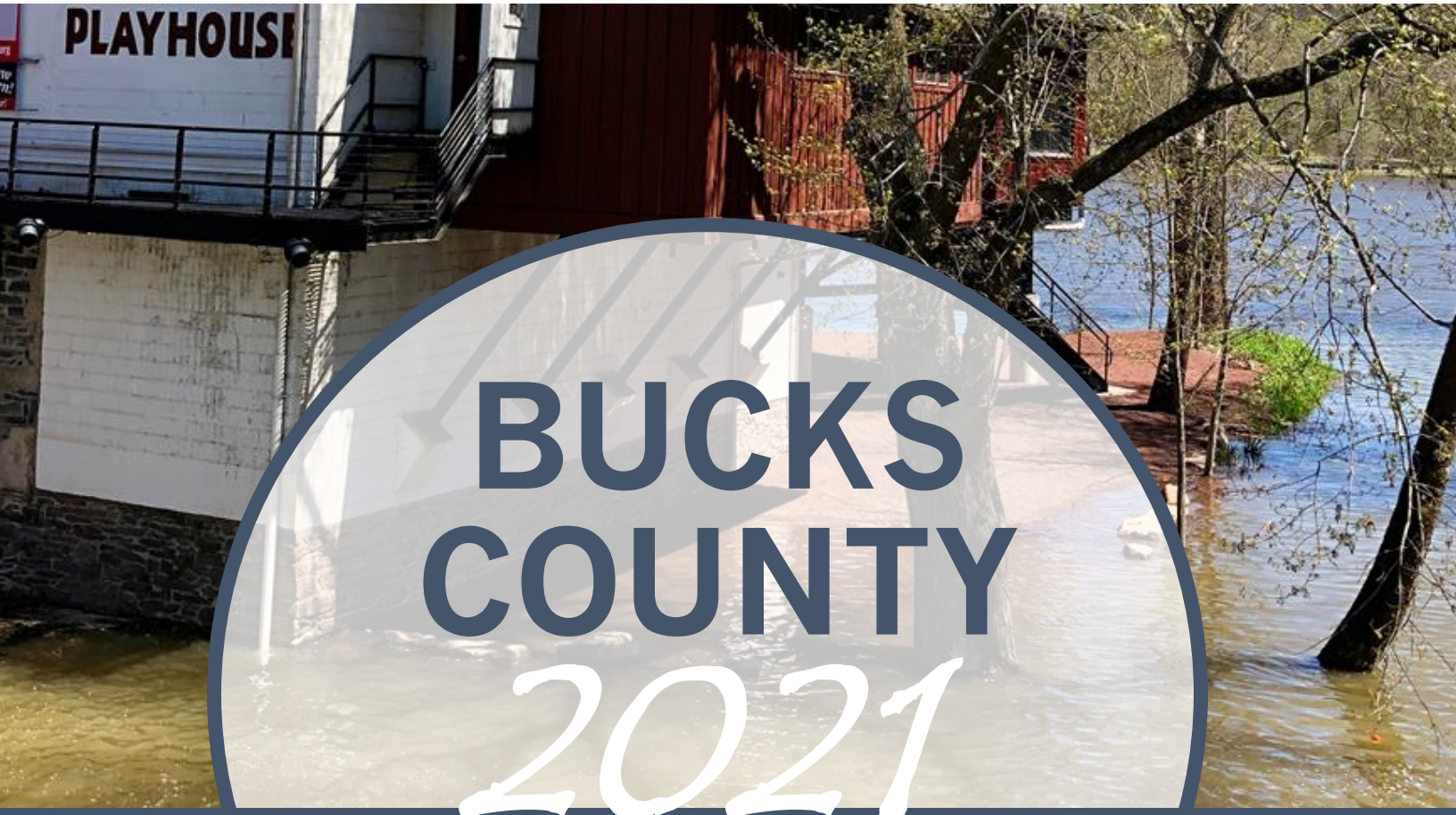

BUCKS COUNTY 2021

HAZARD MITIGATION PLAN UPDATE

PREPARED FOR:

Bucks County
Planning Commission
1260 Almshouse Road
Doylestown, PA 18901

&

Bucks County
Dept. of Emergency Services
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Certification of Annual Review Meetings

The Bucks County Hazard Mitigation Planning Team (HMPT) has reviewed this Hazard Mitigation Plan. See Section 8 for further details regarding this form. The director of the HMPT hereby certifies the review.

YEAR	DATE OF MEETING	PUBLIC OUTREACH ADDRESSED? *	SIGNATURE
2017	--		
2018	--		
2019	July 11, 2019	Game of Extremes	
2020			
2021			
2022			
2023			

**Confirm yes 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)
2017	Critical Facility data updated		
2019	Additional partnerships developed in preparation for 2021 plan update		

REMINDER: Please attach all associated meeting agendas, sign-in sheets, handouts, and minutes.

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**Sensitive Information – Not for public distribution*

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TABLE OF ACRONYMS			
ACRONYM	FULL NAME	ACRONYM	FULL NAME
BRIC	Building Resilient Infrastructure and Communities	NFIP	National Flood Insurance Program
CFR	Code of Federal Regulations	NFPA	National Fire Protection Association
CRS	Community Ratings System	NHC	National Hurricane Center
DCED	Department of Community and Economic Development	NIDIS	National Integrated Drought Information System
DCNR	Department of Conservation and Natural Resources	NOAA	National Oceanic and Atmospheric Association
DCNR-BOF	Department of Conservation and Natural Resources-Bureau of Forestry	NWS	National Weather Service
DMA	Disaster Mitigation Act	PEIRS	Pennsylvania Emergency Incident Reporting System
EOP	Emergency Operations Plan	PA DEP	Pennsylvania Department of Environmental Protection
EOC	Emergency Operations Center	PaGWIS	Pennsylvania Groundwater Information System
EMC	Emergency Management Coordinator	PASDA	Pennsylvania Spatial Data Access
EPA	Environmental Protection Agency	PDM	Pre-Disaster Mitigation Assistance Program
FEMA	Federal Emergency Management Agency	PDSI	Palmer Drought Severity Index
FIRM	Flood Insurance Rate Map	PEMA	Pennsylvania Emergency Management Agency
FIS	Flood Insurance Study	PennDOT	Pennsylvania Department of Transportation
FMA	Flood Mitigation Assistance Program	RF	Risk Factor

TABLE OF ACRONYMS			
ACRONYM	FULL NAME	ACRONYM	FULL NAME
HMGP	Hazard Mitigation Grant Program	SALDO	Subdivision and Land Development Ordinance
HMPT	Hazard Mitigation Planning Team	SFHA	Special Flood Hazard Area
HMSC	Hazard Mitigation Steering Committee	SOG	Standard Operating Guide
HVA	Hazards Vulnerability Analysis	UCC	Universal Construction Code
ICC	International Code Council	US DOT	United States Department of Transportation
IBC	International Building Code	USACE	United States Army Corps of Engineers
NCDC	National Climatic Data Center	USDA	United States Department of Agriculture
NDIS	National Drought Information System	USGS	United States Geological Survey
NDMC	National Drought Mitigation Center	WYO	Write Your Own

1. Introduction

1.1. Background

The Bucks County, Pennsylvania Hazard Mitigation Steering Committee (HMSC) and local officials recognize the importance of hazard mitigation and related planning. Members of the HMSC are listed in table 3-2.1The HMSC is concerned with addressing both natural and human-made hazards throughout the County. Bucks County is considered part of the Greater Philadelphia metropolitan area and includes approximately 64 miles of the Delaware River along its southeastern border. Since 1955, there have been 25 Presidential Major Disaster and Emergency Declarations which affected Bucks County. Of the 25, 2 are related to the COVID-19 pandemic, 17 were related to hurricanes, tropical storms, and flooding, and five were related to winter storms, snow, and blizzards. The emergency management community, citizens, elected officials and other partner agencies 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 100 proprieties

Bucks County Planning Commission in collaboration with Bucks County Emergency Management Agency have taken an all-hazards approach to this Hazard Mitigation Plan Update.

in Bucks County as of 2017, 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 organizations, and university representatives from Bucks County and the surrounding counties, in cooperation with elected officials of the County and its municipalities, have prepared this Hazard Mitigation Plan (HMP). The HMP is the result of work by the HMSC and HMPT 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.

2011 Plan Update

The 2011 Plan Update consisted of a review of the initial Hazard Mitigation Plan developed in 2006. Eighteen hazards were profiled in the 2011 Plan Update – drought, earthquake, extreme temperature, flood/flash flood/ice jam, hailstorm, hurricane/tropical storm/nor'easter, landslide, lightning strike, subsidence/sinkhole, tornado/windstorm, wildfire, winter storm, structure collapse, dam failure, environmental hazards, transportation accident, urban fire and explosion, and utility interruption. The Plan Update included a review of the original plan's hazards, mitigation goals, and actions, which all were revised, deleted, or modified to address the priorities of Bucks County.

2016 Plan Update

The 2016 Plan Update consisted of a review of the 2011 Plan, which was used as a base document. Each chapter in the 2016 HMP was updated as necessary. A summary was included at the beginning of each chapter to indicate how this Plan was updated from the 2011 version. The Plan Update involved the review of data on potential hazards and reprioritization of these hazards in terms of frequency and severity: twenty-one hazards were profiled in the 2016 Plan Update – drought, earthquake, extreme temperature, flood/flash flood/ice jam, hailstorm, hurricane/tropical storm/nor'easter, landslide, lightning strike, pandemic and infectious disease, radon exposure, subsidence/sinkhole, tornado/windstorm, wildfire, winter storm, structure collapse (infrastructure), dam failure, environmental hazards, terrorism, transportation accident, urban fire and explosion, and utility interruption. Pandemic and infectious disease, radon exposure, and terrorism were all new hazard profiles included in the 2016 Plan Update. The Plan Update included a review of mitigation actions, which were revised, deleted, or modified to address the high priority hazards as well as a Plan Maintenance section.

2021 Plan Update

The 2021 Plan Update is intended to enable the County and its municipalities to effectively reduce the potential risks of identified hazards to the health, safety and property of the residents, business owners, and visitors to the County. The Plan Update will also allow Bucks County municipalities to be eligible for a range of grants and financial assistance following hazard events.

The 2021 Plan Update includes a thorough review and evaluation of the 2016 Plan. Each chapter in the 2021 HMP has been updated where applicable. A summary is included at the beginning of each chapter to indicate how this Plan was updated from the 2016 version. The Plan Update involves the review of data on potential hazards and reprioritization of these hazards in terms of frequency and severity; one additional hazard was added to the risk assessment: gas and liquid pipelines. The pandemic profile was also expanded based on the impacts and experiences of COVID-19. The Plan Update includes a review of mitigation actions, which were revised, deleted, or modified to address the high priority hazards as well as a Plan Maintenance section that describes how the Plan will be updated and maintained during the next five-year cycle.

The 2021 Hazard Mitigation Plan Update comprises seven chapters. Chapter 1 includes the prerequisites of the Plan including letters of adoption by the County Commission and the individual municipalities. Chapter 2 introduces the plan update process and includes an overview of the socio-economic and demographic characteristics. Chapter 3 discusses the planning process. Chapter 4 comprises the hazard identification and risk assessment and examines vulnerability and the potential losses from the top priority hazards. Chapter 4 also includes a historic profile of hazard types and associated losses, and a vulnerability assessment, which analyzes the potential for future damages due to the hazards identified. Chapter 5 contains a capability assessment including a review of existing plans and ordinances from the counties and municipalities. Chapter 6 discusses the mitigation strategy including updated mitigation goals and objectives, mitigation actions, and the method for prioritization and implementation of mitigation actions. Chapter 7 outlines how Bucks County and its municipalities will implement the Plan once it is adopted and ways to monitor progress and ensure continued public involvement.

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 2021 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 and/or after a review each year and/or when other plan updates impact the HMP.

1.4. Authority and Reference

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;
- CFR, Title 44, Parts 201 and 206;
- Disaster Mitigation Act of 2000, Public Law 106-390, as amended; and
- 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; and
- Pennsylvania Floodplain Management Act of October 4, 1978. P.L. 851, No. 166.
- 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: *National Fire Incident Reporting System 5.0: Complete Reference Guide*. January 2008.
- FEMA: *Local Mitigation Plan Review Guide.* October 2011.
- FEMA: *Local Mitigation Planning Handbook.* March 2013.
- FEMA: *Integrating Hazard Mitigation into Local Planning: Case Studies and Tools for Community Officials*. March 2013
- FEMA: *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards.* January 2013.
- FEMA: *Hazard Mitigation Assistance Unified Guidance*. February 2015.

The following Pennsylvania Emergency Management Agency (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 2009.
- PEMA: *Pennsylvania's Hazard Mitigation Planning Standard Operating Guide*. August 2020.

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.

- NFPA 1720: *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments.* 2020.

2. Community Profile

This section includes a profile of Bucks County and its municipalities. Information on the County's geographic profile, climate, demographic profile, and employment and industry profile are included below. While some information such as the study area boundaries and geography have remained unchanged, and derived from the 2016 Plan, other information such as the demographic and employment and industry information has been developed using the latest U.S. Census, the Bucks County 2011 Comprehensive Regional Plan, Delaware Valley Regional Planning Commission (DVRPC) long range plan (Connections 2045) and other recent Economic Development Strategy and Planning documents.

2.1. Geography and Environment

Bucks County covers 622 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 and 295, US Routes 1, 202, 13, the Pennsylvania Turnpike, and State Routes 263, 32, 611, 132, 309, and 413.

