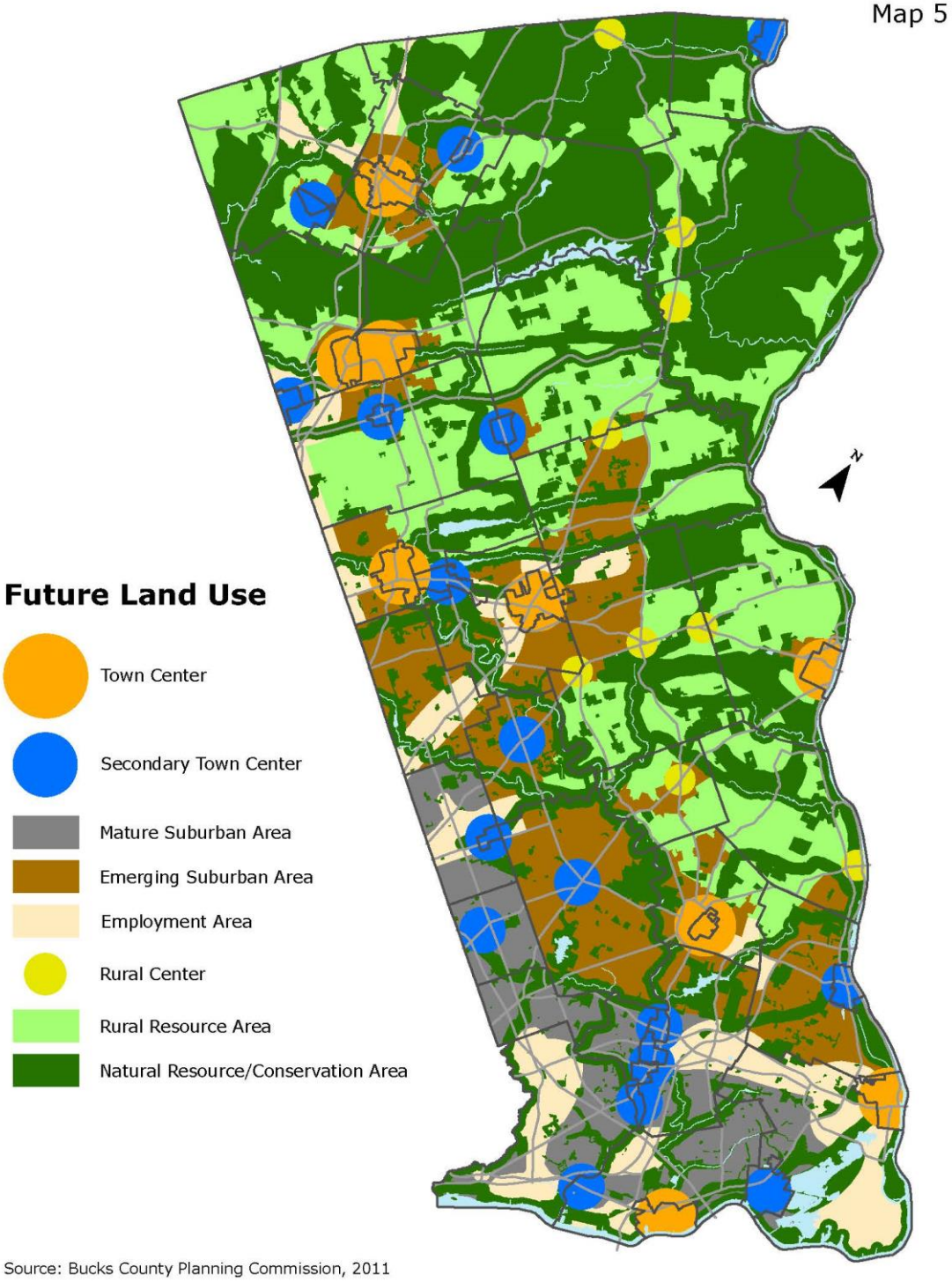
Taking into account population and development trends, the County has designated future areas for growth in the County's Future Land Use Plan map, which is provided in the Comprehensive Plan. The map was developed under the principles of Smart Growth, which seeks to concentrate development around existing infrastructure and transportation networks to preserve open space and natural resources. By identifying areas appropriate for development, the County can better coordinate its growth and steer development away from environmentally sensitive areas and agricultural land.

Nine land use categories were identified in the Future Land Use Plan and include:

- **Town Centers:** High-density, mixed-use development with pedestrian-oriented design and access to transportation networks and a variety of public services (e.g. hospitals, schools, social services).
- **Secondary Town Centers:** Smaller nodes of commercial activity that are expected to function as focal points for redevelopment. Secondary Town Centers are similar to Town Centers but are not as densely developed or offer a diversity of public services, infrastructure, or mix of uses.
- **Mature Suburban Areas:** Older, residential areas that are primarily built-out. Development in these areas will be focused on redevelopment of underutilized lands and effective neighborhood planning.
- **Emerging Suburban Areas:** Areas with available public infrastructure and services intended for future development by municipalities where Smart Growth development should be implemented.
- **Employment Areas:** Single-use, nonresidential areas primarily located along arterial corridors and transportation networks.
- **Rural Centers:** Commercial villages that are in adjacent or located within Natural Resource/Conservation Areas. New development should continue with village-style development that is compact and pedestrian–oriented.
- **Rural Resource Areas:** Large lots, with low density, primarily rural residential and agricultural uses. These areas are not meant for significant development and contain resource rich lands (e.g. farms, significant agricultural soils, and mineral or timber areas).
- **Natural Resource/Conservation Areas:** Largely undeveloped areas that can include greenway corridors, recreation areas, and areas of significant natural resources.
- **Unique Land Uses:** Areas with uses that are significant countywide (e.g. airports, quarries, and landfills).

Figure 4.4-4 illustrates these designated future growth areas.

Figure 4.4-4: Bucks County Future Land Use Plan (BCPC, 2011).



Other initiatives in Bucks County that will influence future development and have the potential to decrease the hazard vulnerability in the future include:

- Efforts to acquire and elevate flood prone properties by Bucks County and individual municipalities.
- A strong comprehensive planning history that began with the Bucks County's first Comprehensive Plan in 1961. The Plan was updated in 1977, 1993, and 2011.
- A defined management process to protect existing and create new linkages between existing greenways across the County captured in the "Bucks County Open Space and Greenways Plan."
- Existing mitigation studies including the 1998 DVRPC document "Bucks County Flood Recovery and Mitigation Strategy" and 2001 "Neshaminy Creek Supplemental Watershed Work Plan No. 5." set the county on a path towards mitigation planning that complements and extends the FEMA Hazard Mitigation planning program.
- All municipalities are covered by a countywide watershed stormwater planning initiative.

Historic Properties

The HMPC determined the need to plan for mitigation specifically for historic properties in Bucks County for the 2016 HMP update. The National Register of Historic Places recognizes five different types of historic properties (NPS, 2002):

- **Building:** A building is created principally to shelter any form of human activity. Properties that qualify as buildings include, but are not limited to, houses, barns, churches, and hotels, and can also refer to a historically and functionally related unit, such as a courthouse and jail.
- **Structure:** A structure is a functional construction made usually for purposes other than creating human shelter. Properties that qualify as structures include, but are not limited to, automobiles, canals, carousels, dams, fences, gazebos, highways, lighthouses, and silos.
- **Object:** An object in a construction that is primarily artistic in nature, and is usually relatively small in scale and simply constructed. Although it may be movable, an object is associated with a specific setting. Properties that qualify as objects include, but are not limited to, boundary markers, monuments, mileposts, fountains, and sculptures.
- **Site:** A site is the location of a significant event, an occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the location itself possesses historic, cultural, or archeological value regardless of the value of any existing structure. Properties that qualify as sites include, but are not limited to, battlefields, campsites, cemeteries, natural feature, rock carving, trail, and village site.
- **District:** A district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development. Properties that qualify as districts include, but are not limited to, business districts, canal systems, college campuses, estates, industrial complexes, residential areas, rural villages, and transportation networks.

Bucks County has a rich history, with many designated historic buildings, districts, sites, objects, and structures throughout the county. Historic properties help citizens understand their unique heritage, their cultural identity, and the origins of their community. Because of the role these properties and areas play in the community, they also provide a familiar "sense of place" for the residents of Bucks County, especially after a disaster. In the aftermath of past disasters, residents have relied on the presence of these areas and properties as a source of comfort. Historic districts, structures, sites, objects, and buildings can also often be valuable economic assets and tourism attractions, which is critical to the economic stability of a community before and after a disaster.

Additionally, the National Historic Preservation Act mandates that there be a review process for all federally funded and permitted projects that will impact sites listed on, or eligible for listing on, the National Register of Historic Places (P.L. 89-665-106, 1966). If one of the registered or eligible properties are affected by a disaster, then all rehabilitation projects will need to undergo a review process, which could slow the recovery process. For all of these reasons, it is important to mitigate the effects of hazards on these historic properties.

Historic properties in Bucks County can be vulnerable to the impacts of all of the hazards profiled in the 2016 HMP; however, the initial analysis focused on flooding hazards in relation to the location of the designated historic properties. The Pennsylvania Historical and Museum Commission (PHMC) maintains a database of registered and evaluated and unevaluated eligible properties in the Cultural Resources GIS (CRGIS) system. This data includes the locations and information on each of the identified properties in Bucks County, including those identified by the state or the locality as having historical or cultural importance. The locations of all identified historic districts, structures, sites, objects, and buildings and the location of floodplains in Bucks County are illustrated in Figure 4.4-5. Table 4.4-12 details the number of properties included in the CRGIS system that were evaluated and assigned a property type, as well as the number of properties that are in the Special Flood Hazard Area, in each municipality.

Figure 4.4-5: Designated Historic Properties in Bucks County and Floodplain Locations (PHMC, 2015).

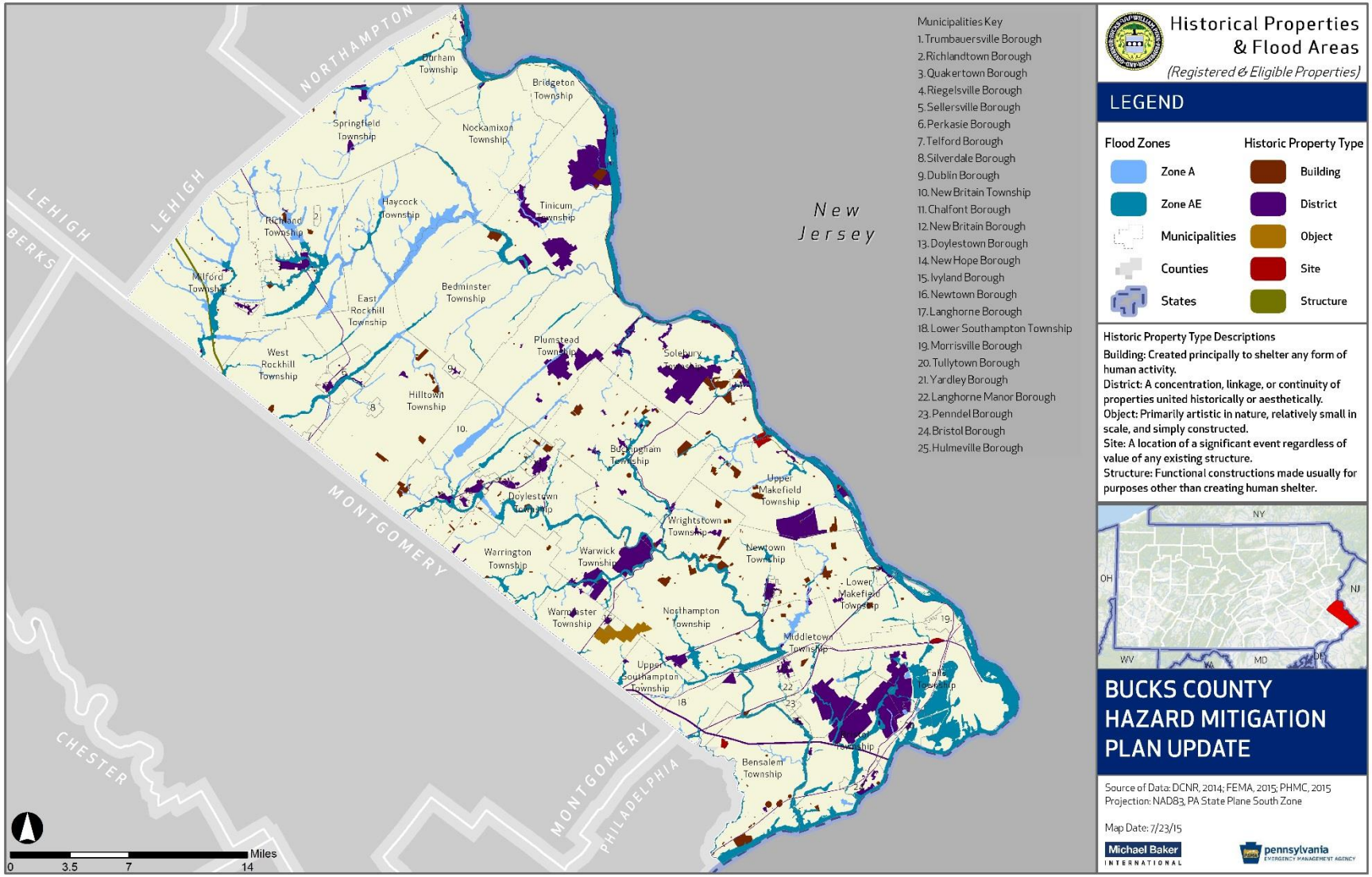


Table 4.4-12: Historical properties in the Special Flood Hazard Area by Municipality (PHMC, 2015).

MUNICIPALITY	BUILDINGS*	BUILDINGS IN SFHA	PERCENT BUILDINGS IN SFHA	DISTRICTS*	DISTRICTS IN SFHA	PERCENT DISTRICTS IN SFHA	OBJECTS	OBJECTS IN SFHA	PERCENT OBJECTS IN SFHA	SITES	SITES IN SFHA	PERCENT SITES IN SFHA	STRUCTURES*	STRUCTURES IN SFHA	PERCENT STRUCTURES IN	TOTAL HISTORICAL PROPERTIES	HISTORICAL PROPERTIES IN SFHA	PERCENT PROPERTIES IN SFHA
Bedminster Township	24	4	17%	1	1	100%	0	0	0%	0	0	0%	16	9	56%	41	14	34%
Bensalem Township	114	5	4%	2	0	0%	0	0	0%	5	0	0%	16	2	13%	137	7	5%
Bridgeton Township	4	3	75%	0	0	0%	0	0	0%	0	0	0%	12	4	33%	16	7	44%
Bristol Borough	488	2	0%	7	4	57%	0	0	0%	0	0	0%	6	1	17%	501	7	1%
Bristol Township	146	26	18%	8	1	13%	1	0	0%	0	0	0%	13	7	54%	168	34	20%
Buckingham Township	87	8	9%	13	5	38%	0	0	0%	0	0	0%	13	9	69%	113	22	19%
Chalfont Borough	39	0	0%	3	2	67%	0	0	0%	0	0	0%	1	1	100%	43	3	7%
Doylestown Borough	86	0	0%	93	0	0%	0	0	0%	0	0	0%	2	1	50%	181	1	1%
Doylestown Township	78	13	17%	4	3	75%	0	0	0%	0	0	0%	12	2	17%	94	18	19%
Dublin Borough	0	0	0%	1	0	0%	0	0	0%	0	0	0%	0	0	0%	1	0	0%
Durham Township	20	7	35%	0	0	0%	0	0	0%	0	0	0%	8	6	75%	28	13	46%
East Rockhill Township	2	1	50%	0	0	0%	0	0	0%	0	0	0%	11	8	73%	13	9	69%
Falls Township	36	0	0%	2	0	0%	0	0	0%	2	2	100%	31	14	45%	71	16	23%
Haycock Township	59	0	0%	0	0	0%	0	0	0%	0	0	0%	8	3	38%	67	3	4%
Hilltown Township	32	4	13%	1	0	0%	0	0	0%	0	0	0%	14	7	50%	47	11	23%
Hulmeville Borough	9	0	0%	2	2	100%	0	0	0%	0	0	0%	0	0	0%	11	2	18%
Ivyland Borough	2	0	0%	2	0	0%	0	0	0%	0	0	0%	0	0	0%	4	0	0%
Langhorne Borough	7	0	0%	4	0	0%	0	0	0%	0	0	0%	0	0	0%	11	0	0%
Langhorne Manor Borough	2	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	2	0	0%
Lower Makefield Township	43	8	19%	2	0	0%	0	0	0%	0	0	0%	10	3	30%	55	11	20%
Lower Southampton Township	14	0	0%	1	0	0%	0	0	0%	1	0	0%	7	3	43%	23	3	13%
Middletown Township	32	4	13%	1	1	100%	0	0	0%	0	0	0%	8	5	63%	41	10	24%
Milford Township	45	5	11%	2	2	100%	0	0	0%	0	0	0%	17	11	65%	64	18	28%

Table 4.4-12: Historical properties in the Special Flood Hazard Area by Municipality (PHMC, 2015).

MUNICIPALITY	BUILDINGS*	BUILDINGS IN SFHA	PERCENT BUILDINGS IN SFHA	DISTRICTS*	DISTRICTS IN SFHA	PERCENT DISTRICTS IN SFHA	OBJECTS	OBJECTS IN SFHA	PERCENT OBJECTS IN SFHA	SITES	SITES IN SFHA	PERCENT SITES IN SFHA	STRUCTURES*	STRUCTURES IN SFHA	PERCENT STRUCTURES IN	TOTAL HISTORICAL PROPERTIES	HISTORICAL PROPERTIES IN SFHA	PERCENT PROPERTIES IN SFHA
Morrisville Borough	19	2	11%	0	0	0%	0	0	0%	0	0	0%	12	4	33%	31	6	19%
New Britain Borough	46	3	7%	3	1	33%	0	0	0%	0	0	0%	5	1	20%	54	5	9%
New Britain Township	71	6	8%	1	0	0%	0	0	0%	4	0	0%	11	8	73%	87	14	16%
New Hope Borough	7	1	14%	4	4	100%	0	0	0%	0	0	0%	6	3	50%	17	8	47%
Newtown Borough	434	2	0%	26	3	12%	0	0	0%	0	0	0%	4	2	50%	464	7	2%
Newtown Township	41	4	10%	5	3	60%	0	0	0%	0	0	0%	2	1	50%	48	8	17%
Nockamixon Township	6	0	0%	2	1	50%	0	0	0%	0	0	0%	15	7	47%	23	8	35%
Northampton Township	48	4	8%	1	1	100%	0	0	0%	0	0	0%	12	3	25%	61	8	13%
Penndel Borough	2	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	2	0	0%
Perkasie Borough	9	0	0%	2	1	50%	0	0	0%	0	0	0%	3	3	100%	14	4	29%
Plumstead Township	25	0	0%	5	2	40%	0	0	0%	1	0	0%	19	7	37%	50	9	18%
Quakertown Borough	20	4	20%	1	1	100%	0	0	0%	0	0	0%	6	6	100%	27	11	41%
Richland Township	20	3	15%	1	1	100%	0	0	0%	1	0	0%	9	6	67%	31	10	32%
Richlandtown Borough	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Riegelsville Borough	4	2	50%	1	1	100%	0	0	0%	0	0	0%	2	2	100%	7	5	71%
Sellersville Borough	37	3	8%	3	1	33%	0	0	0%	0	0	0%	3	1	33%	43	5	12%
Silverdale Borough	1	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	1	0	0%
Solebury Township	86	11	13%	66	7	11%	0	0	0%	0	0	0%	26	17	65%	178	35	20%
Springfield Township	8	2	25%	3	3	100%	0	0	0%	0	0	0%	9	6	67%	20	11	55%
Telford Borough	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Tinicum Township	50	12	24%	5	4	80%	0	0	0%	0	0	0%	34	23	68%	89	39	44%
Trumbauersville Borough	1	0	0%	1	0	0%	0	0	0%	0	0	0%	0	0	0%	2	0	0%
Tullytown Borough	13	0	0%	1	1	100%	0	0	0%	0	0	0%	3	2	67%	17	3	18%
Upper Makefield Township	75	9	12%	6	3	50%	0	0	0%	1	0	0%	10	4	40%	92	16	17%

Table 4.4-12: Historical properties in the Special Flood Hazard Area by Municipality (PHMC, 2015).