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 Bucks County Base Map

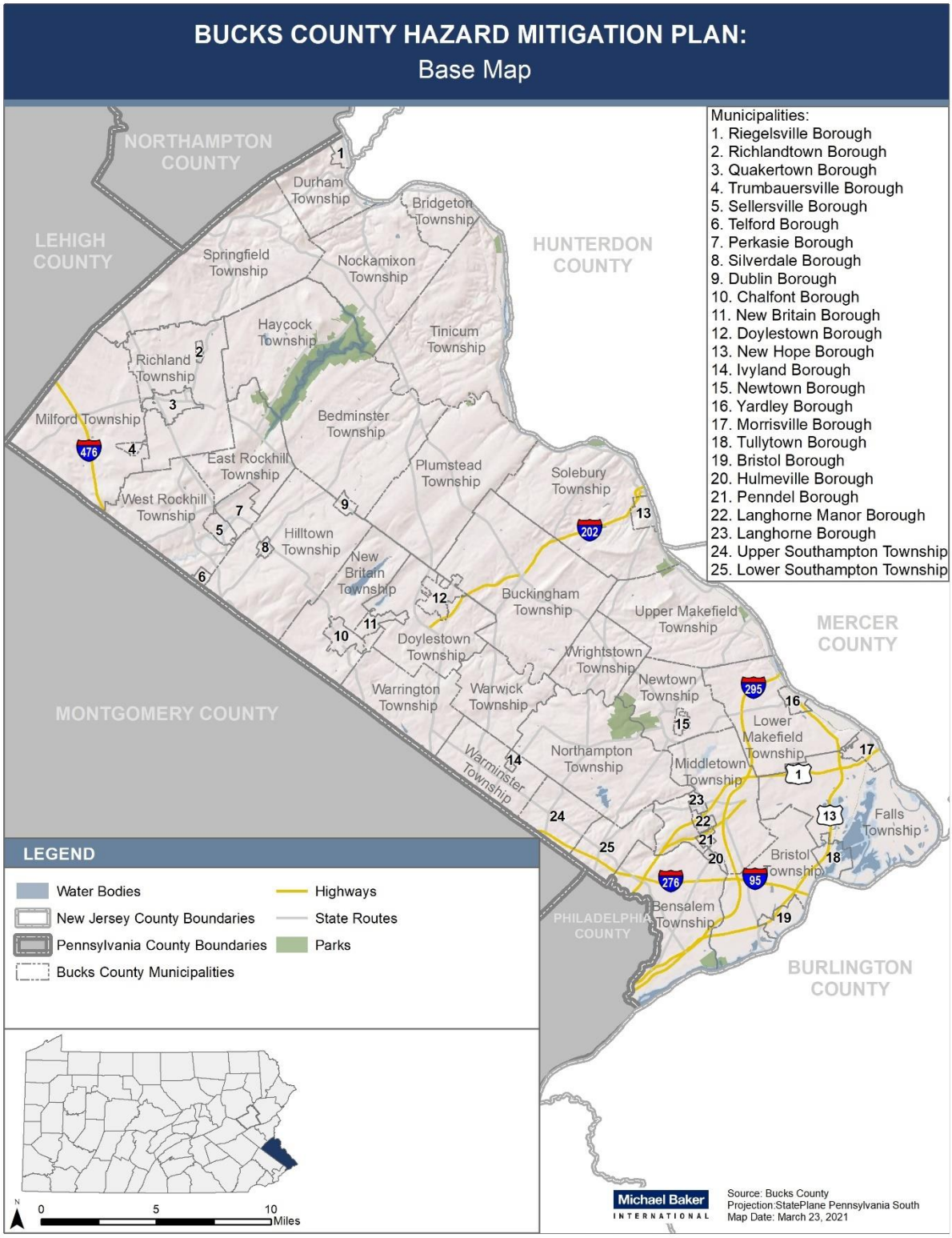
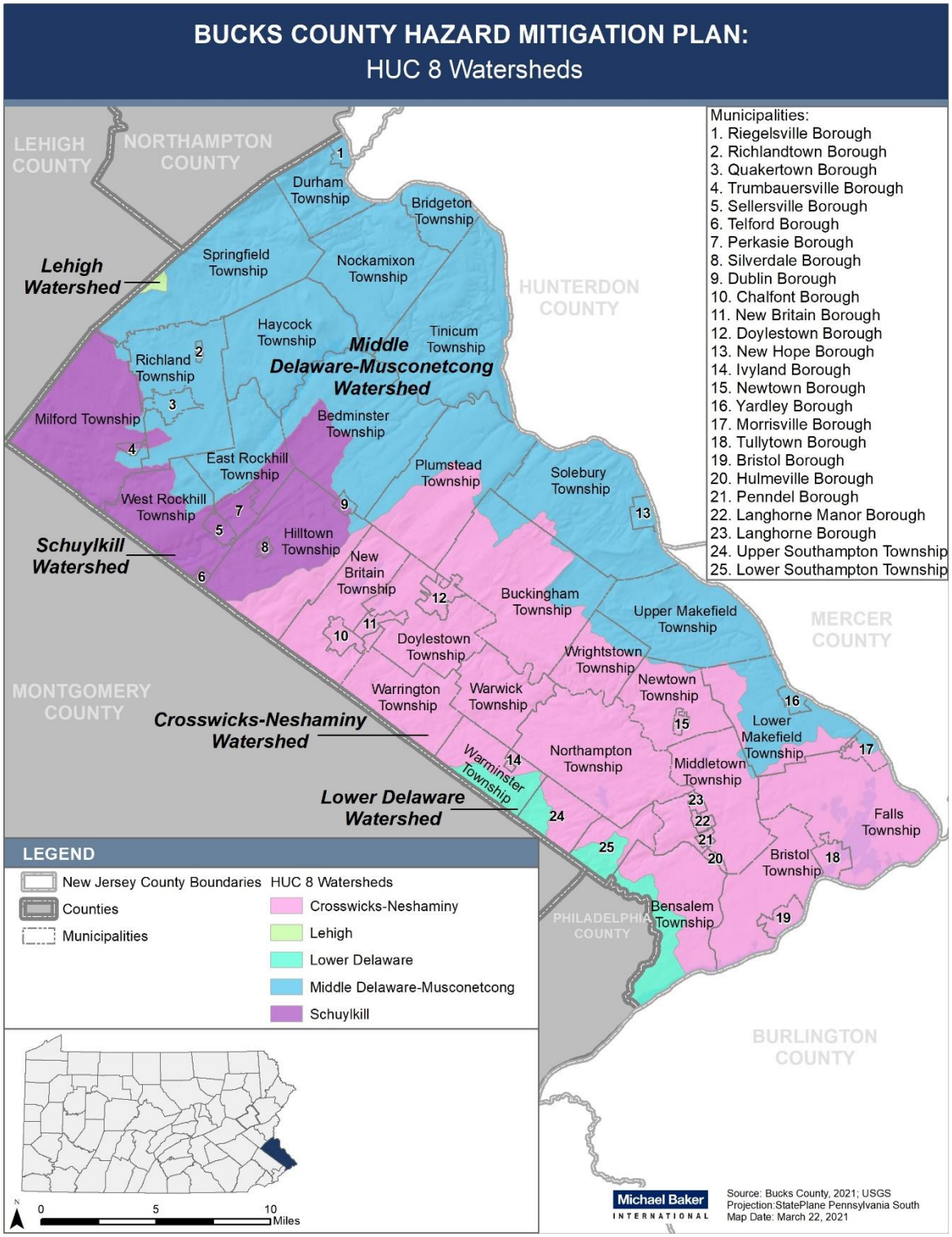


Figure 2.1-2 Bucks County Watersheds



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 (Bucks County, 2021a).

The fertile soil along the river as well as in the lower-populated areas of the county is well-suited for agriculture; from its founding to the present day, 16% of Bucks County is cultivated for farming, according to the 2011 Bucks County Comprehensive Plan (BCPC, 2011a). 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 include many historic properties while retaining the 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, 19 percent, of the workforce in Bucks County. Table 2.2-1 details the industries in Bucks County at the end of 2018, according to the U.S. Bureau Labor of Statistics North American Industry Classification System.

Table 2.2-1 Bucks County Job Counts, NAICS Industry Sector, 2018 (US Census, 2018)

INDUSTRY	COUNT	SHARE
Agriculture, Forestry, Fishing and Hunting	510	0.2%
Mining, Quarrying, and Oil and Gas Extraction	160	0.1%
Utilities	860	0.3%
Construction	17,453	6.3%
Manufacturing	27,918	10.1%
Wholesale Trade	16,038	5.8%
Retail Trade	36,327	13.2%
Transportation and Warehousing	8,212	3.0%

Table 2.2-1 Bucks County Job Counts, NAICS Industry Sector, 2018 (US Census, 2018)

INDUSTRY	COUNT	SHARE
Information	4,895	1.8%
Finance and Insurance	8,503	3.1%
Real Estate and Rental and Leasing	2,822	1.0%
Professional, Scientific, and Technical Services	17,370	6.3%
Management of Companies and Enterprises	3,182	1.2%
Administration & Support, Waste Management and Remediation	15,616	5.7%
Educational Services	19,712	7.2%
Health Care and Social Assistance	52,420	19.0%
Arts, Entertainment, and Recreation	6,784	2.5%
Accommodation and Food Services	21,913	7.9%
Other Services (excluding Public Administration)	10,513	3.8%
Public Administration	4,441	1.6%
TOTAL	275,649	100%

2.3. Population and Demographics

According to the U.S. Census, the population of Bucks County grew by approximately 0.5 percent between 2010 and 2019, from 625,249 to 628,270. Table 2.3-1 shows details the 2010 population, 2019 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 2019 of 60,428. Penndel Borough experienced the greatest increase in population, with a growth of 23.9% from 2,328 to 2,885, while Silverdale Borough experienced the greatest loss of population, with a decrease of 24.3 percent from 871 to 659. 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 (US Census, 2010) (US Census, 2019).

MUNICIPALITY	2010 POPULATION	2019 POPULATION	PERCENT CHANGE (%)
Bedminster Township	6,574	7,128	8.4%
Bensalem Township	60,427	60,428	0.0%
Bridgeton Township	1,277	1,127	-11.7%
Bristol Borough	9,726	9,605	-1.2%
Bristol Township	54,582	53,649	-1.7%
Buckingham Township	20,075	20,248	0.9%

Table 2.3-1 Population and Population Change by Municipality (US Census, 2010) (US Census, 2019).

MUNICIPALITY	2010 POPULATION	2019 POPULATION	PERCENT CHANGE (%)
Chalfont Borough	4,009	4,143	3.3%
Doylestown Borough	8,380	8,286	-1.1%
Doylestown Township	17,565	17,431	-0.8%
Dublin Borough	2,158	2,178	0.9%
Durham Township	1,144	1,106	-3.3%
East Rockhill Township	5,706	5,737	0.5%
Falls Township	34,300	33,542	-2.2%
Haycock Township	2,225	2,100	-5.6%
Hilltown Township	15,029	15,424	2.6%
Hulmeville Borough	1,003	932	-7.1%
Ivyland Borough	1,041	951	-8.6%
Langhorne Borough	1,622	1,709	5.4%
Langhorne Manor Borough	1,442	1,536	6.5%
Lower Makefield Township	32,559	32,662	0.3%
Lower Southampton Township	18,909	19,146	1.3%
Middletown Township	45,436	45,117	-0.7%
Milford Township	9,902	10,064	1.6%
Morrisville Borough	8,728	8,573	-1.8%
New Britain Borough	3,152	2,966	-5.9%
New Britain Township	11,070	11,336	2.4%
New Hope Borough	2,528	2,513	-0.6%
Newtown Borough	2,248	1,957	-12.9%
Newtown Township	19,299	19,610	1.6%
Nockamixon Township	3,441	3,388	-1.5%
Northampton Township	39,726	39,263	-1.2%
Penndel Borough	2,328	2,885	23.9%
Perkasie Borough	8,511	8,550	0.5%
Plumstead Township	12,442	13,980	12.4%
Quakertown Borough	8,979	8,827	-1.7%
Richland Township	13,052	13,264	1.6%
Richlandtown Borough	1,327	1,260	-5.0%
Riegelsville Borough	868	811	-6.6%

Table 2.3-1 Population and Population Change by Municipality (US Census, 2010) (US Census, 2019).

MUNICIPALITY	2010 POPULATION	2019 POPULATION	PERCENT CHANGE (%)
Sellersville Borough	4,249	4,270	0.5%
Silverdale Borough	871	659	-24.3%
Solebury Township	8,692	8,577	-1.3%
Springfield Township	5,035	5,040	0.1%
Telford Borough	2,207	2,141	-3.0%
Tinicum Township	3,995	3,954	-1.0%
Trumbauersville Borough	974	961	-1.3%
Tullytown Borough	1,872	2,169	15.9%
Upper Makefield Township	8,190	8,417	2.8%
Upper Southampton Township	15,152	15,018	-0.9%
Warminster Township	32,682	32,489	-0.6%
Warrington Township	23,418	24,256	3.6%
Warwick Township	14,437	14,612	1.2%
West Rockhill Township	5,256	5,232	-0.5%
Wrightstown Township	2,995	3,099	3.5%
Yardley Borough	2,434	2,480	1.9%
TOTAL	625,249	628,270	0.5%

Bucks County has approximately 21 percent of the population under the age of 18, and 19 percent over the age of 65, according to the 2019 U.S. Census ACS. 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 (US Census, 2019).

CHARACTERISTIC	BUCKS COUNTY	PENNSYLVANIA
Persons Under 5 Years (%)	4.8%	5.4%
Persons Under 18 Years (%)	20.2%	20.5%
Persons 65 Years and Over (%)	19.2%	18.7%
Female Persons (%)	50.9%	51.0%
High School Graduate or Higher (% of population over 25)	27.2%	34.9%
Language Other than English Spoken at Home (%)	12.8%	11.7%

Table 2.3-2 Bucks County and Pennsylvania Population and Housing Characteristics (US Census, 2019).

CHARACTERISTIC	BUCKS COUNTY	PENNSYLVANIA
White (not Hispanic or Latino) (%)	86.7%	79.6%
Hispanic or Latino (%)	5.7%	7.8%
Black or African American (%)	4.2%	11.4%
American Indian and Alaska Native (%)	0.1%	0.2%
Asian (%)	5.2%	3.5%
Native Hawaiian and Other Pacific Islander (%)	0.0%	0.0%
Two or More Races (%)	2.1%	2.6%
Homeownership Rate (%)	78.5%	68.4%
Housing Units in Multi-Unit Structures (%)	19.3%	21.1%
Median Value of Owner-Occupied Housing Units	$321,500	$192,600

The estimated median household income in Bucks County in 2019 was $89,139, about $26,000 greater than the Pennsylvania average and about $20,000 greater than the national average (US Census, 2019). Table 2.3-3 provides details on the income characteristics in Bucks County as compared to the Commonwealth of Pennsylvania. When planning to mitigate risk it is important to consider how different hazard may impact different vulnerable populations. Vulnerable populations to consider include people over 65, children, people financially at risk and more.

Table 2.3-3 Bucks County and Pennsylvania Income Characteristics (US Census, 2019).

CHARACTERISTIC	BUCKS COUNTY	PENNSYLVANIA
Median Household Income	$89,139	$63,463
Per Capita Money Income in Past 12 Months	$47,906	$35,804
Persons Below Poverty Level	5.9%	12%

According to DVRPC, Bucks County is expected to see an 11.50% population change from 2010-2040. Note that the thirty-year population projections for the County and its communities did not include spatial data to develop a figure. Using twenty-year projections, displayed by jurisdiction in Figure 2.3-2, the majority of population influx will be located in the northwest region of the County known as "Upper Bucks" and "Central Bucks". The lowest population increases are expected to be seen in already populated areas of the County that are located in the southeast region, "Lower Bucks," like Bristol Township and Falls Township . Table 2.3-4 below breaks down each municipalities' expected population change in the next thirty years.

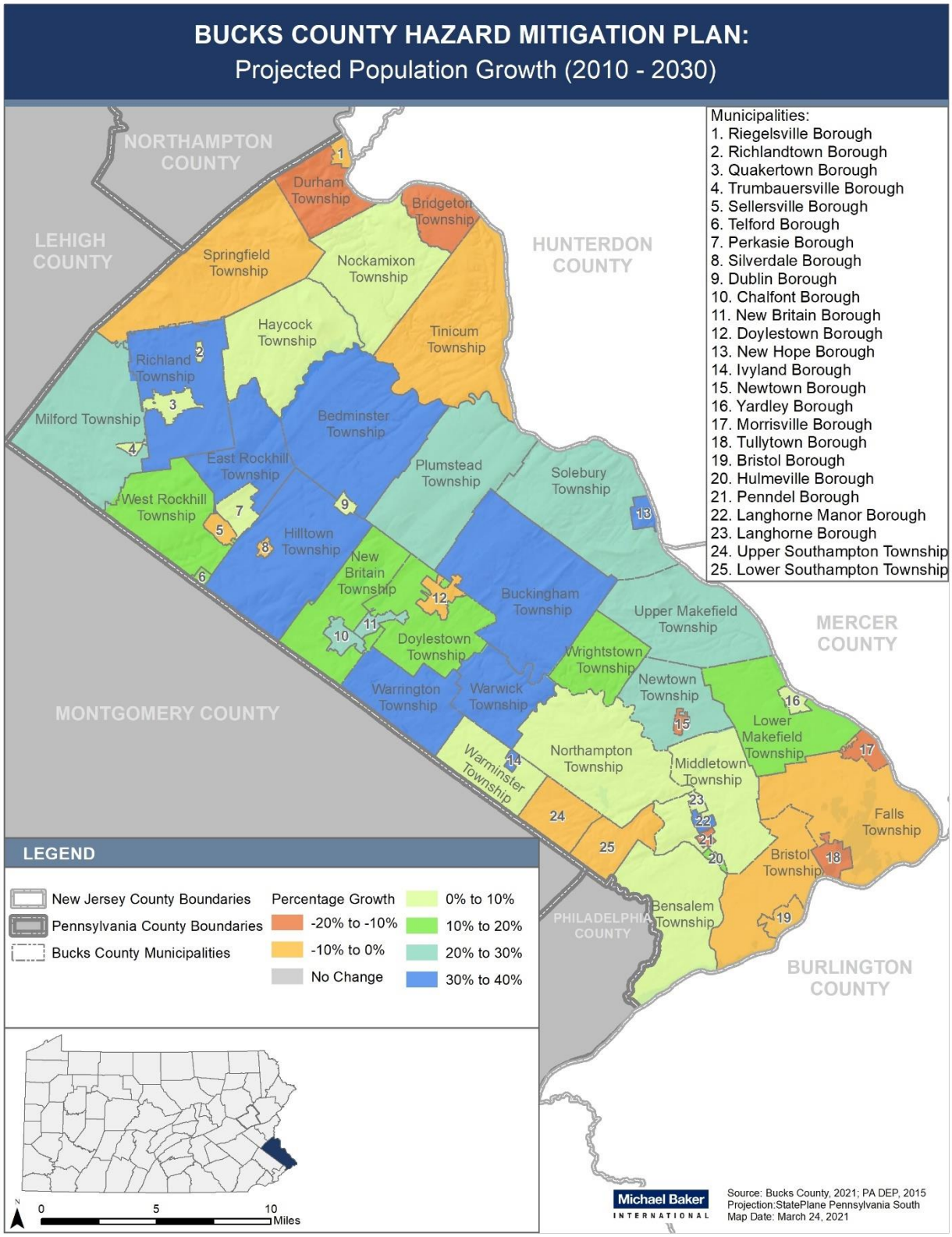
Table 2.3-4 Bucks County Projected Populations 2010-2040 (DVRPC, 2016).

MUNICIPALITY	2010-2040 ESTIMATED POPULATION PERCENT CHANGE	2010-2040 ESTIMATED POPULATION CHANGE
Bucks County	11.50%	72,131
Bedminster Township	27.40%	1,928
Bensalem Township	12.98%	7,838
Bridgeton Township	10.52%	135
Bristol Borough	5.71%	546
Bristol Township	12.51%	6,766
Buckingham Township	17.73%	3,615
Chalfont Borough	16.15%	657
Doylestown Borough	4.20%	349
Doylestown Township	7.21%	1,266
Dublin Borough	12.49%	271
Durham Township	14.25%	163
East Rockhill Township	16.54%	950
Falls Township	2.65%	899
Haycock Township	11.36%	252
Hilltown Township	18.60%	2,838
Hulmeville Borough	5.52%	55
Ivyland Borough	9.02%	95
Langhorne Borough	6.32%	101
Langhorne Manor Borough	6.57%	94
Lower Makefield Township	8.38%	2,745
Lower Southampton Township	3.37%	646
Middletown Township	7.91%	3,593
Milford Township	26.02%	2,616
Morrisville Borough	7.31%	629
New Britain Borough	10.94%	330
New Britain Township	19.33%	2,172
New Hope Borough	8.33%	209
Newtown Borough	14.45%	321
Newtown Township	9.38%	1,848
Nockamixon Township	11.87%	405
Northampton Township	4.83%	1,913
Penndel Borough	14.59%	324
Perkasie Borough	12.28%	1,040
Plumstead Township	34.91%	4,717

Table 2.3-4 Bucks County Projected Populations 2010-2040 (DVRPC, 2016).

MUNICIPALITY	2010-2040 ESTIMATED POPULATION PERCENT CHANGE	2010-2040 ESTIMATED POPULATION CHANGE
Quakertown Borough	3.33%	295
Richland Township	27.71%	3,645
Richlandtown Borough	2.90%	38
Riegelsville Borough	4.43%	38
Sellersville Borough	10.57%	445
Silverdale Borough	3.97%	34
Solebury Township	7.65%	661
Springfield Township	20.97%	1,056
Telford Borough	4.88%	107
Tinicum Township	22.68%	899
Trumbauersville Borough	4.28%	41
Tullytown Borough	13.18%	245
Upper Makefield Township	13.99%	1,155
Upper Southampton Township	5.15%	779
Warminster Township	7.04%	2,295
Warrington Township	18.59%	4,450
Warwick Township	9.87%	1,450
West Rockhill Township	26.97%	1,423
Wrightstown Township	14.63%	445
Yardley Borough	12.04%	294

Figure 2.3-2 Projected Population Change in Bucks County from 2010 to 2030



2.4. Land Use and Development

Bucks County is more than 52 percent residential and approximately 10% of the county is commercial. 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.

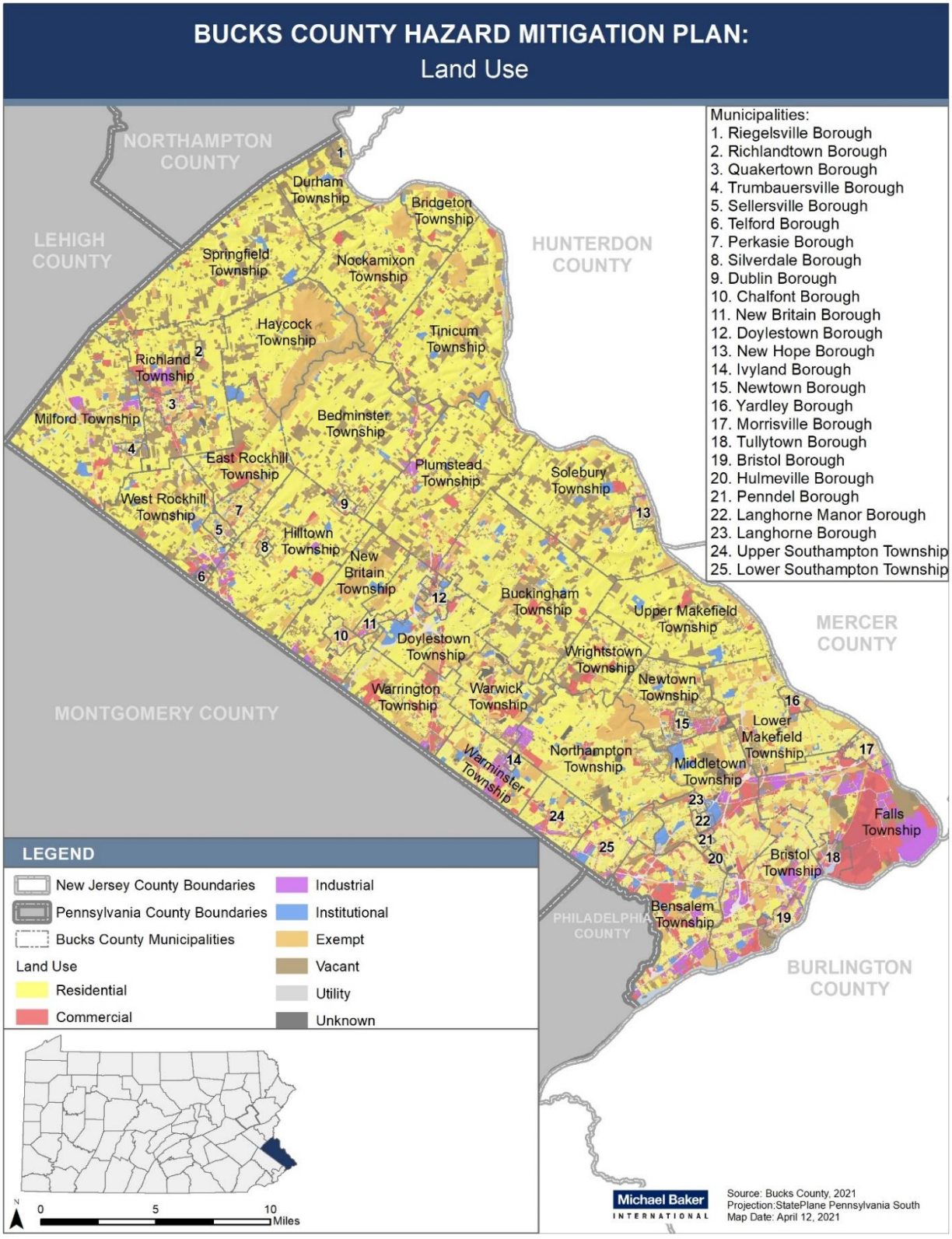
Table 2.4-1 details the land use in Bucks County, also shown in Figure 2.4-1. In table 2.4-1 exempt land use can be defined as any land that is free from paying taxes. Residential land uses are generally low density, single family homes. Higher population density is focused around boroughs such as Doylestown 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, 2021).

LAND USE TYPE	TOTAL ACRES	PERCENT OF BUCKS COUNTY
Commercial	49,471	10%
Exempt	80,430	16%
Industrial	10,300	2%
Institutional	26,447	5%
Residential	260,780	52%
Unknown	2,535	1%
Utility	1,353	0%
Vacant	67,740	14%

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 2.4-2 Current Land Uses in Bucks County



The Bucks County Comprehensive Plan, adopted in 2011, serves as a development guide for local officials, residents, developers, business owners, and interested agencies. The plan identifies areas that should be targeted for strategic development and preservation throughout the county. The comprehensive plan details eight guiding principles that were used to identify development and preservation areas: (1) protect natural, historic, and scenic resources; (2) preserve and expand parks, open space, and agricultural resources; (3) promote energy conservation and efficiency; (4) protect water resources and reduce waste; (5) mitigate hazards to life and property; (6) provide adequate community facilities and services; (7) enhance transportation mobility; (8) promote economic opportunity, housing diversity, and efficient use of land (BCPC, 2011a). During the 2021 Hazard Mitigation Plan update process, Bucks County was also updating the Comprehensive Plan. County planners will integrate the 2021 Hazard Mitigation Plan into this update.

Bucks County also adopted the Open Space and Greenways Plan in 2011. This plan was used to develop a decision making, implementation and management tool designed to protect and create linkages between the county's natural resources, open space and farmland, recreational facilities, and historic and cultural resources. The plan identifies corridors that could potentially host trails for public recreation, wildlife viewing, lessons in history, and alternative transportation. This acts as a guidance document for municipalities, conservation groups, landowners, and developers to identify greenways that should be preserved from development (BCPC, 2011b). Since the adoption of the Open Space and Greenways Plan, Bucks County has published six trail feasibility studies: (1) Mill-Queen Anne-Black Ditch Creeks, 2014; (2) Upper Neshaminy Creek Trail, 2014; (3) Lower Neshaminy Creek Trail, 2016; (4) Middle Neshaminy Creek Trail, 2019; (5) Newtown Rail Trail, 2019, and; (6) Liberty Bell Trail.

Bucks County updated the Municipal Waste Management Plan for 2018-2028 for the Pennsylvania Department of Environmental Protection between 2014 and 2019. Municipal waste management plans provide ten-year guidance for solid waste management. This includes regulation of haulers, designation of disposal sites for municipal solid waste and recyclables, documentation of flow of municipal waste generated, and assurance of disposal capacity for ten years. The plan provides detailed descriptions of waste generated, waste facilities, and safe disposal practices in Bucks County (BCPC, 2019a).

In 2017, the County published their Emergency Debris Management Plan, which is focused on helping the county to respond to a natural or manmade debris-generating event (BCEMA, 2017). The plan helps identify agencies and activities that are involved in debris operations in order to help coordinate response in the case of an event. Initiatives in this plan help address debris that may be caused by hazard events, including tornadoes, floods, winter storms, earthquakes and civil disturbance.

An additional discussion of future land development and how it interacts with hazards is provided in Section 4.4.4. Implementation actions related to hazard mitigation are detailed in Chapter 6, in addition to plan integration efforts.

2.5. Data Sources and Limitations

The Bucks County tax assessment parcel database and the County's address points were used as an inventory of properties throughout the County. The address points 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 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 21, 2017, was downloaded from the FEMA Map Service Center (FEMA, 2017a). 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 collected from the Bucks County Open Data Website. Any data not available on the open data site such as fire departments, police departments, parcels, and address points were provided by Bucks County GIS Department. Additional data was provided by the Pennsylvania Department of Transportation, the Pennsylvania Department of Environmental Protection 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

Bucks County considers fourteen types of facilities critical; or essential to the health and welfare of the community:

- **Airport**
- **Correctional Facility**
- **Day Care**
- **EOC**
- **Fire Department**
- **Hospital**
- **Municipal Building**
- **Nursing / Retirement Home**
- **Police Department**
- **Railroad Station**
- **Rescue Squad**
- **School**
- **1 Senior Center**
- **Wastewater Plant**

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 Centers for Environmental Information (NCEI) 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 NCEI from data gathered by the National Weather Service (NWS), another division of NOAA. NCEI then presents it on their website in various formats. The data used for this plan came from 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 NCEI, 2021).

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 2015 and 2021 updates. Current PEIRS data is not publicly available.