MUNICIPALITY	BUILDINGS*	BUILDINGS IN SFHA	PERCENT BUILDINGS IN SFHA	DISTRICTS*	DISTRICTS IN SFHA	PERCENT DISTRICTS IN SFHA	OBJECTS	OBJECTS IN SFHA	PERCENT OBJECTS IN SFHA	SITES	SITES IN SFHA	PERCENT SITES IN SFHA	STRUCTURES*	STRUCTURES IN SFHA	PERCENT STRUCTURES IN	TOTAL HISTORICAL PROPERTIES	HISTORICAL PROPERTIES IN SFHA	PERCENT PROPERTIES IN SFHA
Upper Southampton Township	30	0	0%	1	1	100%	0	0	0%	0	0	0%	5	2	40%	36	3	8%
Warminster Township	10	0	0%	2	0	0%	1	0	0%	0	0	0%	3	1	33%	16	1	6%
Warrington Township	66	2	3%	2	0	0%	0	0	0%	0	0	0%	1	1	100%	69	3	4%
Warwick Township	65	4	6%	2	0	0%	0	0	0%	1	0	0%	13	8	62%	81	12	15%
West Rockhill Township	18	1	6%	1	0	0%	0	0	0%	0	0	0%	8	2	25%	27	3	11%
Wrightstown Township	35	6	17%	4	1	25%	0	0	0%	0	0	0%	13	4	31%	52	11	21%
Yardley Borough	3	1	33%	4	1	25%	0	0	0%	0	0	0%	8	4	50%	15	6	40%
Multiple Municipalities	2	0	0%	23	15	65%	0	0	0%	1	1	100%	29	21	72%	55	37	67%
Grand Total	**2,621**	**172**	**7%**	**325**	**77**	**24%**	**2**	**0**	**0%**	**17**	**3**	**18%**	**476**	**245**	**51%**	**3,441**	**497**	**14%**

*PHMC catalogues data by evaluated features; in some cases this system results in the reporting of multiple numbers of buildings, districts, and structures where only one building, district, or structure exists. This is not the case for in every municipality, but can result in a higher number of reported properties for some municipalities..

Mitigation planning for historic properties is a four phase process, which is summarized in Table 4.4-13.

Table 4.4-13: Phased Approach for Historic Property Mitigation Planning (FEMA, 2015).

PHASE	STEP
Phase 1: Organize Resources	Assess the level of awareness and support for protecting your community's historic properties, and identify resources for mitigating hazards to historic properties
	Build the planning team; identify and recruit historic preservation experts
	Engage the public during key points in the hazard mitigation planning process
Phase 2: Assess Risks	Identify hazards that are likely to affect your community
	Profile hazards to determine hazard-prone areas and the magnitude of each hazard
	Inventory historic properties vulnerable to likely hazards by conducting field surveys for unknown resources and performing a geospatial analysis of known and newly identified resources
	Estimate the associated amount of potential losses to historic properties
Phase 3: Develop a Mitigation Plan	Develop mitigation goals and objectives for your historic properties based on your community's preservation priorities
	Identify, evaluate, and prioritize actions
	Prepare an implementation strategy
	Document the mitigation planning process and public input
Phase 4: Implement the Plan and Monitor Progress	Sensitivity of information
	Required regulatory review
	Interagency coordination and agreements
	Evaluate and update your plan
	Update your historic property inventory data

The Pennsylvania Historical and Museum Commission (PHMC) has limited funds to provide to municipalities to for planning and for project implementation under the Keystone Historic Preservation Program. The Keystone program provides funding support for projects that identify, preserve, promote, and protect historic and archaeological resources, including those vulnerable to hazards. Additionally, FEMA Pre-Disaster Mitigation grant funds can also be used for this planning.

Through the HMP update planning process ten municipalities – Bensalem Township, Bristol Borough, Doylestown Township, Haycock Township, Richland Township, Solebury Township, Springfield Township, Tinicum Township, Upper Makefield Township, and Yardley Borough – expressed interest in beginning to explore hazard mitigation planning for their historic properties. Municipal level detail maps for each of these municipalities are included in **Appendix H – Local Municipality Historic Property Vulnerability Maps**. More detail on the planning process these municipalities undertook and the mitigation actions they have identified for further planning is included in Section 6.

5. Capability Assessment

5.1. Update Process Summary

Bucks County has a number of resources it can access to implement hazard mitigation initiatives including emergency response measures, local planning and regulatory tools, administrative assistance and technical expertise, fiscal capabilities, and participation in local, regional, state, and federal programs. The presence of these resources enables community resiliency through actions taken before, during, and after a hazard event.

The 2011 HMP update included a process to validate the human, physical, technological, informational, planning, and financial resources identified in the 2006 HMP Capability Assessment. Additionally, the Planning Team completed a Capability Assessment Survey, which was distributed to all 54 municipalities, to identify additional capabilities and resources to support hazard mitigation in Bucks County. The 2011 HMP provided an updated inventory of the most critical local planning tools available within each municipality and a summary of the fiscal and technical capabilities available through programs and organizations outside of the County. It also identified emergency management capabilities and the processes used for implementation of the National Flood Insurance Program.

For the 2016 HMP update, the HMPC completed a revised Capability Assessment Survey, which was developed based on the most recent FEMA and PEMA guidance. The survey asked about the most common plans, tools, and programs found in Pennsylvania communities; about staff and personnel resources; about financial resources; about the community political willingness to enact policies and programs related to mitigation; and ended with a self-assessment of capabilities. In addition, communities completed FEMA's National Flood Insurance Program (NFIP) Worksheet as a part of assessing their capabilities. The NFIP Worksheet was developed to obtain information on participation in and compliance with the NFIP as well as to identify areas for potential mitigation actions. A number of the data points and statistics available via FEMA's Community Information System (CIS) were pre-populated on the worksheet, allowing municipalities to focus their comments on how they implement the NFIP in their community.

While the capability assessment serves as a good instrument for identifying local capabilities, it also provides a means for recognizing gaps and weaknesses that can be resolved through future mitigation actions. The results of this assessment lend critical information for developing an effective mitigation strategy.

5.2. Capability Assessment Findings

Within Pennsylvania, no county-level capability assessment would be complete without considering the constituent municipalities. Local municipalities have their own governing body, enforce their own rules and regulations, purchase their own equipment, maintain their own infrastructure, and manage their own resources. In many ways, the County is only as good as the capabilities of its constituent municipalities. As such, this capability assessment does not consider Bucks County as a lone entity, but evaluates it in light of the various characteristics and differences of and between its municipalities.

Bucks County's municipalities carry out their daily operations and provide various community services according to their local needs and limitations. Some of these municipalities have formed cooperative agreements and they work jointly with their neighboring municipalities to provide such services as police protection, fire and emergency response, solid waste disposal, recreational opportunities, wastewater treatment, infrastructure maintenance, and water supply management, while others choose to operate on their own. They vary in staff size, resource availability, fiscal status, service provision, municipal population, overall size, and vulnerability to the profiled hazards. As such, it is easy to see why the County's capabilities to deal with hazards are a reflection of the local municipalities.

Generally speaking, the municipalities in Bucks County that tend to have fewer residents usually have less staff, and, by default, a more limited supply of available resources than those municipalities in the more urbanized parts of the County. This is not to say, however, that hazard mitigation is not an important factor in less populated areas of the County. It simply may require a more unified or coordinated approach and/or more efficient utilization of a limited supply of available resources (e.g., financial, technical, and human).

5.2.1. Planning and Regulatory Capability

Pennsylvania municipalities have the authority to govern more restrictively than the state and federal minimum requirements, as long as they are in compliance with all criteria established in the Pennsylvania Municipalities Planning Code (MPC). Municipalities can develop their own policies and programs and implement their own rules and regulations to protect and serve their local residents. Bucks County and municipalities have used, and could continue to use, planning and regulatory tools to support the goals of this hazard mitigation plan and to provide opportunities for further mitigating the potentially negative effects of hazards.

Municipalities implement land use controls via the adoption and enforcement of zoning, subdivision and land development ordinances, building codes, building permit ordinances, floodplain, and stormwater management ordinances. When effectively prepared and administered, these regulations can lead to hazard mitigation. For example, the adoption of the NFIP and the Pennsylvania Floodplain Management Act (Act 166 of 1978) established minimum floodplain management criteria. A municipality must adopt and enforce these minimum criteria to be eligible for participation in the NFIP. Municipalities have the option of adopting a single-purpose ordinance or incorporating these provisions into their zoning and/or subdivision and land development ordinances, or building codes, thereby mitigating the potential impacts of local flooding.

5.2.1.1. Plans and Regulations

Some of the most important planning and regulatory capabilities that can be utilized for hazard mitigation include comprehensive plans, building codes, floodplain ordinances, subdivision and land development ordinances, and zoning ordinances. These tools provide mechanisms for the implementation of adopted mitigation strategies.

Land Use Planning and Regulation Tools

The subsections below provide details on the types of plans and ordinances that Bucks County and the municipalities use to support the goals of this hazard mitigation plan and provide opportunities for further mitigating the potentially negative effects of natural hazards through land use regulation.

Comprehensive Plans

Comprehensive Plans promote sound land use and regional cooperation among local governments to address planning issues. A comprehensive plan is a policy document that states objectives and guides the future growth and physical development of a municipality. These plans serve as the official policy guide for influencing the location, type, and extent of future development by establishing the basis for decision-making and review processes on zoning matters, subdivision and land development, land uses, public facilities and housing needs over time. Pennsylvania's MPC (Act 247 of 1968), as reauthorized and amended, requires counties to prepare and maintain a county comprehensive plan and to update it every 10 years. County governments are required by law to adopt a comprehensive plan, while local municipalities may do so at their option.

With regard to hazard mitigation planning, Section 301(a)2 of the MPC requires comprehensive plans to include a plan for land use, which, among other provisions, suggests that the Plan give consideration to floodplains and other areas of special hazards and other similar uses. The MPC also requires comprehensive plans to include a plan for community facilities and services, and recommends giving consideration to storm drainage and floodplain management.

The existing countywide Comprehensive Plan for Bucks County was developed in 1993 and was updated in 2011. Additionally, all municipalities have developed and adopted comprehensive plans.

Zoning Ordinances

Zoning ordinances allow for local communities to regulate the use of land in order to protect the interested and safety of the general public. Zoning ordinances can be designed to address unique conditions or concerns within a given community. They may be used to create buffers between structures and high-risk areas, limit the type or density of development, and/or require land development to consider specific hazard vulnerabilities. All municipalities in Bucks County have zoning regulations.

Subdivision and Land Development Ordinances

Subdivision and land development ordinances (SALDOs) are intended to regulate the development of housing, commercial, industrial, or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Within these ordinances, guidelines on how land will be divided, the placement and size of roads and the location of infrastructure can reduce exposure of development to hazard events. All jurisdictions within Bucks County have adopted and enforce a subdivision and land development ordinance, see Table 5.2-1.

Floodplain Ordinances

Through administration of floodplain ordinances, municipalities can ensure that all new construction or substantial improvements to existing structures located in the floodplain are flood-proofed, dry-proofed, or built above anticipated flood elevations. Floodplain ordinances may also prohibit development in

certain areas altogether. The NFIP establishes minimum ordinance requirements which must be met in order for that community to participate in the program. However, a community is permitted and in fact, encouraged, to adopt standards which exceed NFIP requirements. Bucks County's floodplain ordinances use the Pennsylvania Model Floodplain Ordinance, and some exceed the minimums; more information on the model ordinance is in Section 5.2.1.3.

Building Codes

Building codes regulate construction standards for new construction and substantially renovated buildings. Standards can be adopted that require resistant or resilient building design practices to address hazard impacts common to a given community. In 2003, the Commonwealth of Pennsylvania implemented Act 45 of 1999, the Uniform Construction Code (UCC), a comprehensive building code that establishes minimum regulations for most new construction, including additions and renovations to existing structures. All 54 municipalities in Bucks County are required to adhere to the UCC. On December 10, 2009 the Commonwealth adopted regulations of the 2009 International Code Council's codes. The effective date of the regulations is December 31, 2009. Since all municipalities in Bucks County are required to abide by the UCC they are required to enforce the 2009 building code regulations for all building permits submitted after December 31, 2009. If a design or construction contract for proposed work was signed between December 31, 2006 and December 30, 2009 then the 2006 International Codes must be abided.

Bucks County and Municipality Capabilities

Table 5.2-1 includes the regulatory capabilities that were identified by the municipalities during the planning process, as well as through Bucks County records.

Table 5.2-1: Summary of planning tools adopted by each municipality in Bucks County (HMP Capability Assessment Surveys, 2016; Bucks County Planning Commission, 2015)

MUNICIPALITY	COMPREHENSIVE PLAN	BUILDING CODE	FLOODPLAIN ORDINANCE - NFIP PARTICIPANT	SUBDIVISION & LAND DEVELOPMENT ORDINANCE	ZONING ORDINANCE
Bedminster Township	Yes	Yes	Yes	Yes	Yes
Bensalem Township	Yes	Yes	Yes	Yes	Yes
Bridgeton Township	Yes	Yes	Yes	Yes	Yes
Bristol Borough	Yes	Yes	Yes	Yes	Yes
Bristol Township	Yes	Yes	Yes	Yes	Yes
Buckingham Township	Yes	Yes	Yes	Yes	Yes
Chalfont Borough	Yes	Yes	Yes	Yes	Yes
Doylestown Borough	Yes	Yes	Yes	Yes	Yes
Doylestown Township	Yes	Yes	Yes	Yes	Yes
Dublin Borough	Yes	Yes	No (No SFHA)	Yes	Yes

Table 5.2-1: Summary of planning tools adopted by each municipality in Bucks County (HMP Capability Assessment Surveys, 2016; Bucks County Planning Commission, 2015)

MUNICIPALITY	COMPREHENSIVE PLAN	BUILDING CODE	FLOODPLAIN ORDINANCE - NFIP PARTICIPANT	SUBDIVISION & LAND DEVELOPMENT ORDINANCE	ZONING ORDINANCE
Durham Township	Yes	Yes	Yes	Yes	Yes
East Rockhill Township	Yes	Yes	Yes	Yes	Yes
Falls Township	Yes	Yes	Yes	Yes	Yes
Haycock Township	Yes	Yes	Yes	Yes	Yes
Hilltown Township	Yes	Yes	Yes	Yes	Yes
Hulmeville Borough	Yes	Yes	Yes	Yes	Yes
Ivyland Borough	Yes	Yes	No (No SFHA)	Yes	Yes
Langhorne Borough	Yes	Yes	Yes	Yes	Yes
Langhorne Manor Borough	Yes	Yes	Yes	Yes	Yes
Lower Makefield Township	Yes	Yes	Yes	Yes	Yes
Lower Southampton Township	Yes	Yes	Yes	Yes	Yes
Middletown Township	Yes	Yes	Yes	Yes	Yes
Milford Township	Yes	Yes	Yes	Yes	Yes
Morrisville Borough	Yes	Yes	Yes	Yes	Yes
New Britain Borough	Yes	Yes	Yes	Yes	Yes
New Britain Township	Yes	Yes	Yes	Yes	Yes
New Hope Borough	Yes	Yes	Yes	Yes	Yes
Newtown Borough	Yes	Yes	Yes	Yes	Yes
Newtown Township	Yes	Yes	Yes	Yes	Yes
Nockamixon Township	Yes	Yes	Yes	Yes	Yes
Northampton Township	Yes	Yes	Yes	Yes	Yes
Penndel Borough	Yes	Yes	Yes	Yes	Yes
Perkasie Borough	Yes	Yes	Yes	Yes	Yes
Plumstead Township	Yes	Yes	Yes	Yes	Yes
Quakertown Borough	Yes	Yes	Yes	Yes	Yes
Richland Township	Yes	Yes	Yes	Yes	Yes
Richlandtown Borough	Yes	Yes	No (No SFHA)	Yes	Yes
Riegelsville Borough	No	Yes	Yes	Yes	Yes
Sellersville Borough	Yes	Yes	Yes	Yes	Yes
Silverdale Borough	Yes	Yes	Yes	Yes	Yes

Table 5.2-1: Summary of planning tools adopted by each municipality in Bucks County (HMP Capability Assessment Surveys, 2016; Bucks County Planning Commission, 2015)

MUNICIPALITY	COMPREHENSIVE PLAN	BUILDING CODE	FLOODPLAIN ORDINANCE - NFIP PARTICIPANT	SUBDIVISION & LAND DEVELOPMENT ORDINANCE	ZONING ORDINANCE
Solebury Township	Yes	Yes	Yes	Yes	Yes
Springfield Township	Yes	Yes	Yes	Yes	Yes
Telford Borough	Yes	Yes	No (No SFHA)	Yes	Yes
Tinicum Township	Yes	Yes	Yes	Yes	Yes
Trumbauersville Borough	Yes	Yes	Yes (No Participation in NFIP)	Yes	Yes
Tullytown Borough	Yes	Yes	Yes	Yes	Yes
Upper Makefield Township	Yes	Yes	Yes	Yes	Yes
Upper Southampton Township	Yes	Yes	Yes	Yes	Yes
Warminster Township	Yes	Yes	Yes	Yes	Yes
Warrington Township	Yes	Yes	Yes	Yes	Yes
Warwick Township	Yes	Yes	Yes	Yes	Yes
West Rockhill Township	Yes	Yes	Yes	Yes	Yes
Wrightstown Township	Yes	Yes	Yes	Yes	Yes
Yardley Borough	Yes	Yes	Yes	Yes	Yes

Stormwater Management Planning and Regulation Tools

The proper management of stormwater runoff can improve conditions and decrease the chance of flooding. The Pennsylvania legislature enacted the Stormwater Management Act (Act 167 if 1978), commonly called Act 167, requiring counties to develop stormwater management plans for designated watersheds. This planning effort results in sound engineering standards and criteria being incorporated into local codes and ordinances to manage stormwater runoff from new development in a coordinated, watershed-wide approach. Without such planning, stormwater is either not controlled by municipal ordinances, or is addressed on a site-to-site or municipal boundary basis. Municipalities within the same watershed may require different levels of control of stormwater. The result is often the total disregard of downstream impacts or the compounding of existing flooding problems.

Act 167 Stormwater Management Plans are intended to improve stormwater management practices, mitigate potential negative impacts from future land uses, and to improve the condition of impaired waterways. This type of plan provides local ordinances that incorporate standards and criteria to manage

and maintain peak runoff flows throughout the combined watersheds as development occurs. Also, it is not the intent of this plan to solve existing flooding or runoff problems, but to identify them for future correction and assure that problems do not get worse. More specifically, this plan does not require the municipalities to correct existing drainage problems.

Bucks County has strong watershed and stormwater management planning and Municipal Environmental Advisory Councils that complement other regulations to protect property owners from floodwaters and the natural landscape from pollution and hazardous materials; see Table 5.2-2 for specific stormwater management plans and regulations in place in Bucks County municipalities.

Table 5.2-2: Watershed and Stormwater Management Planning and Regulations in Bucks County Municipalities

MUNICIPALITY	WATERSHED BOUNDARIES WITHIN MUNICIPALITY	ACT 167 PLAN ORDINANCE (DATE OF ADOPTION)	STORMWATER MANAGEMENT PLANS OR CRITERIA LOCATION	PEAK RATE CONTROL	REQUIRED TO SUBMIT A NPDES SMALL MS4 PERMIT?	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
Bedminster Township	Tochickon Creek and Perkiomen Creek	East Branch Perkiomen SMP 2004 and Tohickon Creek SMP 2002	Stand Alone	Yes	No	
Bensalem Township	Neshaminy Creek Poquessing Creek and Delaware River South		Yes--Bensalem Twp. SMP Section 201-105 SALDO & Water Quality Ordinance, Section 301 (2005-01).		Yes	Yes
Bridgeton Township	Delaware River North		Yes - Stand Alone 9/12/02	Yes	No	
Bristol Borough	Delaware River South and Neshaminy Creek	Neshaminy Creek Watershed SMP 2011 and DE South SMP 2004	Stand Alone	Yes	Yes	Yes
Bristol Township	Neshaminy Creek and Delaware River South		SALDO Section 518; Neshaminy Creek SMP & Storm. Mgmt. Ord. 9/2005	Yes	Yes	Yes
Buckingham Township	Neshaminy Creek and Delaware River South		Stand Alone	Yes	Yes	
Chalfont Borough	Neshaminy Creek		Storm Mngt. Ord. Chapter 26 Waters (Based on Neshaminy 2010)	Yes	Yes	Yes
Doylestown Borough	Neshaminy Creek		SALDO Ordinance amendment No. 2005-4		Yes	

Table 5.2-2: Watershed and Stormwater Management Planning and Regulations in Bucks County Municipalities

MUNICIPALITY	WATERSHED BOUNDARIES WITHIN MUNICIPALITY	ACT 167 PLAN ORDINANCE (DATE OF ADOPTION)	STORMWATER MANAGEMENT PLANS OR CRITERIA LOCATION	PEAK RATE CONTROL	REQUIRED TO SUBMIT A NPDES SMALL MS4 PERMIT?	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
Doylestown Township	Neshaminy Creek	Neshaminy Act 167 Plan (May 3, 2011)	Code of Ord.'s - Chapter 148	Yes	Yes	Yes
Dublin Borough	Tochickon Creek and E. Branch Perkiomen Creek		Yes. SALDO 1985 Article VII Section 705	Yes	No	
Durham Township	Delaware River North		Yes--Stormwater Management Ord. 8/2003	Yes	No	
East Rockhill Township	Tochickon Creek and Perkiomen Creek	Tohickon Creek Watershed Plan (2002)	SALDO, Section 22-516 & Water Ord. - 26-301	Yes	Yes	
Falls Township	Delaware River South	Delaware River South SMP 2004	Stormwater Management Ordinance 4/5/2005 & SALDO 191-46	Yes	Yes	Yes
Haycock Township	Tochickon Creek and Delaware River North		Yes--Stormwater Management Ord.#91 10/7/2002	Yes	No	
Hilltown Township	Neshaminy Creek E. Branch Perkiomen Creek and Tochickon Creek		SALDO- Section 140-40	Yes	Yes	
Hulmeville Borough	Neshaminy Creek		Code of Ord. Jan. 2002 - Chpt. 26, Part 3	Yes	Yes	
Ivyland Borough	Neshaminy Creek		SALDO - Section 606	Yes	Yes	
Langhorne Borough	Neshaminy Creek and Delaware River South		Yes--Ord. 1993 Neshaminy Creek Watershed & SALDO - Section 717	Yes	Yes	
Langhorne Manor Borough	Neshaminy Creek and Delaware River South		Yes--Ord. 1993 Neshaminy Creek Watershed	Yes	Yes	
Lower Makefield Township	Neshaminy Creek and Delaware River South		SALDO-Article XIII Section 178-93	Yes	Yes	Yes
Lower Southampton Township	Neshaminy Creek and Poquessing Creek	Neshaminy Act 167 Plan (2008)	Yes--Ord. #415 SALDO Section 604 & Chapter 17 Sections 101-908	Yes	Yes	