Data on the location of historic properties was obtained through the National Parks Service National Register of Historic Places. The data includes all registered and eligible buildings, structures, sites, objects, and districts.

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 airports, correctional facilities, day cares, EOCs, fire departments, hospitals, municipal buildings, nursing/retirement homes, police departments, railroad stations, rescue squads, schools, and wastewater plants. One of many County senior centers was also included as a critical facility senior center was determined to be a critical facility because it also operates as a emergency shelter site., located in Bristol Township. The list of critical facilities was developed based on information available from Bucks County and the Department of Homeland Security (DHS). Datasets for all critical facility categories were provided by the County except for the day care data, which was obtained from DHS Homeland Infrastructure Foundation-Level Data (HIFLD) Open data portal. The HIFLD Open data portal aggregates data from hundreds of regional and local data providers to compile national datasets of essential assets and infrastructure. As of 2021, this data portal provided access to over 650 national geospatial data layers within the open public domain (DHS, 2021). Table 2.5-1 summarizes the critical facilities in Bucks County by type and by municipality. Table 2.5-2 lists the number of critical facilities by type and data source. A complete listing of critical facilities

and their vulnerability to individual hazards is provided in Appendix E. Due to the sensitive information in Appendix E, this appendix is not available to the public.

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 Critical Facilities by Municipality and Type (Bucks County GIS Department, 2021) (DHS, 2021)

MUNICIPALITY	AIRPORT	CORRECTIONAL FACILITY	DAY CARE	EOC	FIRE DEPARTMENT	HOSPITAL	MUNICIPAL BUILDING	NURSING / RETIREMENT	POLICE DEPARTMENT	RAILROAD STATION	RESCUE SQUAD	SCHOOL	SENIOR CENTER	WASTEWATER PLANT	GRAND TOTAL
Bedminster Township	5	0	3	0	0	0	1	0	1	0	0	2	0	2	14
Bensalem Township	0	0	17	0	8	0	1	1	2	5	4	14	0	0	52
Bridgeton Township	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
Bristol Borough	0	0	4	0	4	0	1	0	1	1	0	3	0	1	15
Bristol Township	0	0	17	0	7	1	1	1	1	1	2	18	1	2	52
Buckingham Township	2	0	7	0	3	0	1	1	1	0	0	5	0	1	21
Chalfont Borough	0	0	4	0	1	0	1	0	0	1	0	1	0	0	8
Doylestown Borough	0	0	4	0	1	0	1	4	1	1	1	5	0	2	20
Doylestown Township	0	4	7	0	1	1	1	5	1	2	1	2	0	2	27
Dublin Borough	0	0	0	0	1	0	1	0	2	0	0	0	0	0	4
Durham Township	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
East Rockhill Township	1	0	2	0	1	0	1	0	0	0	0	4	0	0	9
Falls Township	0	0	10	0	3	1	1	0	1	0	1	12	0	0	29
Haycock Township	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
Hilltown Township	3	0	4	0	2	0	1	0	1	0	0	2	0	1	14
Hulmeville Borough	0	0	1	0	1	0	1	0	1	0	0	0	0	0	4
Ivyland Borough	0	0	0	1	1	0	1	0	1	0	0	0	0	0	4
Langhorne Borough	0	0	2	0	1	0	1	0	1	0	0	0	0	0	5
Langhorne Manor Borough	0	0	1	0	0	0	1	1	1	0	0	1	0	0	5
Lower Makefield Township	0	0	8	0	1	0	1	2	1	0	1	8	0	0	22
Lower Southampton Township	0	0	12	0	2	0	1	1	1	0	1	3	0	0	21
Middletown Township	0	0	10	0	3	1	1	7	1	2	3	12	0	0	40
Milford Township	2	0	4	0	2	1	1	2	0	0	0	3	0	1	16

Table 2.5-1 Critical Facilities by Municipality and Type (Bucks County GIS Department, 2021) (DHS, 2021)

MUNICIPALITY	AIRPORT	CORRECTIONAL FACILITY	DAY CARE	EOC	FIRE DEPARTMENT	HOSPITAL	MUNICIPAL BUILDING	NURSING / RETIREMENT HOME	POLICE DEPARTMENT	RAILROAD STATION	RESCUE SQUAD	SCHOOL	SENIOR CENTER	WASTEWATER PLANT	GRAND TOTAL
Morrisville Borough	0	0	3	0	1	0	1	0	1	0	1	3	0	1	11
New Britain Borough	0	0	3	0	0	0	1	0	0	0	0	1	0	0	5
New Britain Township	1	0	10	0	1	0	1	0	1	0	1	3	0	0	18
New Hope Borough	0	0	0	0	1	0	1	0	1	0	1	2	0	0	6
Newtown Borough	0	0	2	0	1	0	1	1	1	0	0	0	0	0	6
Newtown Township	0	0	12	0	1	0	1	4	1	0	1	8	0	0	28
Nockamixon Township	1	0	1	0	1	0	1	0	0	0	2	4	0	0	10
Northampton Township	0	0	8	0	3	0	1	2	1	0	2	12	0	0	29
Penndel Borough	0	0	1	0	1	0	1	0	1	0	0	1	0	0	5
Perkasie Borough	0	0	6	0	1	0	1	0	1	0	0	1	0	0	10
Plumstead Township	1	0	7	0	3	0	1	0	1	0	1	4	0	0	18
Quakertown Borough	0	0	5	0	2	0	1	2	1	0	0	6	0	0	17
Richland Township	1	0	2	0	1	0	1	0	1	0	0	3	0	1	10
Richlandtown Borough	0	0	0	0	1	0	1	1	0	0	0	0	0	0	3
Riegelsville Borough	0	0	1	0	1	0	1	0	0	0	0	0	0	0	3
Sellersville Borough	0	0	4	0	1	0	1	0	0	0	0	1	0	0	7
Silverdale Borough	0	0	0	0	1	0	1	0	0	0	0	1	0	0	3
Solebury Township	1	0	7	0	1	0	1	0	1	0	0	2	0	0	13
Springfield Township	0	0	3	0	1	0	1	1	1	0	1	1	0	0	9
Telford Borough	0	0	1	0	0	0	0	1	0	0	0	0	0	0	2
Tinicum Township	3	0	0	0	3	0	1	2	1	0	0	1	0	0	11
Trumbauersville Borough	0	0	1	0	1	0	1	0	0	0	0	1	0	0	4
Tullytown Borough	0	0	1	0	1	0	1	0	1	1	0	2	0	0	7

Table 2.5-1 Critical Facilities by Municipality and Type (Bucks County GIS Department, 2021) (DHS, 2021)

MUNICIPALITY	AIRPORT	CORRECTIONAL FACILITY	DAY CARE	EOC	FIRE DEPARTMENT	HOSPITAL	MUNICIPAL BUILDING	NURSING / RETIREMENT	POLICE DEPARTMENT	RAILROAD STATION	RESCUE SQUAD	SCHOOL	SENIOR CENTER	WASTEWATER PLANT	GRAND TOTAL
Upper Makefield Township	0	0	1	0	2	0	1	0	1	0	1	1	0	0	7
Upper Southampton Township	0	0	9	0	1	0	1	1	1	0	2	3	0	0	18
Warminster Township	0	0	11	0	4	0	1	3	1	1	1	8	0	1	31
Warrington Township	0	0	12	0	2	0	1	2	1	0	1	6	0	0	25
Warwick Township	1	0	5	0	1	0	1	1	1	0	1	4	0	1	16
West Rockhill Township	0	0	1	0	0	1	1	2	1	0	1	2	0	1	10
Wrightstown Township	0	0	3	0	1	0	1	0	0	0	1	1	0	0	7
Yardley Borough	0	0	2	0	1	0	1	0	1	1	0	1	0	0	7
TOTAL	22	4	239	1	85	6	53	48	41	16	32	178	1	17	743

Table 2.5-2 Number of Critical Facilities in Bucks County by Type and Data Source

TYPE	NUMBER IN COUNTY	DATA SOURCE
Airport	23	Bucks County GIS, 2021
Correctional Facility	4	Bucks County GIS, 2021
Day Care	241	NHILD, 2021
EOC	1	Bucks County GIS, 2021
Fire Stations	85	Bucks County GIS, 2021
Hospital	6	Bucks County GIS, 2021
Municipal Building	53	Bucks County GIS, 2021
Nursing / Retirement Home	46	Bucks County GIS, 2021
Police Department	41	Bucks County GIS, 2021
Railroad Station	16	Bucks County GIS, 2021
Rescue Squad	32	Bucks County GIS, 2021
School (K-12 and Universities)	178	Bucks County GIS, 2021
Senior Center	1	Bucks County GIS, 2021
Wastewater Plant	17	Bucks County GIS, 2021

Please note, while there are multiple Senior Centers in Bucks County, only one was designated critical because of its role in emergency sheltering operations.

3. Planning Process

3.1. Update Process and Participation Summary

To begin the 2021 HMP process, HMSC, composed of Bucks County Planning Commission and Bucks County Department of Emergency Management representatives, identified individuals and organizations to invite to be a part of the HMPT. The HMSC 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 partner agencies such as university representatives and non-profit organizations. A complete list of partner agencies that were invited throughout the planning process can be found in Appendix C. The HMSC and HMPT met in March 2021 to discuss the overall planning process, identify potential additional parties to include, and begin a discussion on any updates and changes to the hazards and associated mitigation opportunities, 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 HMSC updated the HMPT mailing list based on information provided in the first meeting. Section 3.2 provides additional information about the HMSC and HMPT as well as a table of members with their corresponding organization.

Municipal officials, partner agencies, 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 partner agencies, forms and surveys were distributed and collected throughout the planning process. Forms were presented during meetings and links to fill them out were distributed via email and completed and returned in between scheduled meetings. Communities were reminded of the importance in participating and the possible impact on municipal bond rating and FEMA grant eligibility. Communities were encouraged to attend meetings and submit forms. Table 3.5-1 lists each municipality along with their specific participation and contributions to the planning

The 2021 Bucks County Hazard Mitigation Planning Team included:

- Municipal Officials
- Multiple Bucks County Departments and Agencies
- Bucks County Conservation District
- Holy Family University
- Cairn University
- Bucks County Redevelopment Authority
- Bucks County Water and Sewer Authority
- School District Officials
- SEPTA
- Neighboring Communities

process. Sign-in sheets for each meeting with individual names are available in Appendix C along with all completed forms and surveys.

As the planning process began for the Bucks County HMP update, the COVID-19 pandemic and the national, state, and local public gathering guidelines and restrictions were still ongoing and in full effect. All forms of in-person meetings were transitioned to a virtual setting to ensure the planning process proceeded rather than postponing the plan update but safely. Virtual meetings were held through Cisco WebEx. The WebEx meeting information for each meeting was mailed to municipalities and adjacent counties, as well as emailed to municipalities and partner agencies throughout the planning process.

WebEx is an online conference center that has multiple capabilities for users. As meeting participants logged into each meeting, they had the option to utilize the video feature or remain on audio. The screen sharing feature was used to present the PowerPoint that was created for each meeting. If the participants had questions, they were able to speak directly during the meeting, or they could utilize the chat function and send a message to an individual, group, or the entire audience.

In addition to adjusting the planning process meeting parameters, the forms that were available to the communities and partner agencies for completion were posted online in both PDF format as well as in Google Forms. Google Forms is an interactive online survey program in which several of the forms discussed in Section 3.4 were translated into digital versions. There was greater participation through Google Forms submission of the surveys compared to the PDF copies.

The Bucks County Planning Commission contracted Michael Baker International to support the HMP process and plan development. The 2021 Bucks County HMP was submitted for PEMA review on July 14, 2021 and FEMA review on July 22, 2021.

3.2. The Planning Team

The HMSC for the 2021 HMP included:

Table 3.2-1 Bucks County Hazard Mitigation Plan Steering Committee

PARTICIPANT	TITLE
Evan J. Stone, PLA	Executive Director, Bucks County Planning Commission
Audrey R. Kenny, ENP	Interim Director, Bucks County Emergency Services
Ian Eppig, MS, CFM	Operations and Training Officer, Bucks County Emergency Services
Matthew M. Walters	Senior Planner, Bucks County Planning Commission
Deanna M. Miller	Planner/Recycling Coordinator, Bucks County Planning Commission

The HMSC 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 partner agencies. These individuals were invited to participate in the HMP process. The HMSC worked throughout the process to plan and hold meetings, collect information, and conduct public outreach.

The partner agencies listed in Table 3.2.1-1 served on the 2021 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 3.2.1-1 Municipalities and Partner Agencies Who Participated in the Planning Process

MUNICIPALITY /ORGANIZATION	PARTICIPANT	TITLE
MUNICIPAL PARTICIPANTS		
Bensalem Township	Kenneth Farrall	Director of Building and Planning/Zoning Officer
Bensalem Township	Lt. Robert Race	Emergency Management Coordinator
Bridgeton Township	Teri Lewis	Township Manager
Bridgeton Township	Jim Majewski	Bridgeton Floodplain Administrator
Bristol Borough	Ron DeAngelis	Deputy EMA Coordinator
Bristol Borough	Merle Winslow	Emergency Management Director
Bristol Township	Thomas Scott	Planning Director
Chalfont Borough	Shawn Curran	Manager
Chalfont Borough	Daniel Jenkins	Emergency Management Coordinator
Doylestown Borough	Scott Fleischer	Fire Marshal/ Emergency Management Coordinator
Doylestown Borough	Ron Strouse	Mayor
Doylestown Township	Keith Hass	Executive Director
Doylestown Township	Stephanie Mason	Floodplain Administrator
Doylestown Township	Sinclair Salisbury	Director of Code Enforcement
Dublin Borough	Philip Meyers	Emergency Management Coordinator
Dublin Borough	Kevin Nugent	Emergency Management Coordinator
Durham Township	Danielle Cox	Township Administrator
East Rockhill Township	Marianne Morano	Manager

MUNICIPALITY /ORGANIZATION	PARTICIPANT	TITLE
Falls Township	Rich Dippolito	Emergency Management Coordinator
Falls Township	Matt Takita	Manager / Floodplain Administrator
Haycock Township	Tim Fulmer	Engineer
Hilltown Township	Tim Fulmer	Engineer
Hilltown Township	Tom Louden	Emergency Management Coordinator
Hulmeville Borough	Bill Wheeler	Fire Marshal
Langhorne Borough	Christine Schoell	Floodplain Administrator
Langhorne Manor Borough	Dawn Seader	Council President
Lower Makefield Township	Jim Majewski	Floodplain Administrator
Lower Southampton Township	Joe Galdo	Manager
Lower Southampton Township	Ryan Smith	Fire Marshal / Emergency Management Coordinator
Lower Southampton Township	Raymond Weldie	Board of Supervisors
Middletown Township	Jim McGuire	Director of Emergency Services & Fire Marshal
Middletown Township	Nick Valla	Assistant Township Manager
Milford Township	Nathan Cordero	Floodplain Administrator
Milford Township	Chris Kletzing	Systems IT Manager
Milford Township	Charles Strunk	Chairman
Nockamixon Township	Steve Baluh	Township Engineer
Nockamixon Township	Ed Mocarsi	Emergency Management Coordinator
Northampton Township	Frank Fenton	Emergency Management Coordinator
Northampton Township	Jeff Greenwood	Manager
Northampton Township	Mike Solomon	Floodplain Administrator
Penndel Borough	Nick Foufas	Emergency Management Coordinator
Penndel Borough	Robert Winkler	Mayor
Perkasie Borough	Debbie Sergeant	Code Enforcement Administrator
Plumstead Township	Scott Fleischer	Fire Marshal/ Emergency Management Coordinator
Plumstead Township	Tim Fulmer	Township Engineer
Richland Township	Michael Kisthardt	Richland Police Sgt.
Riegelsville Borough	Frank Preedy	Emergency Management Coordinator
Sellersville Borough	Eileen M. Bradley	Borough Manager
Silverdale Borough	Steve Baluh	Engineer

MUNICIPALITY /ORGANIZATION	PARTICIPANT	TITLE
Solebury Township	Dominick Bellizzie	Chief of Police
Solebury Township	Catherine Cataldi	Township Secretary
Solebury Township	Curstin Genner Jr., PE	Engineer/Floodplain Administrator
Solebury Township	Jean Wiess	Administrative Assistant / Right-to-Know Officer
Solebury Township	Zachary Zubris	Zoning Officer
Springfield Township	Tim Fulmer	Township Engineer
Springfield Township	Jason Wager	Manager
Telford Borough	Mark Fournier	Manager
Tinicum Township	Bill Cahill	Emergency Management Coordinator
Tinicum Township	Joan Tanner	Administrative Services
Trumbauersville Borough	Steve Baluh	Engineer
Trumbauersville Borough	Marilyn Bobb	Emergency Management Coordinator
Trumbauersville Borough	Caroline Thompson	Council Member
Trumbauersville Borough	Craig Wilhelm	Fire Marshal/Code Enforcement Officer
Upper Makefield Township	Denise Burmester	Administrative Assistant
Upper Makefield Township	Robert Kay Sr	Emergency Management Coordinator
Upper Makefield Township	Dave Kuhns	Floodplain Administrator
Upper Southampton Township	Mark Showmaker	Emergency Management Coordinator
Upper Southampton Township	Don Williams	Manager / Floodplain Administrator
Warminster Township	Gary Smith	Zoning Officer
Warminster Township	Joe Velton	Emergency Management Coordinator
Warrington Township	Lee Greenberg	Director of Codes, Inspections and Emergency Services
Warwick Township	Kyle Seckinger	Manager / Planner
West Rockhill Township	Steve Baluh	Engineer
West Rockhill Township	Greg Lippincott	Manager
Wrightstown Township	Ted Middleman	Floodplain Administrator
Wrightstown Township	Joseph Pantano	Manager
Yardley Borough	Wes Foraker	Emergency Management Coordinator
Yardley Borough	Paula Johnson	Manager
OTHER PARTNER AGENCY PARTICIPANTS		

MUNICIPALITY /ORGANIZATION	PARTICIPANT	TITLE
American Red Cross Southeastern Pennsylvania Region	Mike Kiley-Zufelt	Senior Disaster Program Manager
Bristol Township School District	Bob Maloney	Operations Manager
Buckeye Partners, L.P.	Michael Bass	Right of Way Specialist for ROW, Real Estate & Damage Prevention Team
Bucks County	Kevin Spencer	Director of Operations
Bucks County Community College	Mark Moore	Assistant Director
Bucks County Conservation District	Meghan Rogalus	Watershed Specialist
Bucks County Planning Commission	Deanna Miller	Planner
Bucks County Planning Commission	Evan Stone	Executive Director
Bucks County Planning Commission	Matthew Walters	Commissioner
Bucks County Redevelopment Authority	Jeff Darwak	Executive Director
Bucks County Water & Sewer Authority	Jim Napoleon	Manager of Asset Management
Bucks County Department of Emergency Services	Ian Eppig	Operations & Training Officer
Burlington County OEM	Kyle Currier	Planner
Cairn University	Christopher Lloyd	Director, Office of Safety and Security
Central Bucks School District	David Cell	Safety/Security Coordinator
Central Bucks School District	Robert Kleimenhagen	Director of Facilities & Energy Management Operations
Delaware Valley Regional Planning Commission	Chris Linn	Manager
Delaware River Basin Commission	Stacey Mulholland	Government Affairs Lead
FEMA Region 3	Mari Radford	Lead Mitigation Planner
FEMA Region 3	Matthew McCullough	Mitigation Planner
Holy Family University	Dave Neuman	Director of Public Safety
Keystone Municipal Services Inc.	James Kopchak	Building Code Official
Lehigh County Emergency Management Agency	Tanya Hook	Community Outreach Coordinator, Emergency Services
Northampton County Emergency Management	Thomas Guth Jr.	Hazard Mitigation / Disaster Recovery Manager
PA DEP Emergency Response	Rex Miller	Emergency Response Manager

MUNICIPALITY /ORGANIZATION	PARTICIPANT	TITLE
PEMA	Tom Hughes	State Hazard Mitigation Officer
PEMA	Ernest Szabo	State Mitigation Planner
Pennridge School District	Kelly Harper	Director of Operations
Philadelphia Office of Emergency Management	Emma Giardina	Hazard Mitigation Planner
Red Cross	Mary Newsome	Disaster Program Specialist Bucks & Montgomery Counties
SEPTA	Dan Gardella	Engineer
SEPTA	David Montvydas	Chief Engineer
Warminster Municipal Authority	Daulton George	Assistant Manager
Wharton Risk Center, UPenn	Zoe Linder-Baptie	Communication and Engagement Coordinator

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.

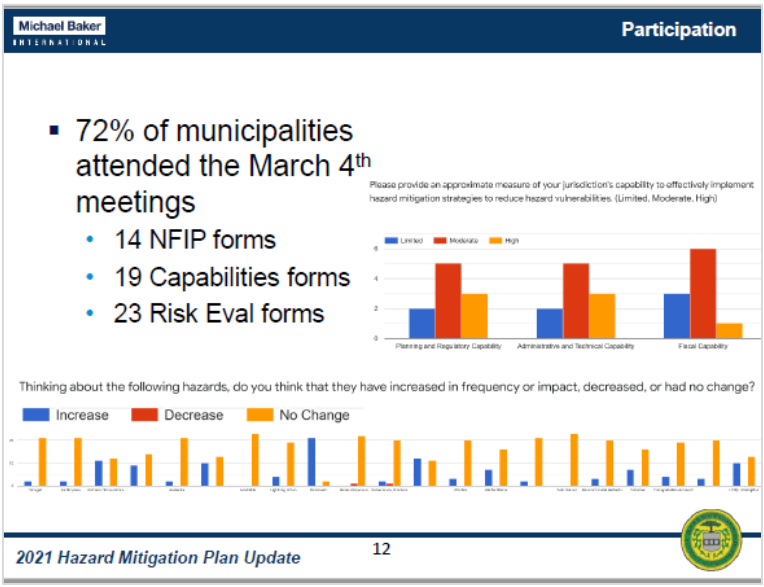
January 26, 2021 – Hazard Mitigation Planning Committee Kickoff call to discuss participation, meeting schedule, data collections and priorities for 2021 update.

March 4, 2021 – Community Kick-Off Meeting held as two webinars 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. Morning and evening session webinars were held to help get as many partner agencies to participate as possible.

Figure 3.3-1 Slide from Presentation at Kickoff Meeting on March 4, 2021.

April 8, 2021 – Risk Assessment and Mitigation Solutions Meeting held as two webinars to review preliminary risk assessment results. The meeting was used to review mitigation goals, objectives, and actions for 2021 update. Participants asked to complete a Risk Assessment, Mitigation Action Review, and New Mitigation Action worksheets. Morning and evening session webinars were held to help get as many partner agencies to participate as possible.

Figure 3.3-2 Slide from Presentation at Mitigation Solutions Meeting on April 8, 2021.

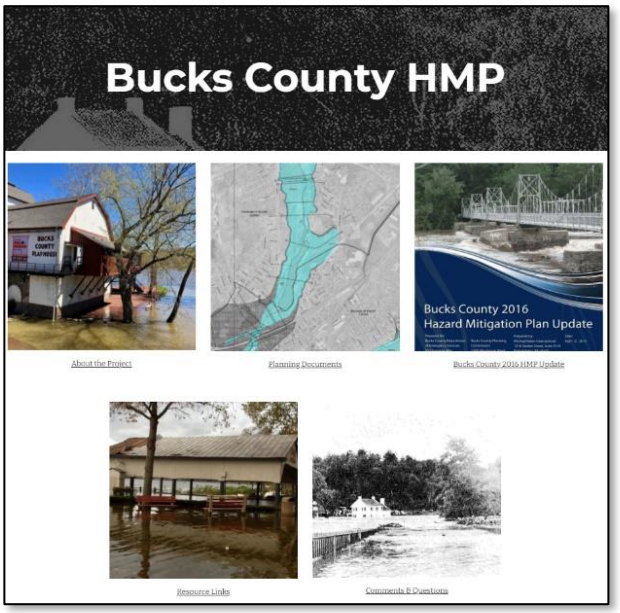


June 10, 2021 –Draft Plan Review Public Meeting held as two webinars to update the attendees about the HMP process and findings. Several verbal comments were noted in the meeting minutes and attendees were informed about the timeline and their opportunity to review the entire plan on the County's Hazard Mitigation Planning website and provide written comments.

3.4. Public & Stakeholder Participation

Each municipality was given multiple opportunities to participate in the HMP process through invitation to meetings, general comment opportunities, one-on-one meetings, review of risk assessment results and mitigation actions, and an opportunity to comment on the draft HMP. A community that opted for one-on-one time was Tinicum Township to discuss and explore the benefits of participating in the Community Rating System (CRS) that provides discounts on flood insurance premiums for residents in the municipality. Additional information regarding the CRS program can be found in Section 5.2.1.3. 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 3.4-1 Bucks County 2021 HMP Update Website



1) *Hazards in Your Community*: Bucks County had a robust risk assessment in its 2015 plan with 21

hazards. For the 2021 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 local nuisance information.

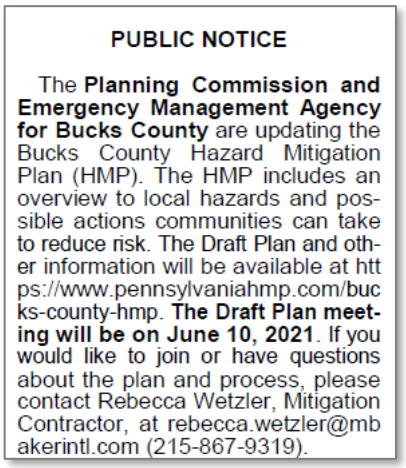
4) *Risk Assessment Exercise:* This form provides an opportunity for municipalities and partner agencies to review and comment on hazard ranking and local impact.

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

6) *New Mitigation Action Form:* This form provides an opportunity for municipalities and partner agencies to add new mitigation actions to the 2021 plan.

Community participation and comment was encouraged throughout the planning process, particularly through the County's project website, https://sites.google.com/site/pennsylvaniahmp/bucks-county-hmp. This site acted as a repository for the entire planning process, including presentations (PPT and meeting recordings), agendas, minutes, and worksheets from each meeting as well as promulgating meeting dates, times, and important announcements. Notably, visitations to the website peaked shortly after public meetings. Newspaper notices were also published in the Bucks County Courier Times and The Intelligencer on June 6, 2021 and June 7, 2021 to notify the citizens of Bucks County of the public meeting held on June 10, 2021 and the opportunity to participate in the planning process. The notice was posted in both newspapers to try and reach multiple audiences because each newspaper covers different areas in Bucks County.

Figure 3.4-2 Public notices posted in the Bucks County Courier Times and the Intelligencer.

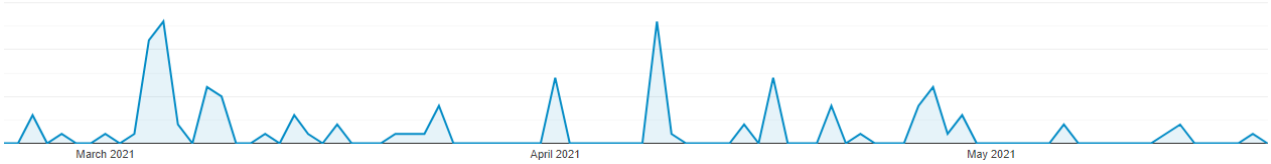


PUBLIC NOTICE

The **Planning Commission and Emergency Management Agency for Bucks County** are updating the Bucks County Hazard Mitigation Plan (HMP). The HMP includes an overview to local hazards and possible actions communities can take to reduce risk. The Draft Plan and other information will be available at https://www.pennsylvaniahmp.com/bucks-county-hmp. **The Draft Plan meeting will be on June 10, 2021**. If you would like to join or have questions about the plan and process, please contact Rebecca Wetzler, Mitigation Contractor, at rebecca.wetzler@mbakerintl.com (215-867-9319).

Several comment forms were received after the meeting via emails and the Comment Form on the project website. All comments received were addressed.

Figure 3.4-3 Sample Website Analytics.



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. For Telford Borough residents to be eligible for FEMA disaster grant funding across the entire municipality, community officials may want to participate in and adopt both County HMPs.

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. About 96 percent of the municipalities, 52 of 54 total municipalities, attended at least one meeting or completed one form, 85 percent (46 municipalities) attended both. This is a decrease from previous years in large part due to meetings being held virtually due to the Covid-19 pandemic.

At the end of April 2021, an HMSC meeting was held. Representatives from the committee reached out to each municipality that had not yet participated in the planning process to encourage participation in the HMP update.

Table 3.5-1 Summary of Participation from Local Municipalities During the 2021 Hazard Mitigation Planning Process.