Table 5.2-2: Watershed and Stormwater Management Planning and Regulations in Bucks County Municipalities

MUNICIPALITY	WATERSHED BOUNDARIES WITHIN MUNICIPALITY	ACT 167 PLAN ORDINANCE (DATE OF ADOPTION)	STORMWATER MANAGEMENT PLANS OR CRITERIA LOCATION	PEAK RATE CONTROL	REQUIRED TO SUBMIT A NPDES SMALL MS4 PERMIT?	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
Middletown Township	Neshaminy Creek and Delaware River South		Amended Ord. 00-09 8/16/2000 & (Section 406 SALDO)	Yes	Yes	Yes
Milford Township	Perkiomen Creek and Tochickon Creek		SALDO Section 512	Yes	Yes / IP	
Morrisville Borough	Delaware River South		ZO-Section 465.15.I & SALDO Section 390-47 & Storm Sewage System & Stormwater Ordinance #951	Yes	Yes	Yes
New Britain Borough	Neshaminy Creek		Storm Mgmt. Ord. Amendment--SALDO 1996	Yes	Yes	
New Britain Township	Neshaminy Creek	Neshaminy Creek SMP	Stormwater Mgmt. Ord. Chapter 25 Stand Alone 4_4_11	Yes	Yes	Yes
New Hope Borough	Delaware River South		Yes-Article V Section 5.05 SALDO	Yes	No	
Newtown Borough	Neshaminy Creek	Neshaminy Creek SMP	Stormwater Ord. #333 (2/1993), SALDO--Section 606	Yes	Yes	
Newtown Township	Neshaminy Creek and Delaware River South	De River South (2004) and Neshaminy Creek SMP (2010)	Stand Alone Chapter 26 Water Part 2 Stormwater Management	Yes	Yes	Yes
Nockamixon Township	Delaware River North and Tohickon Creek	Delaware River North Act 167 Plan (2002) and Tohickon Creek (2002)as one standalone ordinance	Nockamixon Twp. Storm. Mgmt. Ord.106 Sept.18,2002 & SALDO Section 196-516	Yes	No	
Northampton Township	Neshaminy Creek and Little Neshaminy Creek		Chpt. 113 Ord. #499 Stormwater Mgmt. And Grading (Feb. 11, 2005)	Yes	Yes	

Table 5.2-2: Watershed and Stormwater Management Planning and Regulations in Bucks County Municipalities

MUNICIPALITY	WATERSHED BOUNDARIES WITHIN MUNICIPALITY	ACT 167 PLAN ORDINANCE (DATE OF ADOPTION)	STORMWATER MANAGEMENT PLANS OR CRITERIA LOCATION	PEAK RATE CONTROL	REQUIRED TO SUBMIT A NPDES SMALL MS4 PERMIT?	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
Penndel Borough	Delaware River South and Neshaminy Creek	Delaware River South Act 167 Plan (2005) Neshaminy Act 167 Plan (2005) as two stand alone ordinance	Storm. Mngt. Ord. 92-5, Amend. Dec. 1992 & Storm. Mgmt. Ord No. 2005-3--Article IV & Ord. No. 05-4, Article III.	Yes	Yes	
Perkasie Borough	East Branch Perkiomen and Tohickon Creek		SALDO - Section 164-32	Yes	Yes	
Plumstead Township	Neshaminy Creek Delaware River South and Tohickon Creek	Neshaminy Creek SMP ('92) Delaware River South and Tohickon Creek	SALDO Section 22-923 & Twp. Stormwater Mgmt. Ord. 2002-15 adopted 9/17/2002 Amended 2007	Yes	Yes	Yes
Quakertown Borough	Perkiomen Creek and Tochickon Creek		Yes--Act 167 ordinance adopted 2002	Yes	Yes	
Richland Township	Perkiomen Creek Tochickon Creek and Delaware River North		Stormwater Mgmt. Ordinance & SALDO - Section 22-611	Yes	Yes / IP	
Richlandtown Borough	Tohickon Creek		Storm. Mgmt. Ord. and SALDO Sec.524 and 525	Yes	Yes	
Riegelsville Borough	Delaware River North		SALDO - Section 7005l; ZO - Section 1100 (g)	Yes	No	
Sellersville Borough	E. Branch Perkiomen Creek		Stormwater Management Ord. #635 & SALDO - Section 135-34	Yes	Yes	
Silverdale Borough	E. Branch Perkiomen Creek		SALDO - Section 516	Yes	Yes	
Solebury Township	Delaware River South and Neshaminy Creek	Delaware River South SMP and Neshaminy 2011 SMP May 24, 2011	Stand-alone 2011-06	Yes	Yes / IP	Yes
Springfield Township	Delaware River North and Tohickon Creek		Yes--SALDO 1996 & Ord. # 114 4/1996	Yes	Yes / IP	

Table 5.2-2: Watershed and Stormwater Management Planning and Regulations in Bucks County Municipalities

MUNICIPALITY	WATERSHED BOUNDARIES WITHIN MUNICIPALITY	ACT 167 PLAN ORDINANCE (DATE OF ADOPTION)	STORMWATER MANAGEMENT PLANS OR CRITERIA LOCATION	PEAK RATE CONTROL	REQUIRED TO SUBMIT A NPDES SMALL MS4 PERMIT?	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
Telford Borough	E. Branch Perkiomen Creek		(tentative adoption of Act 167 plan)		Yes	
Tinicum Township	Delaware River North and Tohickon Creek		Yes--SALDO Amend. 1/16/90 & Stormwater Management Ordinance, 2005	Yes	No	
Trumbauersville Borough	Perkiomen Creek and Tochickon Creek		SALDO - Section 512 & Ord. No. 197-02 (Stormwater Management Ordinance)	Yes	Yes / IP	
Tullytown Borough	Delaware River South	Delaware River South SMP	Section 700	Yes	Yes	Yes
Upper Makefield Township	Delaware River South and Neshaminy Creek	Delaware River South SMP and Neshaminy Creek SMP 2011	ZO--Section 903.B.9 & SALDO Part 3- 327 (Retention/Detention Basins) Part 3-318 (Str, Drainage System)	Yes	Yes	
Upper Southampton Township	Pennypack Creek and Neshaminy Creek	Neshaminy Creek SMP	SALDO - Section 160-67	Yes	Yes	Yes
Warminster Township	Neshaminy Creek and Little Neshaminy Creek	Neshaminy Creek watershed SMP 2011	Stand Alone	Yes	Yes	
Warrington Township	Pennypack Creek and Little Neshaminy Creek	Neshaminy Creek SMP 2010	Stand Alone Chapter 26 Stormwater Management	Yes	Yes	
Warwick Township	Neshaminy Creek and Little Neshaminy Creek		Storm. Mngt. Ord. 157-14, SALDO. Adopted 6-6-2005 by Ord. No. 2005-2	Yes	Yes	
West Rockhill Township	Perkiomen Creek E. Branch Perkiomen Creek and Tohickon Creek	Tohickon Creek Watershed Plan (2002)	Article V -- Section 516 -- SALDO 2010	Yes	Yes / IP	

Table 5.2-2: Watershed and Stormwater Management Planning and Regulations in Bucks County Municipalities						
MUNICIPALITY	WATERSHED BOUNDARIES WITHIN MUNICIPALITY	ACT 167 PLAN ORDINANCE (DATE OF ADOPTION)	STORMWATER MANAGEMENT PLANS OR CRITERIA LOCATION	PEAK RATE CONTROL	REQUIRED TO SUBMIT A NPDES SMALL MS4 PERMIT?	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
Wrightstown Township	Delaware River South and Neshaminy Creek	Neshaminy Creek SMP and DE South SMP	Neshaminy Creek Watershed Storm. Mgmt. Ord. 226 3/2005 & Delaware R. South Watershed Act 167 Storm. Mgmt. Ord. 2253/ 2005 & Ord. 232 & SALDO Section 516	Yes	Yes	
Yardley Borough	Delaware River South	DE River South SMP	Storm Sewerage System Section 611 SALDO & Mentioned as future goal in Comp. Plan	Yes	Yes	
IP-Individual Permit SMP-Stormwater Management Plan						

Subsidence Regulation Tools

Five municipalities in Bucks County have risk for subsidence due to limestone or other karst topography. These municipalities regulate development to mitigate the impact of karst topography, sinkholes, and surface depressions using regulations described in Table 5.2-3.

Table 5.2-3: Regulations in Place for Municipalities with Risk for Subsidence and Sinkholes	
MUNICIPALITY	REGULATIONS
Buckingham Township	Regulates location of buildings, hazardous materials, on-lot wastewater disposal systems, fill, landfill, drainage systems, detention basins, underground utilities, and blasting. Regulates testing for limestone, wells, wastewater, stormwater facilities, and impervious surface.
Durham Township	Regulates their Karst Geology Region by requiring proposed development to supply geological testing and surveys and provide advanced stormwater requirements to direct the water away from this region.
Riegelsville Borough	Regulates impervious surface and stormwater.
Solebury Township	Regulates Carbonate Geology Overlay District by limiting the location of buildings, hazardous materials, on-lot wastewater disposal systems, and recycling and refuse facilities. Regulates impervious surface and stormwater.
Springfield Township	Requires a Carbonate Geology Study prior to issuance of a zoning permit for any earth disturbance and prior to preliminary plan approval for each subdivision and/or land development located within areas of the Township underlain by carbonate bedrock.

Table 5.2-3: Regulations in Place for Municipalities with Risk for Subsidence and Sinkholes	
MUNICIPALITY	**REGULATIONS**
	Sets requirements for inspections during building and for repair and maintenance if a hazard appears after building. Regulates impervious surface and stormwater.

5.2.1.2. Emergency Management

In Pennsylvania, Emergency Management begins at the municipal level, as required by the PA Emergency Management Service Code. Every county, city, borough, and township in the Commonwealth are required to have an Emergency Management Coordinator who is selected by the elected officials of the jurisdiction. The ultimate responsibility for Emergency Management always rests with the chief elected officials and governing body; however, the Emergency Management Coordinator's role is to develop plans, conduct training, and coordinate all available resources in the community pre- and post-disaster. The Bucks County Emergency Management Agency coordinates countywide emergency management efforts and each municipality has a designated local Emergency Management Coordinator. A significant amount of information used to develop this plan was obtained from the emergency management coordinators.

Emergency Operations Plans

The Emergency Management Services Code (PA Title 35) requires that all municipalities in the Commonwealth have a Local Emergency Operations Plan (EOP) which is updated every two years. At least twenty five of the jurisdictions in the County have or are in the process of developing an EOP. A countywide EOP also exists. Municipalities are not required to sign on to the County EOP, because County staff prefers to keep municipal emergency management coordinators actively engaged at a more local level.

Local Emergency Planning Committee

Effective partnerships are created in advance of a disaster by the Emergency Management Coordinator through the development of a proactive, comprehensive emergency operations plan and other planning, training, and exercise programs. Bucks County formed the Local Emergency Planning Committee (LEPC) to implement the requirements of Title III of the Superfund Amendments and Reauthorization Act of 1986. The LEPC is dedicated to enhancing community safety and preparedness through developing hazardous materials awareness, planning for hazardous materials emergency response, and encouraging partnerships between the community and industry. The LEPC meets five times a year, and works with the emergency response organizations, industry, and the community.

Volunteer Organizations

Voluntary Organizations Active in Disaster

The Bucks County Voluntary Organizations Active in a Disaster (VOAD) is a coalition of nonprofits, businesses, faith based groups, and individuals who are identified to help if a disaster occurs. The VOAD was established by the Bucks County Emergency Management Agency and the United Way of Bucks County to identify volunteers, and determine their skill set, to best match volunteers to non-emergency service response needs after a disaster.

5.2.1.3. Participation in the National Flood Insurance Program

The Pennsylvania Floodplain Management Act (Act 166 of 1978) requires every municipality identified by FEMA to participate in the NFIP and permits all municipalities to adopt floodplain management regulations. It is in the interest of all property owners in the floodplain to keep development and land usage within the scope of the floodplain regulations for their community. This helps keep insurance rates low and makes sure that the risk of flood damage is not increased by property development.

Ninety percent of Bucks County jurisdictions are participants in the NFIP (see Table 5.2-4). The program is managed by local municipalities participating in the program through ordinance adoption and floodplain regulation while the Bucks County Planning Commission provides an oversight and coordination role. Similarly, permitting processes needed for building construction and development in the floodplain are implemented at the municipal level through various ordinances (e.g. zoning, subdivision/land development and floodplain ordinances), but the Planning Commission provides technical assistance and guidance upon request.

FEMA Region III makes available to communities, an ordinance review checklist which lists required provisions for floodplain management ordinances. This checklist helps communities develop an effective floodplain management ordinance that meets federal requirements for participation in the NFIP.

The Pennsylvania Department of Community and Economic Development (DCED) provides communities, based on their CFR, Title 44, Section 60.3 level of regulations, with a suggested ordinance document to assist municipalities in meeting the minimum requirements of the NFIP along with the Pennsylvania Flood Plain Management Act (Act 166). These suggested or model ordinances contain provisions that are more restrictive than state and federal requirements. Suggested provisions include, but are not limited to:

- Prohibiting manufactured homes in the floodway.
- Prohibiting manufactured homes within the area measured 50 feet landward from the top-of bank of any watercourse within a special flood hazard area.
- Special requirements for recreational vehicles within the special flood hazard area.
- Special requirement for accessory structures.
- Prohibiting new construction and development within the area measured 50 feet landward from the top-of bank of any watercourse within a special flood hazard area.
- Providing the County Conservation District an opportunity to review and comment on all applications and plans for any proposed construction or development in any identified floodplain area.

Act 166 mandates municipal participation in and compliance with the NFIP. It also establishes higher regulatory standards for new or substantially improved structures which are used for the production or storage of dangerous materials (as defined by Act 166) by prohibiting them in the floodway. Additionally, Act 166 establishes the requirement that a Special Permit be obtained prior to any construction or expansion of any manufactured home park, hospital, nursing home, jail, and prison if said structure is located within a special flood hazard area.

All jurisdictions in Bucks County that participate in the NFIP received new flood maps and updated their floodplain ordinances in accordance with the PA Model Floodplain Ordinance in March 2015. Table 5.2-4 details the municipalities participating in the NFIP, their current policies and coverage, and the amount of claims and amount received from those claims since 1978.

Table 5.2-4: Bucks County Municipal National Flood Insurance Program Information (FEMA CIS, 2015).

MUNICIPALITY	PARTICIPA-TION STATUS	POLICIES IN FORCE	TOTAL PREMIUM AND COVERAGE	TOTAL CLAIMS SINCE 1978	TOTAL PAID SINCE 1978
Bedminster Township	Participating	16	$3,958,300	7	$53,199
Bensalem Township	Participating	186	$50,239,300	254	$4,172,591
Bridgeton Township	Participating	93	$20,963,900	206	$7,000,865
Bristol Borough	Participating	77	$23,701,800	48	$590,243
Bristol Township	Participating	664	$134,284,400	288	$6,740,360
Buckingham Township	Participating	73	$21,296,500	24	$488,704
Chalfont Borough	Participating	21	$5,835,000	11	$168,297
Doylestown Borough	Participating	27	$7,618,500	14	$233,147
Doylestown Township	Participating	73	$20,506,000	36	$199,087
Dublin Borough	Not Participating	N/A	N/A	N/A	N/A
Durham Township	Participating	36	$9,467,400	79	$2,801,224
East Rockhill Township	Participating	12	$2,657,600	5	$19,279
Falls Township	Participating	335	$71,340,700	108	$951,716
Haycock Township	Participating	11	$2,465,000	8	$84,754
Hilltown Township	Participating	21	$4,986,000	6	$9,555
Hulmeville Borough	Participating	34	$9,011,500	112	$1,834,602
Ivyland Borough	Not Participating	N/A	N/A	N/A	N/A
Langhorne Manor Borough	Participating	3	$980,000	13	$136,957
Langhorne Borough	Participating	3	$1,140,000	72	$1,664,732
Lower Makefield Township	Participating	370	$106,676,300	202	$4,769,217
Lower Southampton Township	Participating	106	$28,736,000	149	$2,389,967
Middletown Township	Participating	282	$66,758,000	266	$5,318,516
Milford Township	Participating	34	$7,895,800	19	$106,809
Morrisville Borough	Participating	65	$12,271,900	17	$142,352
New Britain Borough	Participating	2	$600,000	0	$0
New Britain Township	Participating	35	$11,208,000	9	$113,165
New Hope Borough	Participating	251	$65,832,500	373	$15,182,133

Table 5.2-4: Bucks County Municipal National Flood Insurance Program Information (FEMA CIS, 2015).

MUNICIPALITY	PARTICIPA-TION STATUS	POLICIES IN FORCE	TOTAL PREMIUM AND COVERAGE	TOTAL CLAIMS SINCE 1978	TOTAL PAID SINCE 1978
Newtown Borough	Participating	11	$3,250,000	9	$14,883
Newtown Township	Participating	51	$13,747,900	10	$119,920
Nockamixon Township	Participating	14	$3,210,700	21	$892,602
Northampton Township	Participating	136	$38,352,900	93	$1,346,572
Penndel Borough	Participating	3	$770,000	0	$0
Perkasie Borough	Participating	24	$5,785,100	24	$1,393,432
Plumstead Township	Participating	40	$11,038,600	72	$2,691,682
Quakertown Borough	Participating	109	$28,058,600	35	$494,013
Richland Township	Participating	51	$13,200,600	17	$173,554
Richlandtown Borough	Not Participating	N/A	N/A	N/A	N/A
Riegelsville Borough	Participating	91	$17,947,600	119	$2,306,537
Sellersville Borough	Participating	29	$6,894,900	53	$1,165,804
Silverdale Borough	Participating	0	N/A	N/A	N/A
Solebury Township	Participating	134	$38,072,900	221	$7,762,342
Springfield Township	Participating	17	$5,025,400	21	$380,632
Telford Borough	Not Participating	N/A	N/A	N/A	N/A
Tinicum Township	Participating	138	$33,933,600	281	$11,212,561
Trumbauersville Borough	Not Participating	N/A	N/A	N/A	N/A
Tullytown Borough	Participating	7	$1,407,000	2	$6,887
Upper Makefield Township	Participating	202	$54,865,900	333	$13,677,561
Upper Southampton Township	Participating	105	$28,826,600	83	$1,647,569
Warminster Township	Participating	81	$21,577,000	58	$682,044
Warrington Township	Participating	95	$25,593,800	105	$2,112,551
Warwick Township	Participating	65	$16,406,800	20	$319,826
West Rockhill Township	Participating	10	$1,938,900	8	$41,511
Wrightstown Township	Participating	14	$3,417,500	11	$339,421
Yardley Borough	Participating	263	$59,575,700	760	$24,920,397
TOTAL		**4,520**	**$1,123,328,400**	**4,682**	**$128,873,772**

Community Rating System

The NFIP's Community Rating System (CRS) provides discounts on flood insurance premiums in those communities that establish floodplain management programs that go beyond NFIP minimum requirements. Under the CRS, communities receive credit for more restrictive regulations; acquisition; relocation, or flood-proofing of flood-prone buildings, preservation of open space; and other measures that reduce flood damage or protect the natural resources and functions of floodplains.

The CRS was implemented in 1990 to recognize and encourage community floodplain management activities that exceed the minimum NFIP standards. Section 541 of the 1994 Act amends Section 1315 of the 1968 Act to codify the CRS in the NFIP, and expands the CRS goals to specifically include incentives to reduce the risk of flood-related erosion and to encourage measures that protect natural and beneficial floodplain functions. These goals have been incorporated into the CRS, and communities now receive credit toward premium reductions for activities that contribute to them.

Under the CRS, flood insurance premium rates are adjusted to reflect the reduced flood risk resulting from community activities that meet a minimum of three of the following CRS goals:

- Reduce flood losses
- Reduce damage to property
- Protect public health and safety
- Prevent increases in flood damage from new construction
- Reduce the risk of erosion damage
- Protect natural and beneficial floodplain functions
- Facilitate accurate insurance rating
- Promote the awareness of flood insurance

There are 10 CRS classes that provide varied reduction in insurance premiums. Class 1 requires the most credit points and gives the largest premium reduction; Class 10 receives no premium reduction. CRS premium discounts on flood insurance range from 5 percent for Class 9 communities up to 45 percent for Class 1 communities. The CRS recognizes 18 creditable activities that are organized under four categories: Public Information, Mapping and Regulations, Flood Damage Reduction, and Flood Preparedness.

In 2014, Newtown and Lower Makefield Townships began the process to participate in the CRS.