	Combined Participation	Meeting Participation			Documentation Provided				
*Jurisdiction**	*2021*	*Kick-Off Meeting*	*RAMS Meeting*	*Draft Plan Review Meeting*	*Risk Evaluation*	*NFIP Guide*	*Capability Assessment*	*Update on Previous Action*	*New Action*
Bucks County	O	O	O	O	O		O	O	
Bedminster Township	O	O		O		O	O	O	O
Bensalem Township	O		O	O	O	O	O	O	
Bridgeton Township		O							
Bristol Borough	O	O	O	O	O	O	O		
Bristol Township	O	O	O	O	O	O	O		
Buckingham Township	O		O		O	O	O	O	O
Chalfont Borough	O	O	O	O	O	O	O	O	O
Doylestown Borough	O	O	O	O	O		O		O
Doylestown Township	O	O	O	O	O	O	O	O	
Dublin Borough	O	O		O	O				
Durham Township	O	O		O	O				
East Rockhill Township	O	O	O	O	O	O	O	O	O
Falls Township	O	O						O	
Haycock Township	O	O	O	O	O	O	O	O	O
Hilltown Township	O	O	O	O	O	O	O	O	O
Hulmeville Borough	O	O	O		O		O		
Ivyland Borough	O	O			O	O			
Langhorne Borough	O	O	O		O				
Langhorne Manor Borough	O	O	O	O	O				
Lower Makefield Township	O	O	O	O	O	O	O		
Lower Southampton Township	O	O	O	O	O		O		
Middletown Township	O		O		O	O	O		
Milford Township	O	O	O		O	O	O	O	O
Morrisville Borough									
New Britain Borough	O			O	O				

Table 3.5-1 Summary of Participation from Local Municipalities During the 2021 Hazard Mitigation Planning Process.

	Combined Participation	Meeting Participation			Documentation Provided				
*Jurisdiction**	*2021*	*Kick-Off Meeting*	*RAMS Meeting*	*Draft Plan Review Meeting*	*Risk Evaluation*	*NFIP Guide*	*Capability Assessment*	*Update on Previous Action*	*New Action*
New Britain Township	O			O	O		O		
New Hope Borough		O							
Newtown Borough	O			O	O				
Newtown Township	O			O	O			O	
Nockamixon Township	O	O	O	O	O	O	O		O
Northampton Township	O	O	O		O	O	O		
Penndel Borough		O		O					
Perkasie Borough			O						
Plumstead Township	O	O	O	O	O	O	O	O	O
Quakertown Borough									
Richland Township	O	O	O		O	O	O		
Richlandtown Borough				O					
Riegelsville Borough	O	O	O	O	O	O	O		
Sellersville Borough	O	O	O	O	O	O	O		
Silverdale Borough	O		O	O				O	O
Solebury Township	O	O	O	O	O	O	O		
Springfield Township	O	O	O	O	O	O	O	O	O
Telford Borough	O			O	O		O		
Tinicum Township	O	O	O	O	O	O	O		O
Trumbauersville Borough	O	O	O	O	O	O	O		O
Tullytown Borough					O		O		
Upper Makefield Township	O	O	O	O	O	O	O		O
Upper Southampton Township	O	O	O	O	O	O	O		
Warminster Township	O	O	O	O	O	O	O	O	
Warrington Township	O	O	O	O	O	O	O		
Warwick Township	O	O	O	O	O	O	O		

Table 3.5-1 Summary of Participation from Local Municipalities During the 2021 Hazard Mitigation Planning Process.

	Combined Participation	Meeting Participation			Documentation Provided				
*Jurisdiction**	*2021*	*Kick-Off Meeting*	*RAMS Meeting*	*Draft Plan Review Meeting*	*Risk Evaluation*	*NFIP Guide*	*Capability Assessment*	*Update on Previous Action*	*New Action*
West Rockhill Township	O	O	O	O	O		O	O	O
Wrightstown Township	O	O		O	O				
Yardley Borough	O	O	O	O	O	O	O		O
Municipal Totals	46	51			48				

**All communities participated in the 2016 Hazard Mitigation Plan update.*

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 37 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 the Risk Evaluation 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 2019 Pennsylvania State HMP update, and past disaster declarations, the HMPT determined that the 22 hazards identified in the current plan were valid for the update, and determined the need to include the following the additional hazard: Gas and Liquid Pipelines. Preliminary analysis on these hazards was reviewed at the Risk Assessment and Mitigation Solutions Workshop, where attendees confirmed that these 22 hazards were the proper focus for the 2021 HMP update.

The HMPT identified three additional hazards – illegal dumping, opioid addiction, and cyber terrorism – that are important to highlight as possible hazards that may become a significant issue in the future, but ultimately the HMPT decided to not include a full

Hazard profiles in the 2021 HMP include the following Natural and Human-Made Hazards:

- **Drought**
- **Earthquake**
- **Extreme Temperature**
- **Flood, Flash Flood, Ice Jam**
- **Hailstorm**
- **Hurricane, Tropical Storm, Nor'easter**
- **Landslide,**
- **Lightning Strike**
- **Pandemic and Infectious Disease**
- **Radon Exposure**
- **Subsidence, Sinkhole**
- **Tornado, Windstorm**
- **Wildfire**
- **Winter Storm**
- **Structure Collapse (Infrastructure)**
- **Dam Failure**
- **Environmental Hazards (Hazardous Materials Releases)**
- **Terrorism**
- **Transportation Accident**
- **Urban Fire and Explosion**
- **Utility Interruption**
- **Gas and Liquid Pipelines**

profile for them at this time. Illegal dumping, opioid addiction, and cyber terrorism descriptions can be located in Table 4.2-5. Should any of these three hazards become a higher risk to the planning area, the appropriate actions will be taken to include the hazard profiles in the current plan during its five-year lifespan, or they will be included in the next plan 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 partner agencies participating in the planning process then evaluated the impact of hazard profiled in their jurisdiction or organization using the Risk Assessment Exercise (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 1953 through 2021 that have affected Bucks County. Additional declarations beyond 2021 can be found on the FEMA website at: https://www.fema.gov/data-visualization/disaster-declarations-states-and-counties.

Table 4.2-1 Presidential Disaster and Emergency Declarations affecting Bucks County (FEMA, 2021a).

DECLARATION NUMBER	DATE	EVENT
4506	March 30, 2020	COVID-19 Pandemic
3441	March 13, 2020	COVID-19 Pandemic
4267	March 23, 2016	Severe Winter Storm and Snowstorm
3367	February 6, 2014	Severe Winter Storm

Table 4.2-1 Presidential Disaster and Emergency Declarations affecting Bucks County (FEMA, 2021a).

DECLARATION NUMBER	DATE	EVENT
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, flooding, severe storms, and COVID-19. 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.

In addition to these Presidentially declared events, 44 events warranted Gubernatorial Disaster Declarations or Proclamations. Table 4.2-2 lists Gubernatorial Disaster Declarations or Proclamations that have been issued for Bucks County between 1955 and 2021.

Table 4.2-2 Gubernatorial Disaster Declarations or Proclamations Affecting Bucks County (PEMA, 2021a).

DATE	EVENT
April 15, 2021	Proclamation of Disaster Emergency – Civil Disturbance
February 1, 2021	Proclamation of Disaster Emergency – Winter Weather
December 15, 2020	Proclamation of Disaster Emergency – Winter Weather
May 30, 2020	Proclamation of Disaster Emergency – Civil Disturbance
March 6, 2020	Proclamation of Disaster Emergency – Coronavirus (COVID-19)
January 18, 2019	Proclamation of Disaster Emergency – Severe Winter Event
August, 2018	Proclamation of Disaster Emergency–Rapid, Heavy Rainfall Resulting in Flash Floods
March, 2018	Proclamation of Emergency-- Opioid Crisis, Severe Winter Storms
January, 2018	Proclamation of Disaster Emergency--Opioid Crisis
March, 2017	Proclamation of Emergency-- Severe Winter Storm
March, 2017	Proclamation of Emergency-- Severe Winter Storm
January, 2016	Proclamation of Emergency--Severe Winter Storm
August, 2015	Proclamation of Emergency-- Severe Storms
January, 2015	Proclamation of Emergency-- Severe Winter Storms
February, 2014	Proclamation of Disaster--Severe Winter Storm
February, 2014	Proclamation of Disaster--Severe Winter Storm
February, 2014	Proclamation of Disaster Emergency--Severe Winter Storm
January, 2014	Proclamation of Disaster Emergency--Extreme Weather, Utility Interruption
June, 2013	Proclamation of Emergency – High Winds, Thunderstorms, Heavy Rain, Tornado, Flooding
October, 2012	Proclamation of Emergency – Hurricane Sandy
April, 2012	Proclamation of Emergency – Spring Winter Storms
August 2011 (amended September 2011)	Proclamation of Emergency - Severe Storms and Flooding (Lee/Irene)
January, 2011	Proclamation of Emergency - Severe Winter Storm
February, 2010	Proclamation of Emergency - Severe Winter Storm
April, 2007	Severe Storm
February, 2007	Proclamation of Emergency - Severe Winter Storm
February, 2007	Proclamation of Emergency - Regulations
April, 2007	Proclamation of Emergency - Severe Winter Storm
September, 2006	Proclamation of Emergency - Tropical Depression Ernesto
September, 2005	Proclamation of Emergency - Hurricane Katrina
February, 2002	Drought & Water Shortage
August, 2000	Flooding
July, 1999	Drought
September, 1995	Drought

Table 4.2-2 Gubernatorial Disaster Declarations or Proclamations Affecting Bucks County (PEMA, 2021a).

DATE	EVENT
November, 1980	Drought Emergency
January, 1978	Heavy Snow
February, 1978	Blizzard
February, 1974	Truckers Strike
February, 1972	Heavy Snow
January, 1966	Heavy Snow
February, 1958	Heavy Snow
September, 1955	Drought

Bucks County has also received Small Business Administration (SBA) Assistance for a number of disaster events. A Small Business Administration Disaster Declaration qualifies communities for access to affordable, timely, and accessible financial assistance. The twenty-two County events receiving Small Business Administration disaster-related loan assistance are listed below.

Table 4.2-3 Small Business Administration Disaster Declarations Affecting Bucks County (SBA, 2021).

DATE	EVENT
December, 2020	Tropical Storm Isaias
August, 2020	Civil Unrest
August, 2019	Severe Weather and Flooding
January, 2019	Apartment Building Fire
July, 2016	Flash Flooding
April, 2014	Severe Winter Storms
August, 2009	Storms and Flooding
September, 2008	Fire
August, 2008	Fire
November, 2007	Fire
August, 2007	Hail and High Winds
April, 2007	Severe Storms and Flooding
August, 2001	Flooding
May, 2001	Fire
March, 2001	Fire
January, 1996	Fire
August, 1993	Flash Flood
February, 1993	Fire
June, 1992	Fire
May, 1990	Fire
December, 1988	Fire

Table 4.2-3 Small Business Administration Disaster Declarations Affecting Bucks County (SBA, 2021).

DATE	EVENT
June, 1987	Fire

4.2.2. Summary of Hazards

The table below summarizes hazards identified in the 2021 Bucks County HMP Update.

Table 4.2-4 Hazards Identified in the Bucks County 2021 Mitigation Plan Update.

NATURAL HAZARDS		
Drought	Earthquake	Extreme Temperatures
Flood, Flash Flood, Ice Jam	Hailstorm	Hurricane, Tropical Storm, Nor'easter
Landslide	Lightning Strike	Pandemic and Infectious Disease
Radon Exposure	Subsidence, Sinkhole	Tornado, Windstorm
Wildfire	Winter Storm	
HUMAN-MADE HAZARDS		
Structure Collapse (Infrastructure)	Dam Failure	Environmental Hazards
Terrorism	Transportation Accident	Urban Fire and Explosion
Utility Interruption	Gas and Liquid Pipeline	

As described in Section 4.1, the HMPT 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 2016 HMP, the 2019 Standard State All-Hazard Mitigation Plan, and the Standard List of Hazards, the HMPT decided that the 2021 plan update should identify, profile, and analyze 22 hazards. Table 4.2-5 contains a complete list of the 22 hazards that have the potential to impact Bucks County. Hazard profiles are included in Section 4.3 for each of these hazards.

Table 4.2-5 List and description of natural and manmade hazards profiled in the 2021 Hazard Mitigation Plan Update (PEMA, 2020a)

HAZARD	HAZARD DESCRIPTION
NATURAL HAZARDS	
	Drought is defined as a deficiency of precipitation experienced over an extended period of time, usually a season or more. Droughts increase the risk of other hazards, like wildfires, flash floods, and landslides or debris flows. This hazard is of particular concern in Pennsylvania due to the prevalence of farms and other water-dependent industries, water-dependent recreation uses, and residents who depend on wells for drinking water.
	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.
	Extreme heat often results in the highest number of annual deaths of all weather-related hazards. In most of the United States, extreme heat is defined as a long period (2 to 3 days) of high heat and humidity with temperatures above 90 degrees. Extremely cold air comes every winter in at least part of the country and affects millions of people across the United States. The arctic air, together with brisk winds, can lead to dangerously cold wind chill values. People exposed to extreme cold are susceptible to frostbite and hypothermia in a matter of minutes.
	Flooding is the temporary condition of partial or complete inundation of normally dry land, and it is the most frequent and costly of all natural hazards in Pennsylvania. 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. 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.
	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. Hailstorms can cause significant damage to homes, vehicles, livestock, and people.

Table 4.2-5 List and description of natural and manmade hazards profiled in the 2021 Hazard Mitigation Plan Update (PEMA, 2020a)

HAZARD	HAZARD DESCRIPTION
	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 counterclockwise (in the Northern Hemisphere) and whose diameter averages 10-30 miles across. Potential threats from hurricanes include powerful winds, heavy rainfall, storm surges, coastal and inland flooding, rip currents, tornadoes, and landslides. The Atlantic hurricane season runs from June 1 to November 30.
	In a landslide, masses of rock, earth or debris move down a slope. Landslides can be caused by a variety of factors, including earthquakes, storms, fire, and human modification of land. Areas that are prone to landslide hazards include previous landslide areas, areas on or at the base of slopes, areas in or at the base of drainage hollows, developed hillsides with leach field septic systems, and areas recently burned by forest or brush fires.
	Lightning is a giant spark of electricity resulting from the build-up of positive and negative charges within a thunderstorm. The flash or "bolt" of light can occur within the thunderstorm cloud or between the cloud and the ground. Lightning is a leading cause of injury and death from weather-related hazards. Although most lightning victims survive, people struck by lightning often report a variety of long-term, debilitating symptoms.
	A pandemic is a global outbreak of disease that occurs when a new virus emerges in the human population, spreading easily in a sustained manner, and causing serious illness. An epidemic describes a smaller-scale infectious outbreak, within a region or population, that emerges at a disproportional rate. Infectious disease outbreaks may be widely dispersed geographically, impact large numbers of the population, and could arrive in waves lasting several months at a time.
	Radon is a radioactive gas produced by the breakdown of uranium in soil and rock that can lead to lung cancer in people exposed over a long period of time. Most exposure comes from breathing in radon gas that enters homes and buildings through foundation cracks and other openings. According to the DEP, approximately 40% of Pennsylvania homes have elevated radon levels.