5.2.2. Administrative and Technical Capability

Administrative capability is described by an adequacy of departmental and personnel resources for the implementation of mitigation-related activities. Technical capability relates to an adequacy of knowledge and technical expertise of local government employees or the ability to contract outside resources for this expertise in order to effectively execute mitigation activities. Common examples of skill sets and technical personnel needed for hazard mitigation include: planners with knowledge of land development/ management practices, engineers or professionals trained in construction practices related to buildings and/or infrastructure (e.g. building inspectors), planners or engineers with an understanding of natural and/or human caused hazards, emergency managers, floodplain managers, land surveyors, scientists familiar with hazards in the community, staff with the education or expertise to assess community

vulnerability to hazards, personnel skilled in geographic information systems, resource development staff or grant writers, fiscal staff to handle complex grant application processes.

Based on assessment results, municipalities in Bucks County have moderate administrative and technical staff needed to conduct hazard mitigation-activities. There seems to be sufficient emergency management staff across the County and a majority of municipalities have engineering capabilities either in-house or via outside consultants. However, personnel dedicated to land surveying or scientists with hazard knowledge related to community hazards was less likely with just over half of survey respondents indicating they had these capabilities. This result is not necessarily surprising since these tasks are typically contracted to outside providers. A majority of communities do have their own personnel skilled in geographic information systems but approximately one-third does not have staff with these skills. Only half of the communities have grant writers who could assist in Hazard Mitigation Assistance Program applications. All municipalities in the County have an identified emergency management coordinator.

Other local organizations that could act as partners include Bucks County Conservation District, Penn State Cooperative Extension, environmental groups, and watershed associations.

State agencies which can provide technical assistance for mitigation activities include, but are not limited to:

- Pennsylvania Department of Community and Economic Development;
- Pennsylvania Department of Conservation and Natural Resources;
- Pennsylvania Department of Environmental Protection; and
- Pennsylvania Department of Transportation.

Federal agencies which can provide technical assistance for mitigation activities include, but are not limited to:

- Army Corp of Engineers;
- Department of Housing and Urban Development (HUD);
- Department of Agriculture (DoA);
- Economic Development Administration;
- Emergency Management Institute (EMI);
- Environmental Protect Agency (EPA);
- FEMA; and
- Small Business Administration.

5.2.2.1. Political Capability

One of the most difficult capabilities to evaluate involves the political will of a jurisdiction to enact meaningful policies and projects designed to mitigate hazard events. The adoption of hazard mitigation measures may be seen as an impediment to growth and economic development. In many cases, mitigation may not generate interest among local officials when compared with competing priorities. Therefore, the local political climate must be considered when designing mitigation strategies, as it could

be the most difficult hurdle to overcome in accomplishing the adoption or implementation of specific actions.

The Capability Assessment Survey was used to capture information on each jurisdiction's political capability. Survey respondents were asked to identify examples of political capability, such as guiding development away from hazard areas, restricting public investments or capital improvements within hazard areas, or enforcing local development standards that go beyond minimum state or federal requirements (i.e. building codes, floodplain management ordinances, etc…). These examples were used to guide respondents in scoring their community on a scale of "unwilling" (0) to "very willing" (5) to adopt policies and programs that reduce hazard vulnerabilities. Of the 14 municipalities that responded, scores ranged from 3-5 with an average score of 4.14.

5.2.2.2. Self-Assessment

In addition to the inventory and analysis of specific local capabilities, the *Capability Assessment Survey* required each local jurisdiction to conduct its own self-assessment of its capability to effectively implement hazard mitigation activities. As part of this process, county and municipal officials were encouraged to consider the barriers to implementing proposed mitigation strategies in addition to the mechanisms that could enhance or further such strategies. In response to the survey questionnaire, local officials classified each of the capabilities as either "limited," "moderate" or "high." Table 5.2-5 summarizes the results of the self-assessment survey as a percentage of responses received. For example, 67 percent of communities who responded indicated their community had limited fiscal capabilities related to hazard mitigation activities that reduce hazard vulnerabilities.

Table 5.2-5: Summary of self-assessment capability responses expressed as a percentage of responses received.

CAPABILITY CATEGORY	LIMITED	MODERATE	HIGH
Planning & Regulatory	20%	40%	40%
Administrative & Technical	27%	40%	33%
Fiscal	67%	13%	20%
Political	7%	47%	47%
Community Resiliency	20%	27%	53%

5.2.2.3. Existing Limitations

Bucks County's greatest limitation is that approximately 64 miles of the Delaware River border the County. Though the Delaware River provides the county with natural resources, scenic beauty, and recreational activity, the river and its tributaries have contributed to numerous flooding events. There have been 109 flood events since 1993 (see Table 4.3.4-1); these flood events most typically are the result of heavy precipitation causing flooding along rivers and streams especially the Delaware River and Neshaminy Creek.

Bucks County and its municipalities are working hard to mitigate the negative impacts of flooding. For example, the County has acquired or elevated flood-prone properties by utilizing FEMA mitigation grant funding, which has resulted in 90 mitigated properties. In addition, the County has mitigated 148

properties along Neshaminy Creek with funding provided through the US Department of Agriculture Natural Resource Conservation Service (NRCS) (BCPC, 2011). There is strong planning and regulatory capability between the municipalities and the county government. Planning related to mitigation, flooding, watersheds, stormwater management, and comprehensive planning should decrease the county's vulnerability to hazards in the future.

5.2.3. Fiscal Capability

The decision and capacity to implement mitigation-related activities is often strongly dependent on the presence of local financial resources. While some mitigation actions are less costly than others, it is important that money is available locally to implement policies and projects. Financial resources are particularly important if communities are trying to take advantage of state or federal mitigation grant funding opportunities that require local-match contributions. Based on survey results, most municipalities within the County perceive fiscal capability to be limited. State programs which may provide financial support for mitigation activities include, but are not limited to:

- Community Conservation Partnerships Program
- Community Revitalization Program
- Municipal Assistance Program
- Growing Greener Program
- Keystone Communities Grant Program
- Local Government Capital Projects Loan Program
- Pennsylvania Heritage Areas Program
- Pennsylvania Recreational Trails Program
- Land & Water Conservation Fund
- Municipal Assistance Program
- Technical Assistance Program

Federal programs which may provide financial support for mitigation activities include, but are not limited to:

- Community Development Block Grants (CDBG)
- Disaster Housing Program
- Emergency Conservation Program
- Emergency Management Performance Grants (EMPG)
- Emergency Watershed Protection Program
- Hazard Mitigation Grant Program (HMGP)
- Flood Mitigation Assistance Program
- Non-insured Crop Disaster Assistance Program
- Pre-Disaster Mitigation Program (PDM)
- Repetitive Flood Claims Grant Program (RFC)
- Severe Repetitive Loss Grant Program (SRL)
- Weatherization Assistance Program

5.2.4. Education and Outreach

Education and outreach programs and methods are used to implement mitigation activities and communicate hazard-related information. Examples include fire safety programs that fire departments deliver to students at local schools; participation in community programs, such as Firewise Communities Certification or StormReady Certification; and activities conducted as part of hazard awareness campaigns, such as Tornado or Flood Awareness Month. In addition to these activities, the County has a communication tool called "Ready Bucks" used to alert residents about hazard and other important community news. For example, the tool can be used to relay critical information about severe weather events, sudden road closures, missing persons, and evacuations. Residents can sign up for the free alerts online at: http://www.buckscounty.org/readybucks. However, overall municipalities in Bucks County report limited education and outreach capability.

5.2.5. Plan Integration

Plan integration recognizes that hazard mitigation is most effective when it works in concert with other plans, regulations, and programs. Per FEMA, plan integration is described as the regular consideration and management of hazard risks in a community's existing planning framework. The planning framework is the collection of plans, policies, codes, and programs that guide land use and development, how those are maintained and implemented, and the roles of a range of stakeholders to evaluate and update them. Effective integration of hazard mitigation occurs when the planning framework fosters development that does not increase risks from known hazards or leads to redevelopment that reduces risk from known hazards (FEMA, 2013).

5.2.5.1. Existing Planning Mechanisms

There are numerous existing regulatory and planning mechanisms in place at the state, county, and municipal level of government which support hazard mitigation planning efforts. These tools include the Commonwealth of Pennsylvania Standard All-Hazard Mitigation Plan, local floodplain management ordinances, the Bucks County Comprehensive Plan, Bucks County Hazard Vulnerability Analysis (HVA), local Emergency Operation Plans, local zoning ordinances, local subdivision and land development ordinances, and local comprehensive plans. These mechanisms were discussed at community meetings and are described in more detail in Section 5.2. Table 5.2-6 includes the planning frameworks that were identified in Bucks County.

Table 5.2-6: Planning Framework in Bucks County

PLANNING LEVEL	PLAN
STATE	2013 Commonwealth of Pennsylvania Standard All-Hazard Mitigation Plan
	Keystone Principles and Criteria for Growth, Investment, and Resource Conservation
REGIONAL	Delaware Valley Regional Planning Commission: Connections 2035
	Lehigh Valley Comprehensive Plan
	Montgomery County Comprehensive Plan
	Philadelphia 2035 Comprehensive Plan
COUNTY	Bucks County Waterfront Revitalization Plan
	Landmark Towns of Bucks County
	Bucks County Open Space and Greenway Plan

Table 5.2-6: Planning Framework in Bucks County	
PLANNING LEVEL	**PLAN**
	Bucks County Natural Areas Inventory
	Bucks County Bicycle Plan
	2011 Bucks County Hazard Mitigation Plan
	Bucks County Hazard Vulnerability Analysis (HVA)
	Bucks County Comprehensive Plan Update
	Bucks County Flood Recovery and Mitigation Strategy
	Neshaminy Creek Supplemental Watershed Work Plan
	Bucks County Natural Areas Program
	Bucks County Emergency Operations Plan
MUNICIPALITY	Local Emergency Operations Plans
	Municipality Local Land Use Regulations
	Act 167 Stormwater Management Plans

Information from several of these documents has been incorporated into this plan and mitigation actions have been developed to further integrate these planning mechanisms into the hazard mitigation planning process. The County HVA provided direction for hazard identification as well as extensive information on past occurrences including anecdotal information. Floodplain management ordinance information was used to aid in the establishment of local capabilities in addition to participation in the NFIP. These plans share common philosophies and strategies that are embodied in the Commonwealth's Keystone Principles, which provides a strategy for interagency coordination in addressing the goals and objectives for the realization of economic development and resource conservation in the Commonwealth.

5.2.5.2. Incorporation into Other Planning Mechanisms

Hazard mitigation planning is most effective when it works in concert with other plans, regulations, and programs. Ensuring that the goals and actions of hazard mitigation are applied to comprehensive planning efforts promotes safe and resilient growth, effective emergency management, and an overall reduction of risk. The most important planning and regulatory mechanisms that can be utilized for hazard mitigation – hazard mitigation plans, emergency operations plans, comprehensive plans, building codes, floodplain ordinances, and subdivision and zoning ordinances – have been discussed in more detail in Section 5.2. These local planning mechanisms provide a vehicle for the implementation of adopted mitigation strategies and ensure that growth is not steered towards high hazard areas. This section highlights the link between current planning in Bucks County and the integration with the 2016 Hazard Mitigation Plan to strengthen these actions in the future.

Bucks County Comprehensive Plan

The Bucks County Planning Commission issued an update to its County Comprehensive Plan in 2011. The plan establishes a shared vision of how the County would like to guide future growth and conserve resources as well as the policy recommendations for attaining these goals. Table 5.2-6 outlines the planning endeavors in the region relevant to Bucks County.

In addition, the 2011 Bucks Comprehensive Plan outlines eight "Guiding Principles" that identify key priorities of the County. The Guiding Principles serve to guide future decisions and actions by the County,

local municipalities, and residents to ensure that the shared vision of the County is achieved in a cohesive manner. One of the principles specifically addresses hazard mitigation and reducing the loss of life and property. The other seven principles are either directly or indirectly linked to hazard mitigation planning. Supplementing these principles, are crosscutting actions that the County has prioritized to meet multiple Plan objectives. The comprehensive plan includes detailed strategies and actions for each of the identified principles. A full list of the hazard mitigation related strategies and actions for Principle 5: Mitigate Hazards to Life and Property is included in Table 5.2-8; however, at the end of the planning process, the county prioritized six of these actions, which are outlined with the guiding principles in Table 5.2-7 below.

Table 5.2-7: Planning Principles and Prioritized Actions Guiding Development in Bucks County (BCPC, 2011)
GUIDING PRINCIPLES OF COMPREHENSIVE PLAN
Principle 1: Protect Natural, Historic and Scenic Resources
Principle 2: Preserve and Expand Parks, Open Space, and Agricultural Resources
Principle 3: Promote Energy Conservation and Efficiency
Principle 4: Protect Water Resources and Reduce Waste
Principle 5: Mitigate Hazards to Life and Property
Principle 6: Provide Adequate Community Facilities and Services
Principle 7: Enhance Transportation Mobility
Principle 8: Promote Economic Opportunity, Housing Diversity, and Efficient Use of Land
PRIORITIZED ACTIONS
Action 1: Reduce Our Vehicle Miles Traveled
Action 2: Expand Our Open Space Preservation Efforts
Action 3: Promote Comprehensive Water Resources Management
Action 4: Increase Housing Opportunities in Development Areas
Action 5: Create Walkable Communities
Action 6: Expand Business and Job Opportunities

The Comprehensive Plan demonstrates the full integration of the County's hazard mitigation goals, as outlined in the 2011 Bucks County Hazard Mitigation Plan. Specifically, Principle 5, which mitigates hazards to life and property, is described as assessing the county's vulnerability to hazards and developing mitigation actions as part of a prioritized implementation strategy to reduce the risk from potential hazards. Preventing new development from contributing to flooding problems, controlling development in the floodplain, and making changes in repetitive flooding areas are examples of needed actions. Actions that could be vehicles for achieving the goals of Principle 5 are Actions #2 and #3. However, Actions #1, #4, and #5 can also reduce the hazard vulnerability of the County through the promotion of the polices that embody smart growth and tradition neighborhood design. In addition, Action #1, reducing the vehicle miles traveled of county residents, could contribute to a lower risk of transportation accidents in the County.

As stated above, Principle 5 provides the most specific relation to the goals and objectives of the Hazard Mitigation Plan; however, some of the other principles also are related to the goals and objectives of this

plan. Table 5.2-8 includes a full list of the mitigation related actions and their associated strategy and guiding principle.

Table 5.2-8: Hazard Mitigation Related Actions in Bucks County (BCPC, 2011)	
STRATEGY	**ACTION**
PRINCIPLE 1: PROTECT NATURAL, HISTORIC, AND SCENIC RESOURCES	
Land/Water Interface Resources – Floodplain Strategy	Assist municipalities with updating floodplain requirements and ordinance language to comply with new FEMA floodplain maps.
	Encourage 100 percent protection of floodplains delineated by FEMA or detailed hydrological studies performed by registered engineers qualified to prepare such studies, where no FEMA mapping is available.
	Support municipal regulations and land use tools that prevent development in and remove existing structure from floodplains to reduce risks to life and property.
	Support the buy-out or elevation of floodprone properties and the return of these areas to a natural state.
PRINCIPLE 4: PROTECT WATER RESOURCES AND REDUCE WASTER	
Water Resources Strategy	Cooperate with state, county, and municipal government officials to help implement appropriate recommendations of the Pennsylvania State Water Plan (Act 220).
	Establish wellhead protection areas/overlay zones, source water protection areas, stream corridor protection areas, and conservation management districts.
	Monitor the progress of the State Water Plan and its implications regarding critical water planning areas in Bucks County.
	Prohibit incompatible uses near surface water and preserve and manage groundwater recharge areas to ensure a sustainable water supply.
	Protect water resources, natural resources, and riparian areas.
	Review and update, as necessary, municipal ordinance language related to water resource protection.
Water Service Strategy	Protect water resources to meet peak and emergency demands.
	Promote interconnection of water supply systems to foster emergency preparedness.
	Encourage the provision of water service that is consistent with growth management.
	Use municipal comprehensive plans, zoning, and well regulations to coordinate land use goals with water resource considerations.
Water Supply Planning	Assist municipalities on integrating water resource protection standards with land use regulations, wastewater facilities, stormwater management, natural resources, and open space planning.
	Coordinate with the Delaware River Basin Commission and PaDEP on water supply planning and drought emergency management.
	Encourage integrated water resources planning through use of land development, water supply, stormwater, and wastewater techniques that maintain natural functions of the hydrologic cycle.
	Encourage municipalities and water suppliers to coordinate efforts in developing source water protection and wellhead delineation plans to protect water sources from over-withdrawal and potential sources of contamination.

Table 5.2-8: Hazard Mitigation Related Actions in Bucks County (BCPC, 2011)	
STRATEGY	**ACTION**
	Encourage the coordination of efforts of agencies (government, private and nonprofit) responsible for the planning and management of water resources quality and quantity.
	Participate in PaDEP's source water protection grant program.
	Use aquifer yield potential to help assure that development in groundwater-dependent areas does not exceed the capability of underlying aquifers. Plan development location and intensities with consideration of available water resources.
PRINCIPLE 5: MITIGATE HAZARDS TO LIFE AND PROPERTY	
Preparedness to Reduce Potential Damage Strategy	Identify by municipality and evaluate protection of existing critical facilities with the highest relative vulnerability in the 1 percent annual chance floodplain.
	Identify and evaluate strategies for repetitive-loss properties.
	Provide public outreach/education regarding strategies (e.g., floodproofing) for property owners in the 1 percent annual chance floodplain.
	Address identified data limitations regarding lack of detailed information about individual structures located in the 1 percent annual chance floodplain.
	Identify and evaluate protection for hazardous material storage in floodplain.
	Obtain detailed flood studies and FIRMs (including 0.2 percent annual chance flood) for areas with the greatest potential damage and threat to residents.
	Identify the most vulnerable and critical existing structures and infrastructure due to the effects of severe weather.
	Utilize available county level datasets with characteristics of individual structures for improved hazard planning and outreach.
	Identify and prioritize funding for transportation infrastructure projects that will reduce impact of hazards.
Disaster-Resistant Future Development Strategy	Encourage and facilitate the development or revision of zoning/land-use ordinances to limit development in high-hazard areas.
	Provide adequate and consistent enforcement of ordinances and codes within and between jurisdictions.
Hazard Mitigation as a Public Value Strategy	Provide public education to increase awareness of hazards and opportunities for mitigation.
	Promote partnerships between the municipalities and the county to continue to develop a countywide approach to identifying and implementing mitigation actions.
Response and Recovery Capabilities Strategy	Increase awareness by residents (i.e., through public outreach/education) of actions to take during an emergency.
	Enhance response capability of county and municipal fire, police, and emergency medical services personnel to special populations.
	Continue and increase coordination between critical facilities and emergency responders.

Strategies and actions from the Comprehensive Plan have been incorporated into the Hazard Mitigation Plan Update in Section 4.4.4 Future Development and Vulnerability and into the Mitigation Strategy. Additionally, as stated above, the hazard mitigation principles have been integrated into the Comprehensive Plan, which will guide development in Bucks County for ten years.

Bucks County Watersheds ACT 167 Plans

There are eight Act 167 Plans for Bucks County that address stormwater management by providing prioritized recommendations to mitigate and reduce the impacts from development and improve condition of local water bodies. The ACT 167 Plans that pertain to Bucks County include:

- Delaware River (North)
- Delaware River (South)
- East Branch Perkiomen
- Neshaminy and Little Neshaminy Creeks approved by Bucks County on August 8, 2010
- Pennypack Creek
- Poquessing Creek
- Saucon Creek
- Tohickon Creek

These plans include goals, objectives, and actions developed in relation to developing criteria and standards for future development and redevelopment in the watersheds that minimize hydrologic and water quality impacts. These actions are directly related to hazard mitigation planning because these criteria often involve mechanisms to control stormwater volume and recharge. Table 5.2-9 details the actions from each of the Act 167 plans in Bucks County that are related to hazard mitigation.