Table 4.2-5 List and description of natural and manmade hazards profiled in the 2021 Hazard Mitigation Plan Update (PEMA, 2020a)

HAZARD	HAZARD DESCRIPTION
	Land subsidence is a gradual settling or sudden sinking of the ground surface due to the movement of subsurface materials. A sinkhole is a subsidence feature resulting from the sinking of surficial material into a pre-existing subsurface void. Subsidence and sinkholes are geologic hazards that can impact roadways and buildings and disrupt utility services. Subsidence and sinkholes are most common in areas underlain by limestone and can be exacerbated by human activities such as water, natural gas, and oil extraction.
	A tornado is a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground. About 1,250 tornadoes hit the U.S. each year, with about 16 hitting Pennsylvania. Damaging winds exceeding 50-60 miles per hour can occur during tornadoes, severe thunderstorms, winter storms, or coastal storms. These winds can have severe impacts on buildings, pulling off the roof covering, roof deck, or wall siding and pushing or pulling off the windows.
	A wildfire is an unplanned fire that burns in a natural area. Wildfires can cause injuries or death and can ruin homes in their path. Wildfires can be caused by humans or lightning, and can happen anytime, though the risk increases in period of little rain. In Pennsylvania, 98% of wildfires are caused by people.
	A winter storm is a storm in which the main types of precipitation are snow, sleet, or freezing rain. 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. Most deaths from winter storms are not directly related to the storm itself, but result from traffic accidents on icy roads, medical emergencies while shoveling snow, or hypothermia from prolonged exposure to cold.
HUMAN-MADE HAZARDS	
	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.

Table 4.2-5 List and description of natural and manmade hazards profiled in the 2021 Hazard Mitigation Plan Update (PEMA, 2020a)

HAZARD	HAZARD DESCRIPTION
	Dam failure is the uncontrolled release of water (and any associated wastes) from a dam. This hazard often results from a combination of natural and human causes, and can follow other hazards such as hurricanes, earthquakes, and landslides. The consequences of dam failures can include property and environmental damage and loss of life.
	Hazardous material releases can contaminate air, water, and soils and have the potential to cause injury or death. 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.
	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. Cyber-attacks have become an increasingly pressing concern.
	Transportation accidents are technological hazards involving the nation's system of land, sea, and air transportation infrastructure. A flaw or breakdown in any component of this system can and often does result in a major disaster involving loss of life, injuries, property and environmental damage, and economic consequences.
	Urban fire and explosion hazards include vehicle and building/structure fires as well as overpressure rupture, overheat, or other explosions that do not ignite. This hazard occurs in denser, more urbanized areas statewide and most often occurs in residential structures. Nationally, fires cause over 3,000 deaths and approximately 16,000 injuries each year.

Table 4.2-5 List and description of natural and manmade hazards profiled in the 2021 Hazard Mitigation Plan Update (PEMA, 2020a)

HAZARD	HAZARD DESCRIPTION
	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 • Fuel or Resource Shortage • Electromagnetic Pulse • Information Technology Failure • Ancillary Support Equipment • Public Works Failure • Telecommunications System Failure • Transmission Facility or Linear Utility Accident • Major Energy, Power, Utility Failure
	Pipeline failures are low-probability, potentially high-consequence events. Although gas and liquid pipeline failures are infrequent, the hazardous and inflammable materials released by these events can pose a significant threat to public safety and the built and natural environment. Explosions associated with pipeline failures, for example, can cause severe injury to nearby residents and destroy homes and other property.

Bucks County identified three additional hazards the County is currently exploring and considering to profile in future plan updates. While the County ultimately decided to not complete full profiles on the three hazards in the current update, it was important to highlight the hazards in preparation for a full profile should they be included in future updates.

Table 4.2-6 Hazards Under Exploration for Future Plan Updates (PEMA, 2020a) (Waste Management, 2021)

HAZARD	HAZARD DESCRIPTION
	Cyber terrorism refers to acts of terrorism committed using computers, networks, and the Internet. The most widely cited definition comes from Denning's Testimony before the Special Oversight Panel on Terrorism: "Cyberterrorism…is generally understood to mean unlawful attacks and threats of attack against computers, networks, and the information stored therein when done to intimidate or coerce a government or its people in furtherance of political or social objectives. Further, to qualify as cyberterrorism, an attack should result in violence against persons or property, or at least cause enough harm to generate fear."
	Opioid addiction occurs when an individual becomes physically dependent on opioids, which include opiates and narcotics. Opioids are a synthetic substance found in certain prescription pain medications: morphine, codeine, methadone, oxycodone, hydrocodone, fentanyl, and hydromorphone, and street drugs like heroine. Opioids block the body's ability to feel pain and can create a sense of euphoria. Individuals often build a tolerance to opioid drugs, which leads them to take more of the medication than originally prescribed.

Table 4.2-6 Hazards Under Exploration for Future Plan Updates (PEMA, 2020a) (Waste Management, 2021)

HAZARD	HAZARD DESCRIPTION
 (Illegal Dumping)	Waste Management defines illegal dumping as, "the disposal of trash generated at one location and disposed of at another location without legal permission. This includes dumping yard waste, appliances, tires and other garbage in alleys, dumpsters, vacant lots and open desert locations." While illegal dumping falls under the general hazard category of Hazardous Materials, this could potentially be a new subsection based on recent County trends and concerns.

4.3. Hazard Profiles

NATURAL HAZARDS

4.3.1. Drought

4.3.1.1. *Location and Extent*

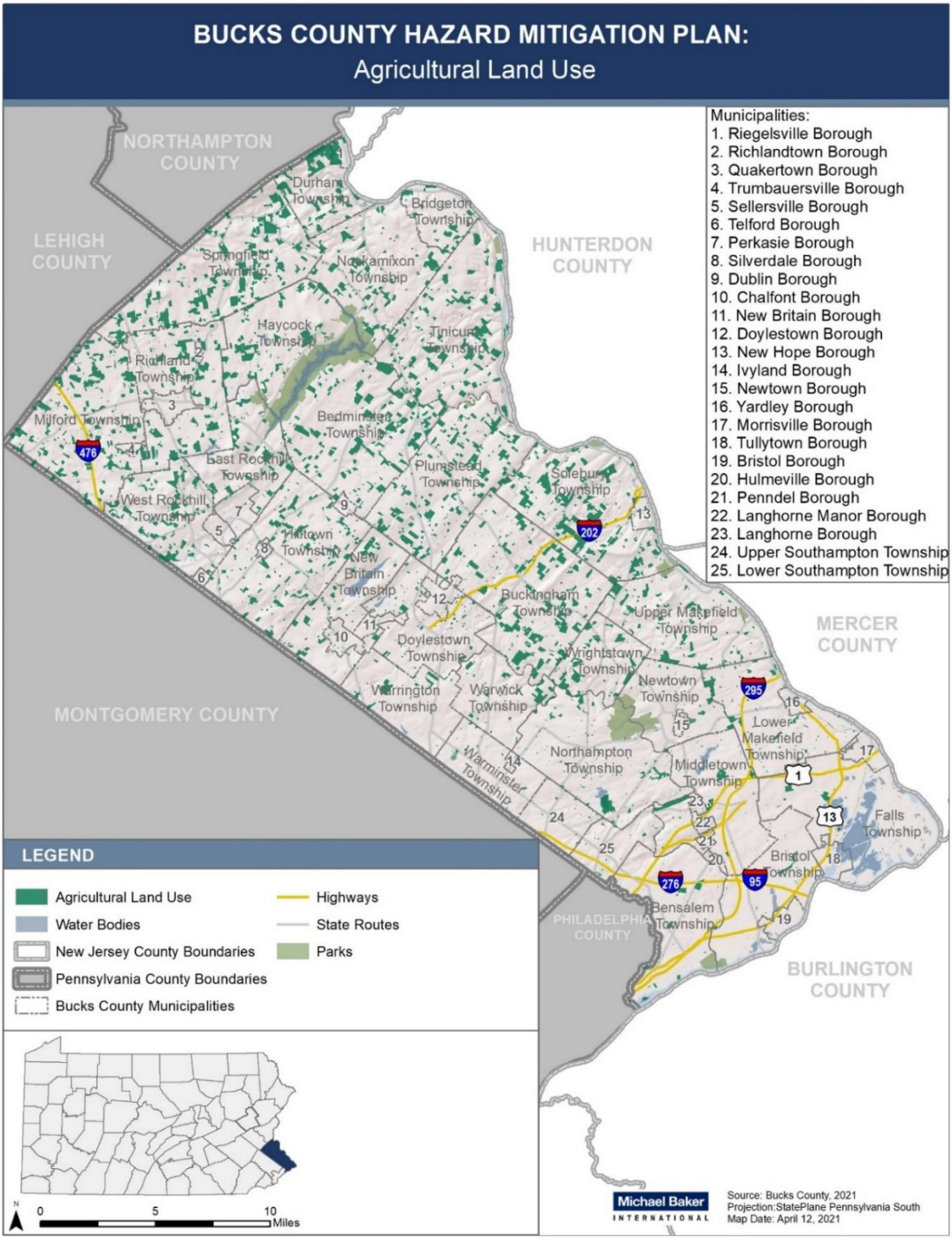
Droughts are regional climatic events, so when these events occur in Bucks County, impacts are felt across the County as well as in areas outside the County boundaries. The spatial extent for areas of impact can range from localized areas in Pennsylvania to the entire Mid-Atlantic region. Areas with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

Drought is defined as the consequence of a natural reduction in the amount of precipitation expected over an extended period, usually a season or more in length. Droughts are regional climatic events, so they typically impact all communities in a relatively uniform fashion with only minor localized variations in rainfall events. Droughts often occur across county boundaries, affecting large areas of Pennsylvania at the same time. Therefore, a drought would affect all of Bucks County, with the largest impact being on areas of the County with extensive agriculture uses.

Locations of droughts nationwide are monitored continuously by USGS, and the PA DEP monitors conditions throughout the state. Maps showing locations currently experiencing drought conditions are posted on various websites (including http://waterwatch.usgs.gov) and show locations where stream flow is below normal and where drought conditions exist or are emerging. As this plan was being developed between February 2021 and May 2021, no communities in Bucks County were experiencing a drought.

The impacts of a drought may be exacerbated and/ or have cascading health impacts as the water evaporates and chemicals present become more concentrated in well water and soil. Perfluorooctanoic Acids (PFOAS) and well contamination continue to be an issue in Bucks County and there may be increased risk during drought.

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 (PDSI) classifications (NOAA NWS, 2021a).

SEVERITY CATEGORY	PDSI 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.

The worst 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 (USGS, 2000). On July 20, 1999, a drought emergency was issued, restricting residents from using water to water lawns, wash cars, fill swimming pools, and operate water fountains. Residents who relied on personal water wells repotted water whenever possible. Local sports were canceled due to field conditions (PSD, 2000). 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 pastureland 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).

As for the past five years, Bucks County, along with 29 other counties in Pennsylvania, were declared a drought watch in November 2016. Lack of rainfall diminished groundwater and dropped reservoir levels. The Pennsylvania Department of Environmental Protection suggested residents within the 30 counties voluntarily reduce their water usage by 5%. Guidelines were issued, but no official restrictions were put into place like the summer of 1999.

Data provided by Cornell University shows that drought conditions in the Southeastern Piedmont region of Pennsylvania, where Bucks County is located, have resulted in Palmer Drought Severity Index level as low as -5.21. This was during a drought that lasted for twenty-five months from 1964 - 1966. In the Southeastern Piedmont region, on average, the region spends 44.4% of the time in the wet category, with the second highest percent of time spent in the near normal category at 17.2% (NRCC, 2021).

Droughts can have varying effects, depending upon what month they occur, severity, duration and location. Some droughts have their greatest impact on agriculture and even short-term droughts, when coupled with extreme temperatures can be devastating. Others may impact water supply or other water use activities such as recreation. Most droughts cause direct impacts to aquatic resources. Drought events are defined by rainfall amounts, vegetation conditions, soil-moisture conditions, water levels in reservoirs, stream flow, agricultural productivity, or economic impacts.

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.
- Loss of water for navigation and recreation.

- Increase in nitrate levels which can have health impacts on pregnant women and children.

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, Pennsylvania 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 2017, the most recent data available from the DEP, is shown in Table 4.3.1-2. Descriptions for drought status categories (i.e. watch, warning, and emergency) are included in Section 4.3.1.2.

Table 4.3.1-2 Past Drought Events in Bucks County (PADEP, 2017)

DATE	DROUGHT STATUS	DATE	DROUGHT STATUS
Nov 18, 1980 - Apr 20, 1982	Emergency	Jun 10, 1999 - Jun 20, 1999	Warning
Nov 10, 1982 - March 28, 1983	Warning	Jul 20, 1999 - Sep 30,1999	Emergency
Jan 23, 1985 - Apr 26, 1985	Warning	Sep 30, 1999 - May 5, 2000	Watch
Apr 26, 1985 - Dec 19, 1985	Emergency	Nov 6, 2001 - Dec 5, 2001	Watch
Jul 7, 1988 - Dec 12, 1988	Watch	Dec 5, 2001 - Feb 12, 2002	Warning
Mar 3, 1989 - May 15, 1989	Warning	Feb 12, 2002 - June 14, 2002	Emergency
Sep 13, 1991 - Sep 11, 1992	Warning	Jun 14, 2002 - Sept 5, 2002	Warning
Sep 11, 1992 - Jan 15, 1993	Watch	Sep 5, 2002 - Nov 7, 2002	Emergency
Sep 1, 1995 - Sep 20, 1995	Warning	Nov 7, 2002 - Dec 19, 2002	Warning
Sep 20, 1995 - Nov 8, 1995	Emergency	Apr 11, 2006 - Jun 30, 2006	Watch
Nov 8, 1995 - Dec 18, 1995	Warning	Oct 5, 2007 - Feb 15, 2008	Watch
Oct 27, 1997 - Jan 16, 1998	Warning	Sept 16, 2010 - Nov 10 2010	Warning
Dec 3, 1998 - Dec 14, 1998	Watch	Aug 5, 2011 - Sept 2, 2011	Watch
Dec 14, 1998 - March 15, 1999	Warning	Nov 3, 2016 - May 16, 2017	Watch
Mar 15, 1999 - Jun 10, 1999	Watch		

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. The drought watches and warnings, while not declared emergencies, have led to drought conditions and impacts in the County. 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.