Table 5.2-9: Act 167 Plan Actions Relevant to Hazard Mitigation

ACTION	LOCATION IN PLAN
East Branch Perkiomen The purpose to promote the public health, safety, and welfare within the Neshaminy Creek watershed by maintaining the natural hydrologic regime and by minimizing the harms and maximizing benefits through: • A comprehensive program of stormwater management (SWM), including reasonable regulation of development and activities causing accelerated runoff, is fundamental to the public health, safety, welfare, and the protection of the people of the municipality and all the people of the Commonwealth, their resources, and the environment.	Goal #2 — Objectives 2A, 2C
Neshaminy and Little Neshaminy Creeks SW Ordinance: The purpose to promote the public health, safety, and welfare within the Neshaminy Creek watershed by maintaining the natural hydrologic regime and by minimizing the harms and maximizing benefits through: • A comprehensive program of stormwater management (SWM), including reasonable regulation of development and activities causing accelerated runoff, is fundamental to the public health, safety, welfare, and the protection of the people of the municipality and all the people of the Commonwealth, their resources, and the environment.	Goal #2 — Objectives 2A, 2C

Table 5.2-9: Act 167 Plan Actions Relevant to Hazard Mitigation	
ACTION	**LOCATION IN PLAN**
Pennypack Creek • This watershed is essentially "built-out"; therefore, identifying opportunities for retrofitting existing stormwater facilities and finding locations for new Best Management Practices (BMPs) in areas that are not currently served by stormwater facilities. The use of stormwater BMPs as the preferred means to achieve improved water quality, groundwater recharge and retention, stream bank protection, and volume control. The implementation of these retrofits and new BMPs in conjunction with regulation of new development and redevelopment through new stormwater ordinances will reduce stormwater problems in the Pennypack Creek Watershed. • Restoration of riparian stream buffers is recommended as an opportunity to address the goal of preserving and restoring flood carrying capacity of streams.	Goal #1 – Objective 1G Goal #2 — Objectives 2A, 2C
Poquessing Creek • Ordinance objective is to minimize or prevent the hydrologic and water quality impacts of future development and redevelopment in the watershed. • Determine problem areas and apply corrective measures to existing problem areas and implement regulations geared towards redevelopment.	Goal #1 – Objective 1G Goal #2 — Objectives 2A, 2C
Saucon Creek The purpose to promote the public health, safety, and welfare within the Saucon Creek watershed by maintaining the natural hydrologic regime and by minimizing the harms and maximizing benefits through: • Development of a comprehensive program of stormwater management, including reasonable regulation of development and activities causing accelerated erosion and loss of natural infiltration, which is fundamental to the public health, safety and welfare and the protection of the people of the municipality and all of the people of the Commonwealth, their resources and the environment.	Goal #1 – Objective 1G Goal #2 — Objectives 2A, 2C
Tohickon Creek The purpose is to promote health, safety, and welfare within the Tohickon Creek Watershed by minimizing the damages resulting from inadequate management of accelerated stormwater runoff resulting from development throughout a watershed through: • A comprehensive program of stormwater management, including reasonable regulation of development and activities causing accelerated erosion, is fundamental to the public health, safety, welfare, and the protection of the people of the municipality and all the people of the Commonwealth, their resources, and the environment.	Goal #1 – Objective 1G Goal #2 — Objectives 2A, 2C
Delaware River (North) & Delaware River (South)* Act 167 plans were developed for the Delaware River (North) and Delaware River (South) watersheds in 2002 and 2004, respectively. However, these plans are not known to be publically available. With the exception of Pennypack Creek, which is primarily "built-out," we assume that the goals and objectives expressed in these plans are similar in nature to other watershed planning efforts in the County.	

Bucks County Open Space and Greenway Plan

In 2011 Bucks County developed the Bucks County Open Space and Greenways Plan to provide a decision making, implementation, and management tool designed to protect and create linkages between the County's vast natural resources, open space and farmland, recreational facilities, and historic and cultural

resources. The preservation of open space and greenways can be relevant to hazard mitigation goals, because the space may be able to manage stormwater, mitigating the effects of flooding. Table 5.2-10 provides detail on the action identified in the Bucks County Open Space and Greenways Plan relevant to hazard mitigation.

Table 5.2-10: Open Space and Greenway Plan Actions Relevant to Hazard Mitigation Planning

ACTION	LOCATION IN PLAN
The presence of open space, greenways, and recreational areas provides numerous and diverse benefits to the communities in which they are located. These benefits can be classified into six areas including environmental, social, recreational, transportation, economic, and educational. ENVIRONMENTAL Slows down stormwater runoff and decreases the chance of stream flooding. One study reported that a 1 percent increase in protected wetlands along a stream corridor reduced peak stream flows by 3.7 percent1	Goal #2 — Objectives 2A

6. Mitigation Strategy

6.1. Update Process Summary

The 2006 and 2011 Bucks County HMPs included goals, objectives, and actions. Mitigation *goals* are general guidelines that explain what the County wants to achieve. Goals are usually expressed as broad policy statements representing desired long-term results. Mitigation *objectives* describe strategies or implementation steps to attain the identified goals. Objectives are more specific statements than goals; the described steps are usually measurable and can have a defined completion date. Actions provide more detailed descriptions of specific work tasks to help the County and its municipalities achieve prescribed goals and objectives.

The goals, objectives, and actions from the 2011 HMP were reviewed with the HMPT at the Kick-off and Mitigation Solutions Meetings. The goals and new hazard mitigation categories were discussed generally at the kickoff meeting. The mitigation strategy was reviewed in detail at the Mitigation Solutions meeting. Forms to evaluate goals and objectives and to evaluate each municipalities' mitigation actions were distributed and collected at and after the meeting. The mitigation strategy was reviewed at the Draft Plan Review Meeting was another generalized form was used to comment on the plan including the mitigation strategy. The HMPC and HMPT decided to remove the response focused goal that was being tracked in other emergency focused planning process and add a new goal for natural systems protection to match the mitigation categories in FEMA's 2013 guidance. Bucks County is progressive in watershed management, storm water management and natural resource protection so existing actions and mitigation successes could be moved under this new goal along with new actions. While the total number of objectives decreased the theme an intent of objectives were carried over in a streamlined slightly re-organized mitigation strategy. The result of a collaborative effort by the HMPT are noted in Table 6.1-1. Copies of mitigation strategy evaluations and action submissions are located in **Appendix C**.

Table 6.1-1: Review of Mitigation Strategy from 2011 Bucks County HMP.

EXISTING STRATEGY DESCRIPTION	REVIEW
Goal 1 – Reduce possibility of injury/death to County residents and reduce potential damage to existing community assets (including residential properties, critical facilities, and infrastructure) due to natural and human-made hazards.	Goal confirmed and continued.
Objective 1.A: Identify by municipality and evaluate protection of existing critical facilities with the highest relative vulnerability in the 1% annual chance floodplain.	Combined and expanded with Objective 1.B.
Action 1.A.1 Conduct cost-benefit analysis of protection of existing critical facilities with the highest relative vulnerability in the 1%-annual chance floodplain.	Mapping analysis in HMP shows these communities have CI in floodplain: Bensalem Township, Bristol Borough, Bristol Township, Doylestown Borough, Lower Makefield Township, Lower Southampton Township, Milford Township, Morrisville Borough, New Britain Borough, Quakertown Borough, Riegelsville Borough, Sellersville Borough, Tinicum Township, and West Rockhill

Table 6.1-1: Review of Mitigation Strategy from 2011 Bucks County HMP.	
	Township. Action combined and revised to proceed with next step of grant applications.
Action 1.A.2 Collect detailed information on critical facilities using Pennsylvania's All-Hazard Mitigation Tool (PA Tool) or Project Opportunity Form.	PA Tool not widely used and tool is under evaluation by PEMA. Action combined and revised to proceed with next step of grant applications.
Objective 1.B: Identify and evaluate strategies for repetitive-loss properties.	Combined and expanded with Objective 1.a.
Action 1.B.1 Conduct cost-benefit analysis of protection of repetitive-loss assets.	Action combined and revised to proceed with next step of grant applications.
Action 1.B.2 Collect detailed information on properties using Pennsylvania's All-Hazard Mitigation Tool (PA Tool) or Project Opportunity Form.	PA Tool not widely used and tool is under evaluation by PEMA. Action combined and revised to proceed with next step of grant applications. Yardley is collecting elevation certificates for properties in floodplain.
Objective 1.C: Provide public outreach/education regarding strategies (e.g., floodproofing) for property owners in the 1% annual chance floodplain.	Objective confirmed and continued.
Action 1.C.1 Work with township/borough officials to increase awareness of model floodplain ordinance and with property owners, including informational mailings to property owners in the 1% annual chance floodplain, and sponsoring a series of workshops about costs and benefits of: • Acquiring and minimizing the cost of flood insurance coverage, and • Property acquisition, relocation, elevation, dry floodproofing, and wet floodproofing.	All participating communities in Bucks County recently updated ordinances to reflect 3/16/15 Effective DFIRM. Many communities, like Morrisville and New Britain, implemented public outreach on this topic. Riegelsville rejected proposed shopping center in floodplain, based on their awareness of sound floodplain management. This action was selected to be ongoing by most municipalities.
Action 1.C.2 Evaluate at the township/borough level the suitability of Community Rating System (CRS) for insurance premium reduction (and flood damage reduction).	Newtown Township and Lower Makefield Township have passed resolutions planning to join CRS and Yardley Borough is pursuing. This action is ongoing.
Action 1.C.3 Consider using “success stories” from other Pennsylvania communities for flood risk management.	Yardley published articles on hazard mitigation in quarterly newsletter. This action was combined and revised to integrate two similar outreach actions.
Objective 1.D: Address identified data limitations regarding lack of detailed information about individual structures located in the 1% annual chance floodplain.	Objective confirmed and continued.
Action 1.D.1 Obtain information for structures in the areas with the highest relative vulnerability to determine the best property protection methods. Information to be obtained includes: • Lowest-floor elevation, • Number of stories, • Presence of a basement, and • Market and/or replacement value.	East Rockhill has implemented enforcement of property maintenance and building codes to ensure compliance to determine that the best property protection is implemented and deems action ongoing. This action is ongoing.
Action 1.D.2 Obtain information for all remaining structures in the 1% annual chance floodplain to determine the best property protection methods to promote with individual property owners. Techniques for gathering information over	This action is ongoing.

Table 6.1-1: Review of Mitigation Strategy from 2011 Bucks County HMP.	
time should include developing and implementing a program for integrated information "capture" at key points in normal township administrative procedures, including applications for building permits at township/borough offices.	
Objective 1.E: Identify and evaluate protection for hazardous material storage in floodplain.	Objective confirmed and continued.
Action 1.E.1 Identify all storage of hazardous materials in floodplains (including non-addressable structures, such as propane tanks).	This action is ongoing.
Action 1.E.2 Evaluate alternative methods to minimize risk from existing storage areas.	This action is ongoing.
Action 1.E.3 Assess means to prevent future storage in floodplain.	This action is ongoing.
Objective 1.F: Obtain detailed flood studies and FIRMs (including .2% annual chance flood) for areas with the greatest potential damage and threat to residents.	Objective complete via the recent 3/16/15 Effective DFIRM.
Action 1.F.1 Apply to PEMA for funding to undertake detailed flood studies for County's high-hazard areas to determine BFE and a full range of flood-recurrence intervals (50%, 20%, 10%, 4%, 2%, 1% and .2% annual chance flood) for use in future refinements of the mitigation plan.	This action is complete via the recent 3/16/15 Effective DFIRM.
Objective 1.G: Implement hazard mitigation measures identified in other planning mechanisms and address hazard mitigation as appropriate in other planning mechanisms.	Objective confirmed and continued but moved under Goal 2 for consistency.
Action 1.G.1 Identify funding and implement floodplain management projects that have previously been defined in the 1998 DVRPC document "Bucks County Flood Recovery and Mitigation Strategy".	This action will be deleted. It is a combination of complete through previous mitigation efforts throughout the county and out of date based on more recent flood analysis in 3/16/15 DFIRM and 2016 Bucks County HMP. The intent of the plan is carried forward in these more recent documents.
Action 1.G.2 Continue non-structural measures for mitigation of flood hazard per the December 2001 "Neshaminy Creek Supplemental Watershed Work Plan No. 5." The plan includes the following major components: Flood warning system, Voluntary property acquisition, Voluntary building elevation and floodproofing, Continuation/ enhancement of floodplain ordinances, flood insurance, and stormwater management.	This action is ongoing. The work plan groupings continue to be implemented; Group 15 which included 3 homes was sent for bidding in 2012.
Action 1.G.3 Evaluate, implement, and perform mitigation projects identified in this and other planning mechanisms, including acquisition, elevation, foundation and building stabilization and other mitigation methods.	This action is ongoing for all communities and move to Objective 1.A. Many communities noted in mitigation action plans that they are working towards identifying projects and applying for funding. Plumstead and Yardley submitted two grant applications each for acquisition/elevation. Riegelsville elevated a house at the approach to bridge and identified project to acquire open space north of Branch Park that is in the floodplain. Lower

Table 6.1-1: Review of Mitigation Strategy from 2011 Bucks County HMP.	
	Southampton has used stormwater management as a mitigation tool. Richland Township has retrofitted traffic signals along Route 309 to be powered by portable generators, has installed generators at critical municipal buildings, and is seeking grants for signal improvements to mitigate identified utility loss and transportation accident hazards.
Action 1.G.4 Build on existing Stormwater Management Planning and encourage implantation of small stormwater mitigation projects on private property (i.e. rain gardens, rain barrels, natural basins).	This action is ongoing and moved to new goal 4.
Objective 1.H: Identify the most-vulnerable and critical existing structures and infrastructure due to the effects of severe weather.	Objective confirmed and continued.
Action 1.H.1 Conduct qualitative evaluation process for critical facilities and infrastructure to determine relative vulnerability and gather information for subsequent refinements of this mitigation plan.	Mapping analysis in HMP shows West Rockhill has CI in floodplain. Action combined and revised to proceed with next step of grant applications.
Action 1.H.2 Identify critical facilities with the highest vulnerability to the effects of power outage (i.e., hospitals, nursing homes, fire, police, rescue, and emergency management).	This action is complete for Doylestown and Plumstead Townships. All Plumstead critical facilities now have generators including the wells and pumps for public water service. This action is ongoing for remaining municipalities.
Action 1.H.3 Develop action plan for reducing potential damage and loss of function at identified critical facilities and infrastructure.	This action is ongoing.
Objective 1.I: Evaluate and prioritize communities that require warning systems and storm shelters.	Objective confirmed and continued.
Action 1.I.1 Identify residents with the highest relative vulnerability to the effects of severe weather and prepare implementation plan.	This action is complete and revised to be for maintenance of these systems. Municipalities and the county have worked to identify vulnerable populations and special needs for evacuation and equipment during disasters. This information can be improve overtime with additional outreach and consistent maintenance. An example of success for this action, is Plumstead Police and Fire have an evacuation plan that addresses vulnerable populations and the unique needs and equipment.
Action 1.I.2 Conduct qualitative evaluation process for managing stranded rural residents and travelers (e.g., temporary shelters).	This action is ongoing.
Action 1.I.3 If warranted, implement additional storm shelters and warning systems near vulnerable communities, including: Identify structures that can be used as tornado safe rooms (some may require structure modifications), or NOAA weather radios for vulnerable populace.	Many communities are using and promoting Ready PA. This action is ongoing.

Table 6.1-1: Review of Mitigation Strategy from 2011 Bucks County HMP.	
Objective 1.J: Utilize available County level datasets with characteristics of individual structures for improved hazard planning and outreach.	Objective confirmed and continued.
Action 1.J.1 Utilize available county GIS Resources for municipal hazard related planning and outreach.	This action is ongoing.
Objective 1.K: Identify and prioritize funding for transportation infrastructure projects that will reduce impact of hazards.	Objective confirmed and continued.
Action 1.K.1 Review prevalence of transportation accidents and known infrastructure deficiencies and advocate for projects and funding that will increase safety.	This action is ongoing. Success in the category includes Lower Southampton implementing traffic signal and road projects and Riegelsville worked with PennDOT to replace a deficient bridge.
Goal 2 – Promote disaster-resistant future development	Goal confirmed and continued.
Objective 2.A: Encourage and facilitate the development or revision of comprehensive plans and zoning/land-use ordinances to limit development in high-hazard areas.	Objective confirmed and continued.
Action 2.A.1 Distribute and promote the inclusion of vulnerability analysis information as part of periodic plan review and revisions at the township/borough level.	This action is ongoing.
Action 2.A.2 Integrate evaluation of snow-removal and emergency access logistics with new development planning.	This action has been implemented by many communities as part of permit and SALDO reviews and remains ongoing for remaining municipalities.
Action 2.A.3 Evaluate ordinances to standardize hydrant connections.	This action has been completed. Fire Departments throughout the county have adapters to be able to connect to the hydrant systems in the county.
Objective 2.B: Encourage and facilitate the adoption of building codes that provide protection for new construction and substantial renovations from the effects of identified hazards.	Objective confirmed and continued.
Action 2.B.1 Evaluate adequacy of township/borough building code implementation.	This action has been completed by Chalfont and Penndel and remains ongoing for other municipalities. Chalfont completed by evaluating and deciding to stay with state law.
Action 2.B.2 Encourage increasing design wind and/or snow load for future development.	This action has been completed by Chalfont and remains ongoing for other municipalities. Chalfont completed by providing encouragement to applicant to address higher design standards and the decision was made to stay with state law and national recognized standards.
Action 2.B.3 Work with township/borough officials to increase awareness among mobile-home owners (i.e., informational mailings, workshops) about requirements for proper anchoring for wind protection.	This action has been completed since it is addressed during the permit review process.
Objective 2.C: Provide adequate and consistent enforcement of ordinances and codes within and between jurisdictions.	Objective confirmed and continued.

Table 6.1-1: Review of Mitigation Strategy from 2011 Bucks County HMP.	
Action 2.C.1 Train the municipal building inspectors to consistently enforce the building code.	This action is ongoing. Municipalities expressed that Building Code Officials receive regular training and tour township regularly.
Goal 3 – Promote hazard mitigation as a public value in recognition of its importance to the health, safety, and welfare of the population.	Goal confirmed and continued.
Objective 3.A: Provide public education to increase awareness of hazards and opportunities for mitigation.	Objective continued and revised slightly to recognize actions moved to this objective.
Action 3.A.1 Identify and publicize success stories as part of an overall consistent public relations program.	Yardley published articles on hazard mitigation in quarterly newsletter. This action was combined and revised to integrate two similar outreach actions.
Action 3.D.1. Evaluate and consider implementing activities to secure "Firewise" designation.	All communities enforce fire codes and elected to move this action forward as ongoing.
Objective 3.B: Promote partnerships between the municipalities and the County to continue to develop a County-wide approach to identifying and implementing mitigation actions.	Objective confirmed and continued.
Action 3.B.1 Convene regular meetings of a restructured HMPC to discuss issues and progress related to the implementation of the plan.	This action was not regularly completed though many municipalities and the county have taken mitigation action. County plans to annual review with other planning initiatives. This action is ongoing.
Objective 3.C: Continue the promotion of disaster resistance in the business community via the hazard mitigation planning initiative.	Objective confirmed and continued.
Action 3.C.1 Renew and expand commitments to hazard mitigation planning among partner organizations.	This action is ongoing.
Goal 4 – Improve Response and Recovery Capabilities.	Goal 4 was removed based on 2013 FEMA HMP guidance for mitigation action categories. Reponses and Recovery is effectively tracked via other planning mechanisms in Bucks County. Some actions were moved to goals 2 and 3 were they made sense in continuing those goals and objectives. A new goal was created to address natural resource action underway and planned in Bucks County
Objective 4.A: Increase awareness by residents (i.e., through public outreach/education) of actions to take during an emergency.	Objective deleted. Actions worked well under Goal 3 and Objective 3.A.
Action 4.A.1 Increase awareness by residents of actions to take during an emergency, including sheltering and evacuation procedures. Methods to be used can include through public outreach (i.e., web site, mailings, workshops, media coverage, and newsletter) and education.	Municipalities regularly distribute information through channels including newsletter, websites, Twitter, Facebook, robo calls, and at public events. For example, Richlandtown community events are utilized as forums to provide education and the opportunity for Q&A with Emergency Responders. This action is revised and moved under Goal 3.

Table 6.1-1: Review of Mitigation Strategy from 2011 Bucks County HMP.	
Action 4.A.2 Secure flood specific signage that warns travelers that barricades are present to prevent them from traveling into floodwater.	Upper Makefield has placed "Subject to Flooding" signs at two areas along the Jericho Creek. This action is ongoing and moved under Goal 3.
Objective 4.B: Enhance response capability of County and municipal fire, police, and emergency medical services personnel to special populations.	Objective deleted. Actions complete and maintenance address in the revised version of Action 1.I.1
Action 4.B.1 Identify special populations requiring additional emergency response.	This action is complete and will be continued as the revised version of Action 1.I.1 for maintenance of this system.
Action 4.B.2 Evaluate means to enhance response capability for those residents.	This action is complete and will be continued as the revised version of Action 1.I.1 for maintenance of this system.
Objective 4.C: Continue and increase coordination between critical facilities and emergency responders.	Objective deleted. Actions worked well revised and under Goal 2 and Objective 2.D.
Action 4.C.1 Increase first responder awareness and preparedness by planning meetings with local hazardous materials facilities to review facility Emergency Operations Plans and procedures.	Richlandtown is coordinating meetings with AmeriGas, Phoebe Richland, Richlandtown Fire Co. and our Emergency Management team to review facility Emergency Operations Plans and Procedures. This action is revised, ongoing, and moved under Goal 2.
Action 4.C.2 Increase awareness and preparedness by planning meetings with local colleges and universities to review facility Emergency Operations Plans and procedures.	This action is revised, ongoing, and moved under Goal 2.

Acquisition and Elevation

Bucks County has made significant progress in hazard mitigation by acquiring and elevating properties within the floodplain. These projects represent significant progress from the 1998 DVRPC document *Bucks County Flood Recovery and Mitigation Strategy* and the December 2001 *Neshaminy Creek Supplemental Watershed Work Plan No. 5*. Efforts to continue acquisition, elevation, and other flood mitigation projects continue in the 2011 HMP under **Objective 1.A: Implement projects that protect properties, critical facilities, and infrastructure from hazards focusing on the 1% annual chance floodplain** and **Objective 2.D: Implement hazard mitigation measures identified in other planning mechanisms and address hazard mitigation as appropriate in other planning mechanisms**. The strength of existing plans and planning mechanisms within Bucks County combined with commitments made in the 2016 HMP show promise for continued mitigation success in Bucks County.

Success in Bucks County has been found in seeking multiple funding sources. FEMA Hazard Mitigation Assistance (HMA) grant funding through PEMA has resulted in at least 143 mitigated properties. Funding through the US Department of Agriculture Natural Resource Conservation Service (NRCS) resulted in at least 148 mitigated properties. Funding through FEMA Increased Cost of Compliance (ICC) claims mitigated at least 85 properties in Bucks County. The Table 6.1-4 shows buyouts, elevations, demolitions and other mitigation completed through HMA, NRCS, and ICC mitigation funding streams. When the NRCS funding is used to elevate a property with a basement an additional room is built to compensate for the

loss of a basement, thus the table distinguishes between elevations and elevations with room addition. In total, these funding streams lead to approximately 376 mitigated properties in Bucks County.

Mitigation of RL and SRL properties is an important aspect of mitigation implementation. Bucks County has 846 RL and 98 SRL properties. These properties have been priorities for mitigation, leading to 155 mitigated RL and SRL properties in Bucks County. This represents a 24 property increase in mitigated properties between the 2011 and 2016 plans; it should be noted that tracking of mitigated properties improved during the same time period between FEMA, PEMA, and local governments. The increase likely represents a combination of new mitigation and better tracking of older mitigation, both of which are mitigation successes. Bucks County's progress towards mitigating properties focuses on areas that are repeatedly flooded, especially along the flood prone Delaware River and Neshaminy Creek.

Table 6.1-2: Mitigated Properties in Bucks County

MUNICIPALITIES	NRCS BUYOUT	NRCS ELEVATION	NRCS ELEVATION & ROOM ADDITION	PEMA/ FEMA BUYOUT & ELEVATION	ICC DEMOLITION	ICC ELEVATION	ICC OTHER	TOTAL
Bensalem Township	7	12	12	18				49
Bridgeton Township				1		15	1	17
Bristol Township	7	40	9	6				62
Durham Township						1		1
Falls Township				1				1
Hulmeville Borough	1	19	7	12				39
Langhorne Borough				5	1	5	2	13
Lower Makefield Township				3		2		5
Lower Southampton Township	1	6		8		1		16
Middletown Township	9	14	2	57				82
New Hope Borough				1		2		3
Northampton Township		2		2				4
Perkasie Borough				1				1
Plumstead Township				1				1
Richland Township				1				1
Tinicum Township				1	1	14		16
Upper Makefield Township				3		14		17
Upper Southampton Township				1				1
Warrington Township				7		4		11
Yardley Borough				15		20	3	38
TOTAL	25	93	30	144	2	78	6	378

Figure 6.1-1: Yardley Borough elevation project.

Bucks County projects are also featured on Mitigation Best Practices Portfolio. *Pumps Keep Morrisville Homes Dry, Elevated Home is Barely Affected by the April Rain* regarding New Hope Borough, and *Home Retrofitting Along River-Ivan Caused Serious Damage* regarding Yardley Borough are stories that all highlight progress in Bucks County to mitigation flooding (FEMA, May 2011). The images in Figure 6.4-2 show an elevation project in progress for Yardley Borough.

Bucks County has accomplished a great deal of mitigation in addition to property specific buyouts, elevations and other mitigation. Key areas of mitigation progress include critical facilities planning and preparedness, outreach before and during disasters, improved hazard mitigation coordination, and data source improvement.

Critical Facilities Planning and Preparedness

There is a great deal of planning related to Critical Facilities preparing, preventing or mitigating, responding, and recovering from disasters. Most critical facilities are required to have emergency preparedness and response plans in order to maintain accreditation and/or have licenses to operate under federal and state regulations. For instance, all hospitals and nursing homes in Bucks County must have emergency plans in order to maintain accreditation and licenses from Pennsylvania. Facilities that produce or store hazardous materials are required to have emergency plans reviewed by the LEPC. The Bucks County Emergency Management Agency coordinates with critical facilities owners and representative organizations like the Delaware Valley Health Care consortium to review and provide input into the planning process. The Bucks County Emergency Management and Planning Commission maintain GIS data on critical facilities that may be used in response or in mitigation planning efforts, as they were used for the update of this HMP. The coordination and planning leads to effective programs like prioritizing critical facilities that should have their power returned first after a disaster. Critical facilities owners coordinate with the Bucks County EMA to have their power returned first in the event of a disaster; this program worked well during Hurricane Irene and Tropical Storm Lee.

Figure 6.1-2: Municipalities Use Facebook to Distribute Information on Hazards, Emergencies and Other Community Interests – Sample from East Rockhill.

Outreach Before and During Disasters

There has and continues to be effective outreach in Bucks County to assist in disaster mitigation, preparedness, response and recovery. Many municipalities have begun to use or expanded use of Facebook, Twitter, robo calls, and municipality websites to reach their communities (see Figure 6.1-2). Outreach conducted between the 2011 and 2016 update includes:

- Municipal outreach on websites for the 2015 DFIRM update.
- County EMA uses reverse 911 to contact residents with disaster specific recorded messages.
- Residents have been encouraged to sign-up for ReadyNotify PA through EMA outreach and via a County Public Information Department campaign.
- County Commissioners regularly publicize success stories in meetings and via the County website.
- LEPC distributes shelter-in-place video.
- EMA staff attends State Legislature Senior Expos and provide preparedness information.
- Municipalities distribute preparedness information provided by county.
- County website provides preparedness information.
- 911 Training Coordinator provides presentations at schools.
- County's special population registry regularly promoted for new registrations and updates.

Figures 6.1-3 and 6.1-4 show the county specific materials regularly distributed by the EMA and the Bucks County ReadyNotify PA website.

Figure 6.1-3: Buck County ReadyNotify PA website (bucks.alertpa.org).

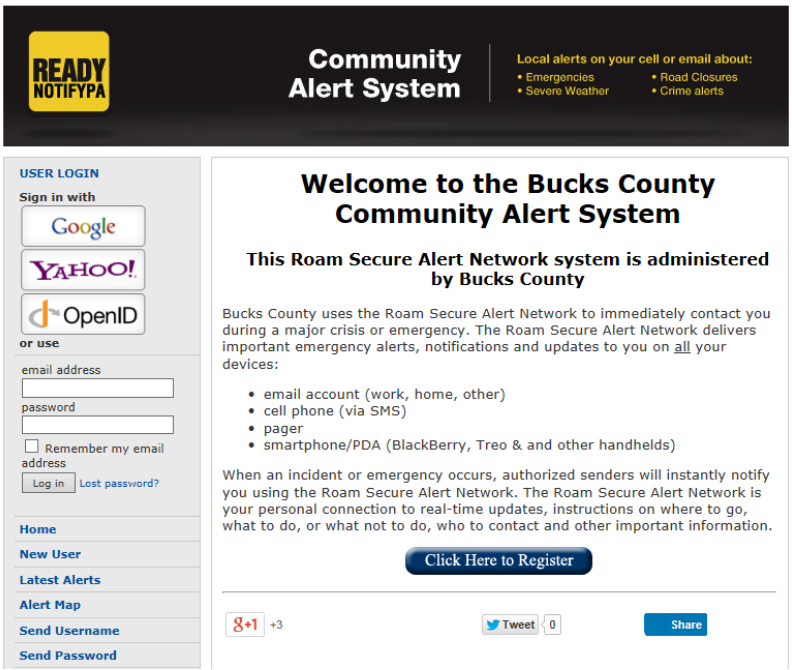
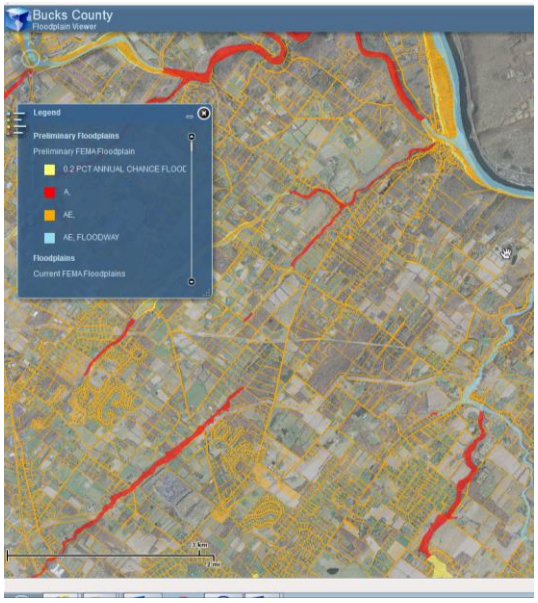


Figure 6.1-4: Snapshot of Bucks County Floodplain Viewer available at gisweb.co.bucks.pa.us.



Improved Hazard Mitigation Coordination

Hazard mitigation coordination has been addressed in three recent planning processes within Bucks County. First, Bucks County's DFIRMs were Effective March 16, 2015. Second, the Comprehensive Plan, which was update in 2011, includes hazard mitigation information and was updated with high levels of municipal participation. Finally, the Executive Director of the Planning Commission and Emergency

Management Director coordinated on mitigation through the Delaware River Flood Task Force. Additionally, municipal and county officials regularly attend the Pennsylvania Planning Association, County Commissioners Association of Pennsylvania, and borough and township associations to share ideas and learn more about mitigation and other effective best practices.

Data Source Improvement

Bucks County has improved items GIS and data capabilities over the last 4 years. One success directly related to mitigation outreach is hosting a Floodplain Viewer on the county website. The tool provides detailed information to assist residents, business, planners, emergency managers and others manage and learn more about floodplains at the local level, see Figure 6.1-5.

Natural Systems Protection

Bucks County is active in stormwater management as shown in Section 5. East Rockhill has implemented projects that will provide a suitable space for storm and flood water to go safely, including a conservation easement along Three Mile Run Creek, bank restoration for Branch Creek and Schwenknill Road, a basin upgrade for 5th Street, and stormwater improvements along Branch Road. Yardley completed installation of backflow preventers on outfalls. Plumstead is working on stream restoration plan for a development with an insufficient buffer. These projects represent one why that stormwater management planning and hazard mitigation planning integrate in Bucks County and have the opportunity to meet matching goals.

Historic Property Hazard Mitigation

During the 2016 HMP update, nine municipalities accomplished an abbreviated version of Phase 1 and the beginning of Phase 2 of the historic preservation hazard mitigation planning process defined in the Integrating Historic Property and Cultural Resource Considerations Into Hazard Mitigation Planning State and Local Mitigation Planning How-To Guide published by FEMA (FEMA, 2005). Phase 1 of the planning process includes identifying the level of awareness and support for protecting historical properties, identifying resources for protecting the properties, identifying experts to help with mitigation efforts, and engaging the public in the effort to protect historic properties, aspects of which were accomplished in the HMP update planning process. The first two steps of Phase 2 of the planning process include identifying and profiling the hazards in the area, which was accomplished through the HMP update process.

Ten municipalities indicated an interest in pursuing mitigation planning for their historic properties: Bensalem Township, Bristol Borough, Doylestown Township, Haycock Township, Richland Township, Solebury Township, Springfield Township, Tinicum Township, Upper Makefield Township, and Yardley Borough. These municipalities identified the properties that were either registered as National Historical Registered Properties, identified as historical properties on a state or local level, or are eligible to be registered through the use of the PHMC CRGIS database. PHMC representatives assisted the representatives of the communities on the HMPC to identify these properties, as well as assisting in identifying possible funding mechanisms for future hazard mitigation projects. In addition to identifying the historic properties in each of these areas, the municipalities also identified which of these properties were vulnerable to flooding in the SFHA. Each of these municipalities are interested in pursuing further planning to identify future projects to mitigate the risks posed to their historical properties, and have identified two actions for historic property hazard mitigation in the Mitigation Action Plan.

6.2. Mitigation Goals and Objectives

Based on results of the goals and objectives evaluation exercise and input from the HMPC and HMPT, a list of four goals and sixteen corresponding objectives was developed. Table 6.2-1 details the mitigation goals and objectives established for the 2016 HMP.

Table 6.2-1: List of Mitigation Strategy Goals and Objectives.
GOAL 1 – REDUCE POSSIBILITY OF INJURY/DEATH TO COUNTY RESIDENTS AND REDUCE POTENTIAL DAMAGE TO EXISTING COMMUNITY ASSETS (INCLUDING RESIDENTIAL PROPERTIES, CRITICAL FACILITIES AND INFRASTRUCTURE) DUE TO NATURAL AND HUMAN-MADE HAZARDS.
Objective 1.A: Implement projects that protect properties, critical facilities, and infrastructure from hazards focusing on the 1% annual chance floodplain.
Objective 1.B: Provide public outreach/education regarding strategies (e.g., floodproofing) for property owners in the 1% annual chance floodplain.
Objective 1.C: Address identified data limitations regarding lack of detailed information about individual structures located in the 1% annual chance floodplain.
Objective 1.D: Identify and evaluate protection for hazardous material storage in floodplain.
Objective 1.E: Identify the most-vulnerable and critical existing structures and infrastructure due to the effects of severe weather.
Objective 1.F: Evaluate and prioritize communities that require warning systems and storm shelters.
Objective 1.G: Utilize available County level datasets with characteristics of individual structures for improved hazard planning and outreach.
Objective 1.H: Identify and prioritize funding for transportation infrastructure projects that will reduce impact of hazards.
GOAL 2 – PROMOTE DISASTER-RESISTANT FUTURE DEVELOPMENT.
Objective 2.A: Encourage and facilitate the development or revision of comprehensive plans and zoning/land-use ordinances to limit development in high-hazard areas.
Objective 2.B: Encourage and facilitate the adoption of building codes that provide protection for new construction and substantial renovations from the effects of identified hazards.
Objective 2.C: Provide adequate and consistent enforcement of ordinances and codes within and between jurisdictions.
Objective 2.D: Implement hazard mitigation measures identified in other planning mechanisms and address hazard mitigation as appropriate in other planning mechanisms.
GOAL 3 – PROMOTE HAZARD MITIGATION AS A PUBLIC VALUE IN RECOGNITION OF ITS IMPORTANCE TO THE HEALTH, SAFETY, AND WELFARE OF THE POPULATION.
Objective 3.A: Provide public education to increase awareness of hazards, opportunities for mitigation and to reduce the impact of disasters on all community members.
Objective 3.B: Promote partnerships between the municipalities and the County to continue to develop a County-wide approach to identifying and implementing mitigation actions.
Objective 3.C: Continue the promotion of disaster resistance in the business community via the hazard mitigation planning initiative.
GOAL 4 – PROTECT NATURAL RESOURCES WITHIN HAZARD AREAS AND USE THEM TO REDUCE RISK AND LOSSES.
Objective 4.A: Implement natural resource planning and projects that assist in hazard mitigation.

6.3. Identification and Analysis of Mitigation Techniques

The mitigation strategy in the updated HMP should include analysis of a comprehensive range of specific techniques or actions. FEMA, through the March 2013 Local Mitigation Handbook, and PEMA, through the October 2013 Standard Operating Guide (SOG), identify four categories of hazard mitigation techniques.

- **Local plans and regulations:** Government authorities, policies, or codes that influence the way land and buildings are developed and built. Examples include, but are not limited to: comprehensive plans, subdivision regulations, building codes and enforcement, and NFIP and CRS.
- **Structure and infrastructure**: Modifying existing structures and infrastructure or constructing new structures to reduce hazard vulnerability. Examples include, but are not limited to: acquisition and elevation of structures in flood prone areas, utility undergrounding, structural retrofits, floodwalls and retaining walls, detention and retention structures, and culverts.
- **Natural systems protection:** Actions that minimize damage and losses and also preserve or restore the functions of natural systems. Examples include, but are not limited to: sediment and erosion control, stream corridor restoration, forest management, conservation easements, and wetland restoration and preservation.
- **Education and awareness:** Actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate the hazards, and may also include participation in national programs. Examples include, but are not limited to: radio or television spots, websites with maps and information, provide information and training, NFIP outreach, StormReady, and Firewise Communities.

Table 6.3-1 identifies mitigation techniques for the hazards identified in the risk assessment. The matrix is used to help identify specific mitigation actions to be included in the mitigation action plan.

Table 6.3-1: Mitigation techniques used for all hazards in Bucks County

HAZARD	MITIGATION TECHNIQUE			
	LOCAL PLANS AND REGULATIONS	STRUCTURE AND INFRASTRUCTURE	NATURAL SYSTEMS PROTECTION	EDUCATION AND AWARENESS
Drought	X	X		X
Earthquake	X			X
Extreme Temperature	X	X		X
Flood, Flash Flood, Ice Jam	X	X	X	X
Hailstorm	X			X
Hurricane, Tropical Storm, Nor'easter	X	X	X	X
Landslide	X			X
Lightning Strike	X			X
Pandemic and Infectious Disease	X			X
Radon Exposure	X			X

Table 6.3-1: Mitigation techniques used for all hazards in Bucks County				
HAZARD	MITIGATION TECHNIQUE			
	LOCAL PLANS AND REGULATIONS	STRUCTURE AND INFRASTRUCTURE	NATURAL SYSTEMS PROTECTION	EDUCATION AND AWARENESS
Subsidence, Sinkhole	X			X
Tornado, Windstorm	X			X
Wildfire	X			X
Winter Storm	X			X
Structure Collapse	X	X		X
Dam Failure	X	X		X
Environmental Hazards	X			X
Terrorism	X			X
Transportation Accident	X	X		X
Urban Fire and Explosion	X			X
Utility Interruption	X			X

6.4. Mitigation Action Plan

Following the Risk Assessment stage of the HMP update process, the Mitigation Solutions Workshop was held on May 5, 2015 to develop a framework for the Mitigation Action Plan (see meeting minutes in **Appendix B**). Following the goals and objectives review and evaluation during the Mitigation Workshop, the group went over mitigation actions and were asked to comment on progress, continued, and new actions. Robust participation in the plan update and mitigation strategy was encouraged, though municipalities were informed that they needed to have at least one mitigation action. The final list of 42 mitigation actions is made up of actions from the existing 2011 Mitigation Action Plan, actions stemming from the 2011 municipal actions, and the new actions developed at and as follow-up to the Mitigation Solutions Workshop.

Table 6.4-1 lists all the mitigation actions for the 2016 HMP. At least one mitigation action was established for each low, moderate, and high-risk hazard in Bucks County, but more than one action is identified for several hazards. Table 6.4-1 includes a prioritization of each of the mitigation actions; the process of deriving this prioritization is explained in the narrative and table following this table. Each jurisdiction has at least one action. Each mitigation action is intended to address one of the goals and objectives identified in Section 6.2.

Table 6.4-1: 2016 Mitigation Action Plan.							
ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Goal 1 – Reduce possibility of injury/death to County residents and reduce potential damage to existing community assets (including residential properties, critical facilities, and infrastructure) due to natural and human-made hazards.							
Objective 1.A: Implement projects that protect properties, critical facilities, and infrastructure from hazards focusing on the 1% annual chance floodplain.							
Action 1.A.1 Proceed with grant applications to suitably protect repetitive-loss properties 1% annual chance floodplain (for owners interested in FEMA mitigation funding).	Bensalem Township, Bridgeton Township, Bristol Borough, Bristol Township, Buckingham Township, Chalfont Borough, Doylestown Borough, Doylestown Township, Durham Township, Falls Township, Hulmeville Borough, Langhorne Borough, Langhorne Manor Borough, Lower Makefield Township, Lower Southampton Township, Middletown Township, Milford Township, New Britain Township, New Hope Borough, Nockamixon Township, Northampton Township, Perkasie Borough, Plumstead Township, Richland Township, Riegelsville Borough, Sellersville Borough, Solebury Township, Springfield Township, Tinicum Township, Upper Makefield	Structure and Infrastructure - NFIP Action	Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities, Bucks County Planning Commission	Within 2 years	Staff time; PEMA Technical Support	High

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
	Township, Upper Southampton Township, Warminster Township, Warrington Township, Warwick Township, West Rockhill Township, Wrightstown Township, Yardley Borough						
Action 1.A.2 Proceed with grant applications to suitably protect and continue operations of critical facilities in the 1% annual chance floodplain and at risk to utilities interruption from flooding and other hazards.	Bensalem Township, Bristol Borough, Bristol Township, Doylestown Borough, Lower Makefield Township, Lower Southampton Township, Milford Township, Morrisville Borough, New Britain Borough, Northampton Township, Quakertown Borough, Riegelsville Borough, Sellersville Borough, Tinicum Township, West Rockhill Township	Structure and Infrastructure - NFIP Action	Dam Failure, Flood, Hurricane, Tropical Storm, Nor'easter, Structure Collapse	Municipalities	Within 2 years	Staff time; PEMA Technical Support; HMGP; PDM	High
Action 1.A.3 Proceed with grant applications for infrastructure that protects community from 1% annual chance floodplain.	East Rockhill Township, Morrisville Borough, Upper Southampton Township, Yardley Borough	Structure and Infrastructure - NFIP Action	Dam Failure, Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities	Within 2 years	Staff time; PEMA Technical Support; HMGP; PDM	High

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Action 1.A.4 Evaluate, implement, and perform mitigation projects identified in this and other planning mechanisms, including acquisition, elevation, foundation and building stabilization, securing access to generator power and other mitigation methods.	All Participating Communities: Bedminster, Bensalem, Bridgeton, Bristol Boro, Bristol Twp, Buckingham, Chalfont, Doylestown Boro, Doylestown Twp, Dublin, Durham, East Rockhill, Falls, Haycock, Hilltown, Hulmeville, Ivyland, Langhorne, Langhorne Manor, Lower Makefield, Lower Southampton, Middletown, Milford, Morrisville, New Britain Boro, New Britain Twp, New Hope, Newtown, Newtown, Nockamixon, Northampton, Penndel, Perkasie, Plumstead, Quakertown, Richland, Richlandtown, Riegelsville, Sellersville, Silverdale, Solebury, Springfield, Telford, Tinicum, Trumbauersville, Tullytown, Upper Makefield, Upper Southampton, Warminster, Warrington, Warwick, West Rockhill, Wrightstown, Yardley	Structure and Infrastructure	Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities, Bucks County Planning Commission	Continuously for next 5 years.	FEMA HMA through PEMA, USDA-NRCS	High

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Objective 1.B: Provide public outreach/education regarding strategies (e.g., floodproofing) for property owners in the 1% annual chance floodplain.							
Action 1.B.1 Work with township/borough officials to increase awareness of model floodplain ordinance and with property owners, including informational mailings to property owners in the 1% annual chance floodplain, and sponsoring a series of workshops about costs and benefits of: Acquiring and minimizing the cost of flood insurance coverage, and Property acquisition, relocation, elevation, dry floodproofing, and wet floodproofing.	Bedminster Township, Haycock Township, Hulmeville Borough, Lower Makefield Township, New Britain Borough, New Britain Township, New Hope Borough, Newtown Borough, Newtown Township, Quakertown Borough, Sellersville Borough, Silverdale Borough, Tinicum Township, Trumbauersville Borough, Tullytown Borough, Warrington Township, West Rockhill Township	Education and Awareness - NFIP Action	Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities, Bucks County Planning Commission	Continuously for next 5 years.	Staff time; DCED and PEMA Technical Support	Medium
Action 1.B.2 Evaluate and/or pursue Community Rating System (CRS) participation for insurance premium reduction (and flood damage reduction).	Chalfont Borough, Doylestown Township, Lower Makefield Township, Newtown Township, Tinicum Township, Yardley Borough	Structure and Infrastructure - NFIP Action	Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities	Within 2 years	Staff time; FEMA Technical Support	Medium

Table 6.4-1: 2016 Mitigation Action Plan.							
ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Objective 1.C: Address identified data limitations regarding lack of detailed information about individual structures located in the 1% annual chance floodplain.							
Action 1.C.1 Obtain information for structures in the areas with the highest relative vulnerability to determine the best property protection methods. Information to be obtained includes: Lowest-floor elevation, Number of stories, Presence of a basement, and Market and/or replacement value.	East Rockhill Township Lower Makefield Township, New Britain Township, Nockamixon Township, Plumstead Township, Upper Southampton Township	Local Plans and Regulations/ Structure and Infrastructure - NFIP Action	Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities	Within 5 years	Staff time; DCED and PEMA Technical Support	Medium
Action 1.C.2 Obtain information for all remaining structures in the 1% annual chance floodplain to determine the best property protection methods to promote with individual property owners. Techniques for gathering information over time should include developing and implementing a program for integrated information "capture" at key points in normal	Lower Makefield Township, New Britain Township	Local Plans and Regulations/ Structure and Infrastructure - NFIP Action	Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities	Within 5 years	Staff time; DCED and PEMA Technical Support	Medium

Table 6.4-1: 2016 Mitigation Action Plan.							
ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
township administrative procedures, including applications for building permits at township/borough offices.							
Objective 1.D: Identify and evaluate protection for hazardous material storage in floodplain.							
Action 1.D.1 Identify all storage of hazardous materials in floodplains (including non-addressable structures, such as propane tanks).	Sellersville Borough, Solebury Township, Tinicum Township, West Rockhill Township	Local Plans and Regulations	Flood, Hurricane, Tropical Storm, Nor'easter, Environmental Hazards, Urban Fire and Explosion	Municipalities, Bucks County Emergency Management Agency	Within 3 years	Staff time	High
Action 1.D.2 Evaluate alternative methods to minimize risk from existing storage areas.	West Rockhill Township	Local Plans and Regulations	Flood, Hurricane, Tropical Storm, Nor'easter, Environmental Hazards, Urban Fire and Explosion	Municipalities	Within 3 years	Staff time	High
Action 1.D.3 Assess means to prevent future storage in floodplain.	West Rockhill Township	Local Plans and Regulations	Flood, Hurricane, Tropical Storm, Nor'easter, Environmental	Municipalities	Within 3 years	Staff time; DCED Technical Support for Model Ordinance	High

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
			Hazards, Urban Fire and Explosion			that addresses hazardous materials in floodplain	
Objective 1.E: Identify the most-vulnerable and critical existing structures and infrastructure due to the effects of severe weather.							
Action 1.E.1 Identify critical facilities with the highest vulnerability to the effects of power outage (i.e., hospitals, nursing homes, fire, police, rescue, and emergency management).	Doylestown Borough, Tinicum Township, West Rockhill Township	Education and Awareness	Dam Failure Drought, Extreme Temperature, Flood, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Lightning Strike, Structure Collapse, Tornado, Wind Storm, Utility Interruption, Winter Storm	Municipalities, Bucks County Emergency Management Agency	Within 3 years	Staff Time; NOAA Storm Ready	Medium
Action 1.E.2 Develop action plan for reducing potential damage and loss of function at identified critical facilities and infrastructure.	Doylestown Borough, West Rockhill Township	Structure and Infrastructure / Education and Awareness	Dam Failure Drought, Extreme Temperature, Flood, Hailstorm,	Municipalities, Bucks County Emergency Management Agency	Within 5 years	Staff Time; DHS; NOAA Storm Ready; Private Funding	Medium

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
			Hurricane, Tropical Storm, Nor'easter, Lightning Strike, Structure Collapse, Tornado, Wind Storm, Utility Interruption, Winter Storm			from Critical Facilities and Infrastructure	
Objective 1.F: Evaluate and prioritize communities that require warning systems and storm shelters.							
Action 1.F.1 Conduct qualitative evaluation process for managing stranded rural residents and travelers (e.g., temporary shelters).	West Rockhill Township	Local Plans and Regulations	Dam Failure, Extreme Temperature, Flood, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Lightning Strike, Tornado, Wind Storm, Utility Interruption, Winter Storm	Municipalities, Bucks County Emergency Management Agency	Within 5 years	Staff Time; DHS; NOAA Storm Ready	Medium

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Action 1.F.2 If warranted, implement additional storm shelters and warning systems near vulnerable communities, including: Identify structures that can be used as tornado safe rooms (some may require structure modifications), or NOAA weather radios for vulnerable populace.	Solebury Township, Trumbauersville Borough, West Rockhill Township	Education and Awareness/ Local Plans and Regulations	Dam Failure, Extreme Temperature, Flood, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Lightning Strike, Tornado, Wind Storm, Utility Interruption, Winter Storm	Municipalities, Bucks County Emergency Management Agency	Within 5 years	Staff Time; DHS; NOAA Storm Ready	High
Objective 1.G: Utilize available County level datasets with characteristics of individual structures for improved hazard planning and outreach.							
Action 1.G.1 Utilize available county GIS Resources for municipal hazard related planning and outreach.	Tinicum Township	Education and Awareness/ Local Plans and Regulations	Dam Failure, Earthquake, Environmental Hazards, Extreme Temperature, Flood, Flash Flood, Ice Jam, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Landslide, Lightning	Municipalities, Bucks County Planning Commission, Bucks County Emergency Management Agency	Within 5 years	Staff time; HMGP; PDM	Medium

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
			Strike, Pandemic, Radon, Structure Collapse, Subsidence, Sinkhole, Terrorism, Tornado, Wind Storm, Urban Fire and Explosion, Utility Interruption, Wildfire, Winter Storm				
Objective 1.H: Identify and prioritize funding for transportation infrastructure projects that will reduce impact of hazards.							
Action 1.H.1 Review prevalence of transportation accidents and known infrastructure deficiencies and advocate for projects and funding that will increase safety.	Bensalem Township, Bristol Borough, Bristol Township, Langhorne Borough, Langhorne Manor Borough, Lower Makefield Township, Lower Southampton Township, Middletown Township, Milford Township, Penndel Borough, Solebury Township, Yardley Borough	Structure and Infrastructure	Structure Collapse, Transportation Accidents	Municipalities, Bucks County Planning Commission, Bucks County General Services Division	Within 5 years	PennDOT	Medium

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Action 1.H.2 Implement signal improvements at intersections that frequently experience traffic accidents.	Richland Township	Structure and Infrastructure	Transportation Accidents	Municipality	Within 5 years	PennDOT	Low
Goal 2 – Promote disaster-resistant future development.							
Objective 2.A: Encourage and facilitate the development or revision of comprehensive plans and zoning/land-use ordinances to limit development in high-hazard areas.							
Action 2.A.1 Distribute and promote the inclusion of vulnerability analysis information as part of periodic plan review and revisions at the township/borough level.	New Britain Township	Education and Awareness/ Local Plans and Regulations	All	Municipalities, Bucks County Planning Commission	Continuously for next 5 years.	Staff Time; Technical assistance from PEMA or FEMA	High
Action 2.A.2 Integrate evaluation of snow-removal and emergency access logistics with new development planning.	Doylestown Borough, East Rockhill Township, Hilltown Township, New Britain Township, Plumstead Township, Silverdale Borough	Local Plans and Regulations	Winter Storm	Municipalities, Bucks County Planning Commission	Continuously for next 5 years.	Staff Time	High
Objective 2.B: Encourage and facilitate the adoption of building codes that provide protection for new construction and substantial renovations from the effects of identified hazards.							
Action 2.B.1 Evaluate adequacy of township/borough building code implementation.	Haycock Township, New Britain Township, Plumstead Township, Silverdale Borough, Springfield Township,	Local Plans and Regulations	Dam Failure, Earthquake, Environmental Hazards, Extreme Temperature,	Municipalities	Continuously for next 5 years.	Staff Time	Medium

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
	Upper Southampton Township		Flood, Flash Flood, Ice Jam, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Landslide, Lightning Strike, Structure Collapse, Subsidence, Sinkhole, Tornado, Wind Storm, Urban Fire and Explosion, Utility Interruption, Wildfire, Winter Storm				
Action 2.B.2 Encourage increasing design wind and/or snow load for future development.	Haycock Township, New Britain Township, Silverdale Borough, Upper Southampton Township	Local Plans and Regulations	Hurricane, Tropical Storm, Nor'easter, Tornado, Wind Storm, Winter Storm	Municipalities	Continuously for next 5 years.	Staff Time	Medium

Table 6.4-1: 2016 Mitigation Action Plan.							
ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Objective 2.C: Provide adequate and consistent enforcement of ordinances and codes within and between jurisdictions.							
Action 2.C.1 Train the municipal building inspectors to consistently enforce the building code.	Chalfont Borough, Doylestown Borough, East Rockhill Township, New Britain Township, Plumstead Township, Silverdale Borough, Upper Southampton Township, West Rockhill Township	Local Plans and Regulations /Structure and Infrastructure	Dam Failure, Earthquake, Environmental Hazards, Extreme Temperature, Flood, Flash Flood, Ice Jam, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Landslide, Lightning Strike, Structure Collapse, Subsidence, Sinkhole, Tornado, Wind Storm, Urban Fire and Explosion, Utility Interruption, Wildfire, Winter Storm	Municipalities, Bucks County Emergency Management Agency	Continuously for next 5 years.	Staff time; DCED and PEMA Technical Support	Medium

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Action 2.C.2 Review and consider updates to the floodplain ordinance, on an annual basis.	*All NFIP Participating Municipalities:* Bedminster, Bensalem, Bridgeton, Bristol Boro, Bristol Twp, Buckingham, Chalfont, Doylestown Boro, Doylestown Twp, Durham, East Rockhill, Falls, Haycock, Hilltown, Hulmeville, Langhorne, Langhorne Manor, Lower Makefield, Lower Southampton, Middletown, Milford, Morrisville, New Britain Boro, New Britain Twp, New Hope, Newtown Boro, Newtown Twp, Nockamixon, Northampton, Penndel, Perkasie, Plumstead, Quakertown, Richland, Riegelsville, Sellersville, Silverdale, Solebury, Springfield, Tinicum, Tullytown, Upper Makefield, Upper Southampton, Warminster, Warrington, Warwick, West Rockhill, Wrightstown, Yardley	Local Plans and Regulations - NFIP Action	Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities	Ongoing	Staff time; DCED and FEMA Technical Support	Medium

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Objective 2.D: Implement hazard mitigation measures identified in other planning mechanisms and address hazard mitigation as appropriate in other planning mechanisms.							
Action 2.D.1 Continue to implement measures for mitigation of flood hazard per the December 2001 "Neshaminy Creek Supplemental Watershed Work Plan No. 5." including Flood warning system, Voluntary property acquisition, Voluntary building elevation and floodproofing, and Continuation/ enhancement of floodplain ordinances, flood insurance, and stormwater management.	Bristol Township, Bensalem Township, Buckingham Township, Hulmeville Borough, Middletown Township, Newtown Township, Lower Southampton Township, Northampton Township, Warwick Township, Wrightstown Township	Local Plans and Regulations/ Structure and Infrastructure	Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities, Bucks County	Continue implementing plan over next 5 years.	USDA-NRCS	High
Action 2.D.2 Continue to implement measures for mitigation of flood hazard per the December 2001 "Neshaminy Creek Supplemental Watershed Work Plan No. 5." including Continuation/ enhancement of floodplain ordinances, flood insurance, and stormwater management.	Buckingham Township, Doylestown Borough, New Britain Borough, New Britain Township, Warminster Township, Warrington Township, Warwick Township	Local Plans and Regulations/ Structure and Infrastructure	Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities, Bucks County	Continue implementing plan over next 5 years.	USDA-NRCS	High

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Action 2.D.3 Develop Disaster Recovery plan that examines impact and plans outreach and continuity of operations for disaster events. Implements steps from planning process that could mitigate impacts and speed recovery for on residents, businesses, and government.	Doylestown Township, Plumstead Township	Local Plans and Regulations	All Hazards	Municipalities	Continuously for next 5 years.	Staff time; DHS	Medium
Action 2.D.4 Continue coordination and planning to mitigate, prepare, and respond to local hazardous materials facilities.	Doylestown Borough, Richlandtown Borough, Tinicum Township, Tullytown Borough	Local Plans and Regulations	Environmental Hazards	Municipalities, Hazardous Materials Facilities	Continuously for next 5 years.	Staff time; DHS	High
Action 2.D.5 Continue coordination and planning with local colleges and universities to be partners to mitigate, prepare, and respond to hazards.	Delaware Valley College, Holy Family University - Bucks County, Philadelphia Biblical University, Doylestown Township, Langhorne Borough, New Britain Borough, Newtown Township	Local Plans and Regulations	All	Municipalities, Delaware Valley College, Holy Family University - Bucks County, Philadelphia Biblical University	Continuously for next 5 years.	Staff time; DHS	High
Action 2.D.6 Inventory the historic properties vulnerable to the identified hazards, assess vulnerability of these	Bensalem Township, Bristol Borough, Doylestown Township, Haycock Township, Richland Township, Solebury	Local Plans and Regulations	All	Municipalities	Continuously for next 5 years.	Staff time; PHMC	Medium

Table 6.4-1: 2016 Mitigation Action Plan.							
ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
assets, and establish preservation priorities by determining which assets are most valuable to the community.	Township, Springfield Township, Tinicum Township, Upper Makefield Township, and Yardley Borough						
Goal 3 – Promote hazard mitigation as a public value in recognition of its importance to the health, safety, and welfare of the population.							
Objective 3.A: Provide public education to increase awareness of hazards, opportunities for mitigation, and to reduce the impact of disasters on all community members.							
Action 3.A.1 Identify and publicize success stories from Bucks County and from other locations that provide a good example for Bucks County as part of an overall public education program.	New Britain Township, Silverdale Borough, Warrington Township, West Rockhill Township	Education and Awareness	All	Municipalities, Bucks County Planning Commission, Bucks County Emergency Management Agency	Continuously for next 5 years.	Staff time	Low
Action 3.A.2 Increase awareness by residents of actions to take before, during and after an emergency. Methods include public outreach and education by website, mailings, workshops, media coverage, newsletter, Twitter and Facebook.	East Rockhill Township, Hulmeville Borough, Langhorne Borough, Lower Southampton Township, New Britain Borough, New Britain Township, New Hope Borough, Plumstead Township, Richlandtown Borough, Sellersville Borough, Silverdale Borough, Tinicum Township, Trumbauersville Borough, Warrington Township	Education and Awareness	All	Municipalities, American Red Cross	Continuously for next 5 years.	Staff time	Medium

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Action 3.A.3 Secure flood specific signage that warns travelers that barricades are present to prevent them from traveling into floodwater.	New Hope Borough, Tinicum Township, Yardley Borough	Education and Awareness	Flood, Hurricane, Tropical Storm, Nor'easter	Municipalities, Bucks County Emergency Management Agency	Within 2 years	Municipal and County Capital Budgets; FEMA HMA	Low
Action 3.A.4 Evaluate and consider implementing activities to secure "Firewise" designation.	Bedminster Township, Bristol Township, Durham Township, East Rockhill Township, Falls Township, Haycock Township, Hilltown Township, Milford Township, Nockamixon Township, Plumstead Township, Richland Township, Solebury Township, Springfield Township, Tinicum Township, West Rockhill Township	Education and Awareness/ Local Plans and Regulations	Wildfire	Municipalities, DCNR Management Agency	Continuously for next 5 years.	Staff time, National Fire Protection Agency, DCNR Bureau of Forestry	Medium
Action 3.A.5 Maintain information and continue outreach to residents with the highest relative vulnerability to the effects of hazards.	Solebury Township, Tinicum Township, Trumbauersville Borough, West Rockhill Township	Education and Awareness	Dam Failure, Extreme Temperature, Flood, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Lightning Strike,	Municipalities, Bucks County Emergency Management Agency	Within 5 years	Staff Time; DHS; NOAA Storm Ready	Medium

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
			Tornado, Wind Storm, Utility Interruption, Winter Storm				
Action 3.A.6 Engage the community on the vulnerability of the historic properties to hazards in the community and identify community members interested in becoming core planning team members to continue the historic property hazard mitigation planning process.	Bensalem Township, Bristol Borough, Doylestown Township, Haycock Township, Richland Township, Solebury Township, Springfield Township, Tinicum Township, Upper Makefield Township, and Yardley Borough	Education and Awareness/ Local Plans and Regulations	All	Municipalities	Continuously for next 5 years.	Staff time; PHMC	Medium
Objective 3.B: Promote partnerships between the municipalities and the County to continue to develop a County-wide approach to identifying and implementing mitigation actions.							
Action 3.B.1 Convene regular meetings of a restructured HMPC to discuss issues and progress related to the implementation of the plan.	Municipal Representatives, Bucks County Planning Commission, Bucks County Emergency Management Agency	Local Plans and Regulations	All	Bucks County Planning Commission, Bucks County Emergency Management Agency	Continuously for next 5 years.	Staff time	Medium
Action 3.B.2 Link available technical assistance top communities that have residents interested in HMA grants yet need additional capacity to	Bensalem Township, Bucks County Planning Commission, Bucks County Emergency Management Agency	Local Plans and Regulations	All	Bucks County Planning Commission, Bucks County Emergency Management Agency	Continuously for next 5 years.	Staff time	Medium

Table 6.4-1: 2016 Mitigation Action Plan.							
ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
pursue complicated application and management process.							
Objective 3.C: Continue the promotion of disaster resistance in the business community via the hazard mitigation planning initiative.							
Action 3.C.1 Renew and expand commitments to hazard mitigation planning among partner organizations.	New Britain Township, Silverdale Borough, Upper Southampton Township	Local Plans and Regulations	All	Municipalities, Bucks County Planning Commission, Bucks County Emergency Management Agency	Continuously for next 5 years.	Staff time	Medium
Goal 4 – Protect natural resources within hazard areas and use them to reduce risk and losses.							
Objective 4.A: Implement natural resource planning and projects that assist in hazard mitigation.							
Action 4.A.1 Evaluate and implement projects to protect and improve natural environment along waterways with projects including preservation, conversation easements, and bank restoration.	East Rockhill Township, Yardley Borough	Natural Systems Protection	Flood, Hurricane, Tropical Storm, Nor'easter	Municipal Environmental Advisory Councils, Watershed Associations, Private property owners	Continuously for next 5 years.	CIP, DEP	Medium
Action 4.A.2 Evaluate and implement projects to manage stormwater effectively.	East Rockhill Township, Lower Southampton Riegelsville	Natural Systems Protection	Flood, Hurricane, Tropical Storm, Nor'easter	Municipal Environmental Advisory Councils, Watershed Associations, Private property owners	Continuously for next 5 years.	CIP, DEP	Medium

Table 6.4-1: 2016 Mitigation Action Plan.

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE	PRIORITY
Action 4.A.3 Build on existing Stormwater Management Planning and encourage implantation of small stormwater mitigation projects on private property (i.e. rain gardens, rain barrels, natural basins).	Doylestown Borough, Penndel Borough, Tinicum Township, Warrington Township, Yardley Borough	Natural Systems Protection	Flood, Hurricane, Tropical Storm, Nor'easter	Municipal Environmental Advisory Councils, Watershed Associations, Private property owners	Continuously for next 5 years.	Private property owners; Water-shed Assoc. Technical Support	Medium

After the HMPT developed the actions, they were compared with one another to determine a ranking or priority by applying the Multi-Objective Mitigation Action Prioritization criteria:

- **Effectiveness** (weight: 20% of score): The extent to which an action reduces the vulnerability of people and property.
- **Efficiency** (weight: 30% of score): The extent to which time, effort, and cost is well used as a means of reducing vulnerability.
- **Multi-Hazard Mitigation** (weight: 20% of score): The action reduces vulnerability for more than one hazard.
- **Addresses High Risk Hazard** (weight: 15% of score): The action reduces vulnerability for people and property from a hazard(s) identified as high risk.
- **Addresses Critical Communications/Critical Infrastructure** (weight: 15% of score): The action pertains to the maintenance of critical functions and structures such as transportation, supply chain management, data circuits, etc.

Scores of 1-3 were assigned for each multi-objective mitigation action prioritization criterion where 1 is a low score and 3 is a high score. Actions were prioritized using the cumulative score assigned to each. Each mitigation action was given a priority ranking (Low, Medium, and High) based on the following:

- Low Priority (highlighted yellow): 1.0 – 1.8
- Medium Priority (highlighted orange): 1.9 – 2.4
- High Priority (highlighted red): 2.5 – 3.0

Cumulative results of the prioritization of mitigation actions are included in Table 6.4-2. This table was reviewed by the Hazard Mitigation Planning Committee and at the Draft Plan Review Meeting. Stakeholders were encouraged to review and comment on draft prioritization; consensus was the prioritization matched expectations.

Benefit Cost Analysis (BCA) and specifically the FEMA BCA Tool is often a next step in the process of implementing actions. The Mitigation Action Prioritization examines 'benefits' on a more generalized basis in the categories, Effectiveness, Multi-Hazard Mitigation, Addresses High Risk Hazard, and Addresses Critical Communications/Critical Infrastructure. 'Cost' is addressed in the Efficiency category. The aim of the Mitigation Action Prioritization is a first review and prioritization of actions. BCA is the next step and more specific analysis completed in the process of applying for grants and implementing specific actions.

Table 6.4-2: Mitigation Action Prioritization.

MITIGATION ACTIONS		MULTI-OBJECTIVE MITIGATION ACTION PRIORITIZATION CRITERIA LOW = 0-1.8 MEDIUM = 1.9-2.4 HIGH = 2.5-3					
NO.	NAME	EFFECTIVENESS	EFFICIENCY	MULTI-HAZARD MITIGATION	ADDRESSES HIGH RISK HAZARD	ADDRESSES CRITICAL COMMUNICATIONS/ CRITICAL INFRASTRUCTURE	TOTAL SCORE
1.A.1	Proceed with grant applications to suitably protect repetitive-loss properties 1% annual chance floodplain (for owners interested in FEMA mitigation funding).	3	3	2	3	1	**2.5**
1.A.2	Proceed with grant applications to suitably protect and continue operations of critical facilities in the 1% annual chance floodplain and at risk to utilities interruption from flooding and other hazards.	3	3	3	3	3	**3**
1.A.3	Proceed with grant applications for infrastructure that protects community from 1% annual chance floodplain.	3	3	2	3	3	**2.8**
1.A.4	Evaluate, implement, and perform mitigation projects identified in this and other planning mechanisms, including acquisition, elevation, foundation and building stabilization, securing access to generator power and other mitigation methods.	3	2	3	3	3	**2.7**
1.B.1	Work with township/borough officials to increase awareness of model floodplain ordinance and with property owners, including informational mailings to property owners in the 1% annual chance floodplain, and sponsoring a series of workshops about costs and benefits of: Acquiring and minimizing the cost of flood insurance coverage, and Property acquisition, relocation, elevation, dry floodproofing, and wet floodproofing.	3	2	1	3	1	**2**

Table 6.4-2: Mitigation Action Prioritization.

MITIGATION ACTIONS		MULTI-OBJECTIVE MITIGATION ACTION PRIORITIZATION CRITERIA LOW = 0-1.8 MEDIUM = 1.9-2.4 HIGH = 2.5-3					
NO.	NAME	EFFECTIVENESS	EFFICIENCY	MULTI-HAZARD MITIGATION	ADDRESSES HIGH RISK HAZARD	ADDRESSES CRITICAL COMMUNICATIONS/ CRITICAL INFRASTRUCTURE	TOTAL SCORE
1.B.2	Evaluate and/or pursue Community Rating System (CRS) participation for insurance premium reduction (and flood damage reduction).	3	2	1	3	1	**2**
1.C.1	Obtain information for structures in the areas with the highest relative vulnerability to determine the best property protection methods. Information to be obtained includes: Lowest-floor elevation, Number of stories, Presence of a basement, and Market and/or replacement value.	2	2	2	3	1	**2**
1.C.2	Obtain information for all remaining structures in the 1% annual chance floodplain to determine the best property protection methods to promote with individual property owners. Techniques for gathering information over time should include developing and implementing a program for integrated information "capture" at key points in normal township administrative procedures, including applications for building permits at township/borough offices.	3	2	1	3	1	**2**
1.D.1	Identify all storage of hazardous materials in floodplains (including non-addressable structures, such as propane tanks).	2	3	3	3	2	**2.65**
1.D.2	Evaluate alternative methods to minimize risk from existing storage areas.	2	3	3	3	2	**2.65**
1.D.3	Assess means to prevent future storage in floodplain.	3	2	3	3	2	**2.55**

Table 6.4-2: Mitigation Action Prioritization.

MITIGATION ACTIONS		MULTI-OBJECTIVE MITIGATION ACTION PRIORITIZATION CRITERIA LOW = 0-1.8 MEDIUM = 1.9-2.4 HIGH = 2.5-3					
NO.	NAME	EFFECTIVENESS	EFFICIENCY	MULTI-HAZARD MITIGATION	ADDRESSES HIGH RISK HAZARD	ADDRESSES CRITICAL COMMUNICATIONS/ CRITICAL INFRASTRUCTURE	TOTAL SCORE
1.E.1	Identify critical facilities with the highest vulnerability to the effects of power outage (i.e., hospitals, nursing homes, fire, police, rescue, and emergency management).	2	2	2	3	3	**2.3**
1.E.2	Develop action plan for reducing potential damage and loss of function at identified critical facilities and infrastructure.	1	2	3	3	3	**2.3**
1.F.1	Conduct qualitative evaluation process for managing stranded rural residents and travelers (e.g., temporary shelters).	2	2	3	3	1	**2.2**
1.F.2	If warranted, implement additional storm shelters and warning systems near vulnerable communities, including: Identify structures that can be used as tornado safe rooms (some may require structure modifications), or NOAA weather radios for vulnerable populace.	3	3	3	3	1	**2.7**
1.G.1	Utilize available county GIS Resources for municipal hazard related planning and outreach.	2	2	3	3	2	**2.35**
1.H.1	Review prevalence of transportation accidents and known infrastructure deficiencies and advocate for projects and funding that will increase safety.	3	2	1	2	2	**2**
1.H.2	Implement signal improvements at intersections that frequently experience traffic accidents.	3	2	1	2	1	**1.85**
2.A.1	Distribute and promote the inclusion of vulnerability analysis information as part of periodic plan review and revisions at the township/borough level.	2	3	3	3	3	**2.8**

Table 6.4-2: Mitigation Action Prioritization.

MITIGATION ACTIONS		MULTI-OBJECTIVE MITIGATION ACTION PRIORITIZATION CRITERIA LOW = 0-1.8 MEDIUM = 1.9-2.4 HIGH = 2.5-3					
NO.	NAME	EFFECTIVENESS	EFFICIENCY	MULTI-HAZARD MITIGATION	ADDRESSES HIGH RISK HAZARD	ADDRESSES CRITICAL COMMUNICATIONS/ CRITICAL INFRASTRUCTURE	TOTAL SCORE
2.A.2	Integrate evaluation of snow-removal and emergency access logistics with new development planning.	2	3	2	3	3	**2.6**
2.B.1	Evaluate adequacy of township/borough building code implementation.	2	2	3	3	1	**2.2**
2.B.2	Encourage increasing design wind and/or snow load for future development.	2	1	3	3	1	**1.9**
2.C.1	Train the municipal building inspectors to consistently enforce the building code.	2	2	3	3	1	**2.2**
2.C.2	Review and consider updates to the floodplain ordinance, on an annual basis.	2	2	3	3	1	**2.2**
2.D.1	Continue to implement measures for mitigation of flood hazard per the December 2001 "Neshaminy Creek Supplemental Watershed Work Plan No. 5." including Flood warning system, Voluntary property acquisition, Voluntary building elevation and floodproofing, and Continuation/ enhancement of floodplain ordinances, flood insurance, and stormwater management.	3	3	2	3	2	**2.65**
2.D.2	Continue to implement measures for mitigation of flood hazard per the December 2001 "Neshaminy Creek Supplemental Watershed Work Plan No. 5." including Continuation/ enhancement of floodplain ordinances, flood insurance, and stormwater management.	3	3	2	3	2	**2.65**

Table 6.4-2: Mitigation Action Prioritization.

MITIGATION ACTIONS		MULTI-OBJECTIVE MITIGATION ACTION PRIORITIZATION CRITERIA LOW = 0-1.8 MEDIUM = 1.9-2.4 HIGH = 2.5-3					
NO.	NAME	EFFECTIVENESS	EFFICIENCY	MULTI-HAZARD MITIGATION	ADDRESSES HIGH RISK HAZARD	ADDRESSES CRITICAL COMMUNICATIONS/ CRITICAL INFRASTRUCTURE	TOTAL SCORE
2.D.3	Develop Disaster Recovery plan that examines impact and plans outreach and continuity of operations for disaster events. Implements steps from planning process that could mitigate impacts and speed recovery for on residents, businesses, and government.	2	2	3	3	2	**2.35**
2.D.4	Continue coordination and planning to mitigate, prepare, and respond to local hazardous materials facilities.	3	2	3	3	3	**2.7**
2.D.5	Continue coordination and planning with local colleges and universities to be partners to mitigate, prepare, and respond to hazards.	3	2	3	3	2	**2.55**
2.D.6	Inventory the historic properties vulnerable to the identified hazards, assess vulnerability of these assets, and establish preservation priorities by determining which assets are most valuable to the community.	3	2	3	3	1	**2.4**
3.A.1	Identify and publicize success stories from Bucks County and from other locations that provide a good example for Bucks County as part of an overall public education program.	1	1	3	3	1	**1.7**
3.A.2	Increase awareness by residents of actions to take before, during and after an emergency. Methods include public outreach and education by website, mailings, workshops, media coverage, newsletter, Twitter and Facebook.	2	1	3	3	1	**1.9**

Table 6.4-2: Mitigation Action Prioritization.

MITIGATION ACTIONS		MULTI-OBJECTIVE MITIGATION ACTION PRIORITIZATION CRITERIA LOW = 0-1.8 MEDIUM = 1.9-2.4 HIGH = 2.5-3					
NO.	NAME	EFFECTIVENESS	EFFICIENCY	MULTI-HAZARD MITIGATION	ADDRESSES HIGH RISK HAZARD	ADDRESSES CRITICAL COMMUNICATIONS/ CRITICAL INFRASTRUCTURE	TOTAL SCORE
3.A.3	Secure flood specific signage that warns travelers that barricades are present to prevent them from traveling into floodwater.	2	1	1	3	1	**1.5**
3.A.4	Evaluate and consider implementing activities to secure "Firewise" designation.	3	2	1	2	2	**2**
3.A.5	Maintain information and continue outreach to residents with the highest relative vulnerability to the effects of hazards.	2	2	3	3	1	**2.2**
3.A.6	Engage the community on the vulnerability of the historic properties to hazards in the community and identify community members interested in becoming core planning team members to continue the historic property hazard mitigation planning process.	3	2	3	3	1	**2.4**
3.B.1	Convene regular meetings of a restructured HMPC to discuss issues and progress related to the implementation of the plan.	2	2	3	3	2	**2.35**
3.B.2	Link available technical assistance top communities that have residents interested in HMA grants yet need additional capacity to pursue complicated application and management process.	3	2	3	3	1	**2.4**
3.C.1	Renew and expand commitments to hazard mitigation planning among partner organizations.	2	2	3	3	2	**2.35**
4.A.1	Evaluate and implement projects to protect and improve natural environment along waterways with projects including preservation, conversation easements, and bank restoration.	3	2	2	3	2	**2.35**

Table 6.4-2: Mitigation Action Prioritization.

MITIGATION ACTIONS		MULTI-OBJECTIVE MITIGATION ACTION PRIORITIZATION CRITERIA LOW = 0-1.8 MEDIUM = 1.9-2.4 HIGH = 2.5-3					
NO.	NAME	EFFECTIVENESS	EFFICIENCY	MULTI-HAZARD MITIGATION	ADDRESSES HIGH RISK HAZARD	ADDRESSES CRITICAL COMMUNICATIONS/ CRITICAL INFRASTRUCTURE	TOTAL SCORE
4.A.2	Evaluate and implement projects to manage stormwater effectively.	3	2	2	3	2	**2.35**
4.A.3	Build on existing Stormwater Management Planning and encourage implantation of small stormwater mitigation projects on private property (i.e. rain gardens, rain barrels, natural basins).	3	2	2	3	2	**2.35**

7. Plan Maintenance

7.1. Update Process Summary

Monitoring, evaluating and updating this plan, is critical to maintaining its value and success in Bucks County's hazard mitigation efforts. Ensuring effective implementation of mitigation activities paves the way for continued momentum in the planning process and gives direction for the future. This section explains who will be responsible for maintenance activities and what those responsibilities entail. It also provides a methodology and schedule of maintenance activities including a description of how the public will be involved on a continued basis. The 2016 HMP continues a review of the plan within 30 days of a disaster event and annual plan evaluation. This HMP's plan maintenance also defines the municipalities' role in updating and evaluating the plan. Finally, the 2016 HMP elaborates upon continued public involvement and how this plan may be integrated into other planning mechanisms in the County. These changes were reviewed at the Final Public Meeting were the HMPC and HMPT concurred with the changes and agreed to review them in more detail during the 30-day review period.

7.2. Monitoring, Evaluating and Updating the Plan

The HMPC established for the 2016 HMP is designated to administer the plan maintenance processes of monitoring, evaluation, and updating with support and representation from all 54 participating municipalities. The Bucks County Planning Commission Executive Director and the Bucks County Emergency Management Agency Director in coordination with colleagues from their respective departments will lead the HMPC in all associated plan maintenance requirements, including annual reviews. The HMPC will coordinate maintenance efforts, but the input needed for effective periodic evaluations will come from community representatives, local emergency management coordinators and planners, the general public and other important stakeholders. The HMPC will oversee the progress made on the implementation of action items identified in the 2016 HMP and modify actions, as needed, to reflect changing conditions. The HMPC will meet annually on or around the anniversary of plan adoption to discuss specific coordination efforts that may be needed with other stakeholders. Should a significant disaster occur within the County, the HMPC will reconvene within 30 days of the disaster to review and update the HMP. Meetings will be summarized in annual reports and progress reports that will be incorporated into the next plan update.

Each municipality will designate a community representative to monitor mitigation activities and hazard events within their respective communities. The local emergency management coordinator would be suitable for this role. This individual will be asked to work with the HMPC to provide updates on applicable mitigation actions and feedback on changing hazard vulnerabilities within their community.

Upon each HMP evaluation, the HMPC will consider whether applications should be submitted for existing mitigation grant programs. A decision to apply for funding will be based on appropriate eligibility and financial need requirements. The HMPC will also support local and county officials in applying for post-disaster mitigation funds when they are available. All state and federal mitigation funding provided to the County or local municipalities will be reported in subsequent plan updates. In addition, new plans and

programs being developed within the County will be evaluated as to the ability and necessity to incorporate the 2016 HMP into them.

The 2016 HMP will be updated every five years, as required by the Disaster Mitigation Act of 2000, or following a disaster event. Future plan updates will account for any new hazard vulnerabilities, special circumstances, or new information that becomes available. During the five-year review process, the following questions will be considered as criteria for assessing the effectiveness the Bucks County HMP.

- Has the nature or magnitude of hazards affecting the County changed?
- Are there new hazards that have the potential to impact the County?
- Do the identified goals and actions address current and expected conditions?
- Have mitigation actions been implemented or completed?
- Has the implementation of identified mitigation actions resulted in expected outcomes?
- Are current resources adequate to implement the Plan?
- Should additional local resources be committed to address identified hazards?

Issues that arise during monitoring and evaluation which require changes to the risk assessment, mitigation strategy and other components of the plan will be incorporated during future updates.

7.3. Continued Public Involvement

As was done during the development of the 2016 HMP, the HMPC will involve the public during the evaluation and update of the HMP through various workshops and meetings. The public will have access to an electronic copy of the current HMP through the Bucks County Planning Commission website. Information on upcoming events related to the HMP or solicitation for comments will be announced via newsletters, newspapers, mailings, and on the County website (www.buckscounty.org). Also several municipalities signed up for public outreach related mitigation actions. The HMPC will incorporate all relevant comments during the next update of the HMP.

8. Plan Adoption

The Plan was submitted to the Pennsylvania State Hazard Mitigation Officer on August 24, 2015. It was forwarded to FEMA for final review and approval-pending-adoption on August 28, 2015. FEMA granted approval-pending-adoption on X, 2016.

This section of the plan includes copies of the local adoption resolutions passed by Bucks County and its municipal governments; a completed Local Mitigation Plan Review Crosswalk can be found in Appendix B. Adoption resolution templates are provided to assist the County and municipal governments with recommended language for future adoption of the HMP.

Bucks County 2016 Hazard Mitigation Plan

County Adoption Resolution

Resolution No. _____

Bucks County, Pennsylvania

WHEREAS, the municipalities of Bucks County, Pennsylvania are most vulnerable to natural and human-made hazards which may result in loss of life and property, economic hardship, and threats to public health and safety, and

WHEREAS, Section 322 of the Disaster Mitigation Act of 2000 (DMA 2000) requires state and local governments to develop and submit for approval to the President a mitigation plan that outlines processes for identifying their respective natural hazards, risks, and vulnerabilities, and

WHEREAS, Bucks County acknowledges the requirements of Section 322 of DMA 2000 to have an approved Hazard Mitigation Plan as a prerequisite to receiving post-disaster Hazard Mitigation Grant Program funds, and

WHEREAS, the Bucks County 2016 Hazard Mitigation Plan has been developed by the Bucks County Emergency Management Agency and the Bucks County Planning Commission in cooperation with other county departments, local municipal officials, and the citizens of Bucks County, and

WHEREAS, a public involvement process consistent with the requirements of DMA 2000 was conducted to develop the Bucks County 2016 Hazard Mitigation Plan, and

WHEREAS, the Bucks County 2016 Hazard Mitigation Plan recommends mitigation activities that will reduce losses to life and property affected by both natural and human-made hazards that face the County and its municipal governments,

NOW THEREFORE BE IT RESOLVED by the governing body for the County of Bucks that:

- The Bucks County 2016 Hazard Mitigation Plan is hereby adopted as the official Hazard Mitigation Plan of the County, and
- The respective officials and agencies identified in the implementation strategy of the Bucks County 2016 Hazard Mitigation Plan are hereby directed to implement the recommended activities assigned to them.

ADOPTED, this _____ day of _____, 2016

ATTEST:

_____

BUCKS COUNTY COMMISSIONERS

By _____

By _____

By _____

Bucks County 2016 Hazard Mitigation Plan

Municipal Adoption Resolution

Resolution No. _____

<*Borough/Township of Municipality Name*>, Bucks County, Pennsylvania

WHEREAS, the <*Borough/Township of Municipality Name*>, Bucks County, Pennsylvania is most vulnerable to natural and human-made hazards which may result in loss of life and property, economic hardship, and threats to public health and safety, and

WHEREAS, Section 322 of the Disaster Mitigation Act of 2000 (DMA 2000) requires state and local governments to develop and submit for approval to the President a mitigation plan that outlines processes for identifying their respective natural hazards, risks, and vulnerabilities, and

WHEREAS, the <*Borough/Township of Municipality Name*> acknowledges the requirements of Section 322 of DMA 2000 to have an approved Hazard Mitigation Plan as a prerequisite to receiving post-disaster Hazard Mitigation Grant Program funds, and

WHEREAS, the Bucks County 2016 Hazard Mitigation Plan has been developed by the Bucks County Emergency Management Agency and the Bucks County Planning Commission in cooperation with other county departments, and officials and citizens of <*Borough/Township of Municipality Name*>, and

WHEREAS, a public involvement process consistent with the requirements of DMA 2000 was conducted to develop the Bucks County 2016 Hazard Mitigation Plan, and

WHEREAS, the Bucks County 2016 Hazard Mitigation Plan recommends mitigation activities that will reduce losses to life and property affected by both natural and human-made hazards that face the County and its municipal governments,

NOW THEREFORE BE IT RESOLVED by the governing body for the <*Borough/Township of Municipality Name*>:

- The Bucks County 2016 Hazard Mitigation Plan is hereby adopted as the official Hazard Mitigation Plan of the <*Borough/Township*>, and
- The respective officials and agencies identified in the implementation strategy of the Bucks County 2016 Hazard Mitigation Plan are hereby directed to implement the recommended activities assigned to them.

ADOPTED, this _____ day of _____, 2016

ATTEST: ***<BOROUGH/TOWNSHIP OF MUNICIPALITY NAME>***

_____ By _____

By _____

9. Appendices

Appendix A Bibliography

Appendix B Local Mitigation Plan Review Crosswalk

Appendix C Meeting and Other Participation Documentation

Appendix D Local Municipality Flood Vulnerability Maps

Appendix E Critical Facilities

Appendix F HAZUS Reports

Appendix G Dam Failure Hazard Profile (Section 4.3.5)

Appendix H Local Municipality Historic Property Vulnerability Maps