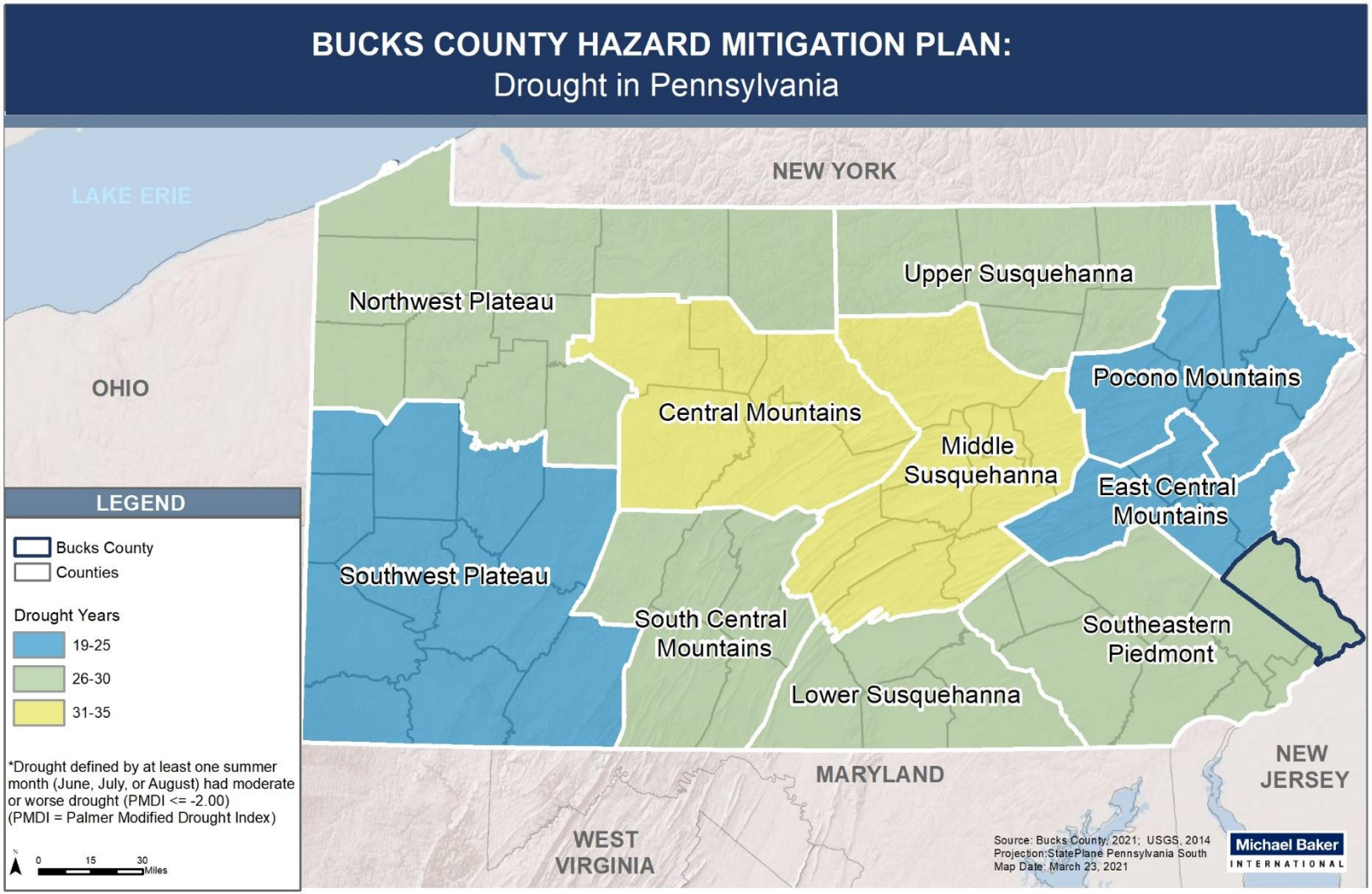
Table 4.3.1-3 Crop Loss Insurance Compensation due to Drought (USDA RMA, 2020).

CROP YEAR	INDEMNITY AMOUNT ($)
2020	$22,501
2019	$279,878
2018	$52,154
2017	$64,681
2016	$162,977
2015	$45,305
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
2001	1,693
1999	37,260
TOTAL	$1,194,468

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, between 1900 and 2017 Bucks County experienced between 26 and 30 drought years, which is defined as at least one summer month (June, July, August) in moderate or worse drought (PMDI <= -2.00).

Figure 4.3.1-2 Drought Frequency in Bucks County from 1900-2017



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 (National Integrated Drought Information System, 2021). Based on national data from 1900 to 2017, Bucks County has had 26-30 drought years, which is represented by the green color in Figure 4.3.1-2. This map illustrates that Bucks County, highlighted with a blue border, is in the zone of the Commonwealth with medium drought prevalence; the only area of the Commonwealth with higher drought prevalence is highlighted yellow along the Middle Susquehanna and Central Mountains. Therefore, the future occurrence of drought for Bucks County can be considered *possible* as defined by the Risk Factor methodology probability criteria (see Table 4.4.1-1).

According to the PEMA, uncertainty regarding the future occurrence of droughts exists due to the potential impacts of climate change as climate change brings increased precipitation, thus potentially lessening the length and/or likelihood of drought. Drought can also accompany extreme heat events. As the average temperature increases in Bucks County, drought events could also increase. Additional information regarding climate change in the past as well as future climate change predictions can be located in Section 4.4.4. The 2021 Pennsylvania Climate Impacts Assessment Update suggests that the likelihood for drought will *increase* by the middle of the 21st century due to more extreme, but less frequent precipitation patterns. The annual maximum consecutive dry days is projected to increase from 12.5 days historically to 13.4 days by mid-century and 13.9 days by end-of-century. This represents a 7% increase by mid-century and 11% increase by end-of-century (PADEP, 2021c).

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 (NOAA NCEI, 2021).

While these were statewide impacts, they illustrate the potential for droughts to severely impair the local economy in more agricultural communities. The USDA Census of Agriculture is conducted once every five years. The latest iteration of the Census of Agriculture was released in 2017. Bucks County ranks 28th out of the 67 counties in Pennsylvania, with agricultural production totaling $75.8 million (USDA, 2017). About 72 percent of this total is the production of crops, including nursery and greenhouse crops ($28 million) and grains and dry beans ($13.6 million); the remaining agricultural production is made up of vegetables, fruits, livestock, poultry, and their products (USDA, 2017). The county ranks 5th in nursery, greenhouse, floriculture, and sod and 28th in grains, oilseeds, dry beans, and dry peas 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 cattle and calves and milk from cows (USDA, 2017). Table 4.3.1-4 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 4.3.1-4 Top Livestock Inventory Items in Bucks County (USDA, 2017).

LIVESTOCK	COUNT
Layers	12,814
Cattle and calves	9,714
Broilers and other meat-type chickens	2,893
Horses and ponies	1,971
Sheep and lambs	1,616
Pullets	1,533

Prolonged drought would affect the 824 farms located in Bucks County, which sold approximately $75,757,000 in agricultural products in 2017 (USDA, 2017). The top crop assortment in Bucks County is nursery, greenhouse, floriculture, and sod, which totaled

$27,956,000 in sales (USDA, 2017). According to the USDA 2017 Census of Agriculture, most sales to date have come from crop sales, totaling $54,893,000 (72%). Livestock sales made up the remaining 28% with $20,864,000. Figure 2.4-1 in the Community Profile shows land uses across Bucks County. This map shows that most cultivated areas in the county are in the western portion of the County. There are also some areas extending in the Northern and Southern Areas of the County.

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 4.3.1-5 outlines the major community water suppliers in the County and the municipalities served.

Table 4.3.1-5 Major Community Water Suppliers in Bucks County and Municipalities Served (BCPC, 2011a)

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

Table 4.3.1-5 Major Community Water Suppliers in Bucks County and Municipalities Served (BCPC, 2011a)

COMPANY	MUNICIPALITIES SERVED
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
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

Table 4.3.1-5 Major Community Water Suppliers in Bucks County and Municipalities Served (BCPC, 2011a)

COMPANY	MUNICIPALITIES SERVED
Warwick Township Water & Sewer Authority	Warwick Township

Bucks County residents that use private domestic wells are more vulnerable to droughts. Table 4.3.1-6 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 4.3.1-6, the municipalities with the highest number of domestic wells are Buckingham, Upper Makefield, Solebury, Plumstead, and Milford Townships respectively.

Table 4.3.1-6 PaGWIS Data for Bucks County (DCNR, 2021)

MUNICIPALITY	NUMBER OF REPORTED DOMESTIC WELLS	MUNICIPALITY	NUMBER OF REPORTED DOMESTIC WELLS
Bedminster Township	781	Newtown Township	146
Bensalem Township	629	Nockamixon Township	782
Bridgeton Township	326	Northampton Township	821
Bristol Borough	215	Penndel Borough	42
Bristol Township	528	Perkasie Borough	100
Buckingham Township	1,596	Plumstead Township	1,325
Chalfont Borough	62	Quakertown Borough	143
Doylestown Borough	109	Richland Township	744
Doylestown Township	979	Richlandtown Borough	10
Dublin Borough	83	Riegelsville Borough	3
Durham Township	208	Sellersville Borough	36
East Rockhill Township	589	Silverdale Borough	9
Falls Township	434	Solebury Township	1,344
Haycock Township	477	Springfield Township	898
Hilltown Township	969	Telford Borough	6
Hulmeville Borough	24	Tinicum Township	1,864
Ivyland Borough	23	Trumbauersville Borough	15
Langhorne Borough	44	Tullytown Borough	39
Langhorne Manor Borough	4	Upper Makefield Township	1,513
Lower Makefield Township	231	Upper Southampton Township	279
Lower Southampton Township	194	Warminster Township	547
Middletown Township	396	Warrington Township	471
Milford Township	1,027	Warwick Township	492

Table 4.3.1-6 PaGWIS Data for Bucks County (DCNR, 2021)

MUNICIPALITY	NUMBER OF REPORTED DOMESTIC WELLS	MUNICIPALITY	NUMBER OF REPORTED DOMESTIC WELLS
Morrisville Borough	64	West Rockhill Township	526
New Britain Borough	53	Wrightstown Township	678
New Britain Township	484	Yardley Borough	14
New Hope Borough	97	Unknown	516
Newtown Borough	65	TOTAL	22,949

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, 2011a). 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. Since the last plan, over 1,000 reported domestic wells have been added to Bucks County. The increase 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). 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.

A drought in Bucks County can have significant detrimental effects on the domestic water supply, especially for well-water, agriculture, and water-dependent recreational activities. Economic effects in Bucks County would include crop loss. No structural damage due to drought is anticipated in Bucks County.

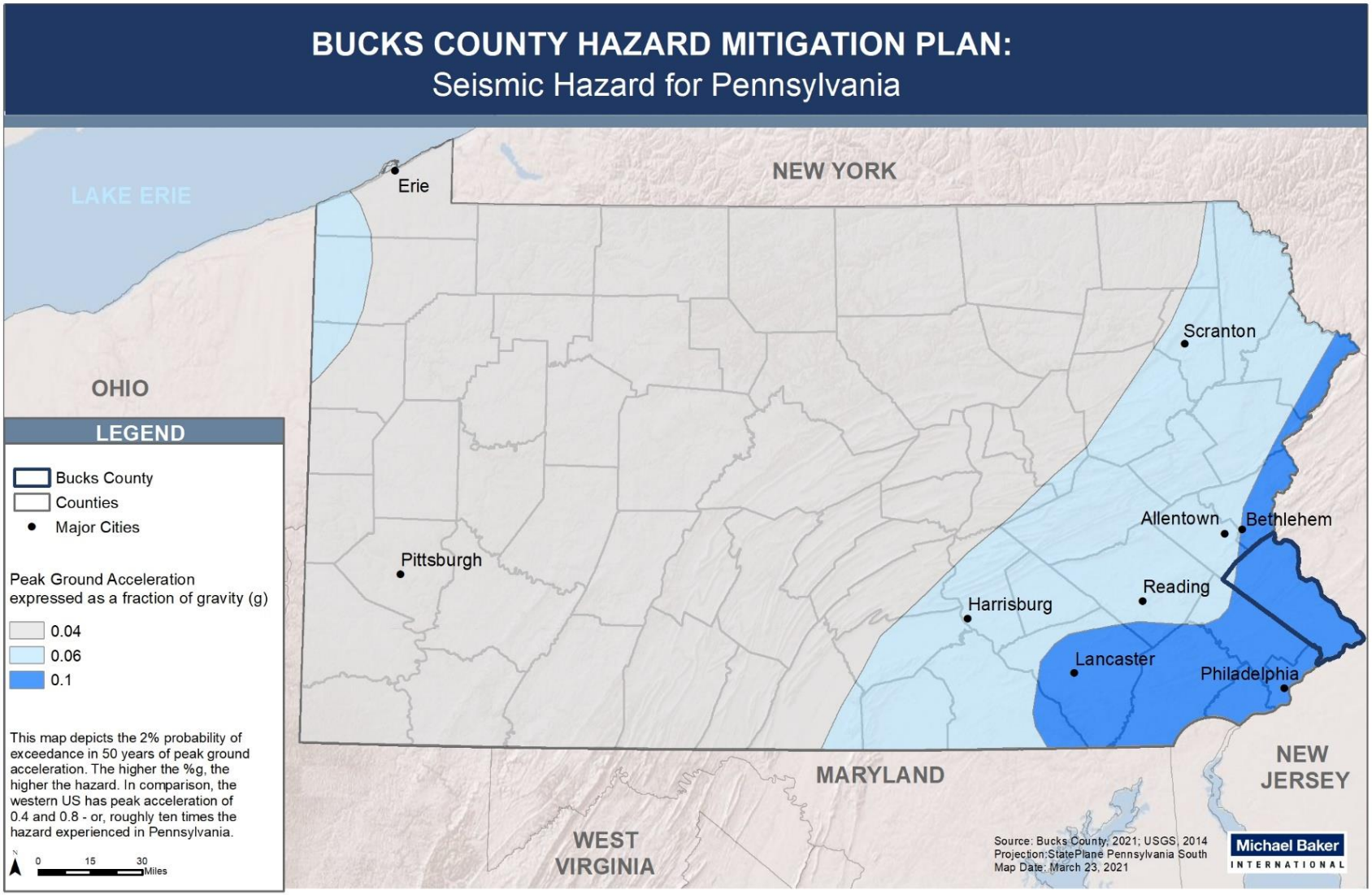
4.3.2. Earthquake

4.3.2.1. *Location and Extent*

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. They can also result from human activity like mine blasts and nuclear experiments. The closest fault line that might contribute to an earthquake in Bucks County is the Mid-Atlantic Ridge, which is approximately 2,000 miles to the east of Pennsylvania. As regional hazards, an earthquake would affect all of Bucks County. Earthquakes can cause damage to buildings and other rigid superstructures, depending on factors like earthquake magnitude, distance of local areas to the earthquake epicenter, and local geologic conditions. It remains incredibly difficult to predict when and where an earthquake will occur in the northeast U.S. and Pennsylvania.

Earthquake events in Pennsylvania typically do not impact areas greater than 100 km (62 miles) from the epicenter, and earthquake epicenters in Bucks County are rare. The area is generally not known for seismicity, and USGS downgraded the probabilistic seismic hazard for much of Pennsylvania in 2014. Figure 4.3.2-1 shows the earthquake hazard in Pennsylvania and Bucks County, expressed as the two-percent probability of exceedance in 50 years of peak ground acceleration (g). The following map was digitized from the National Seismic Hazard report. The majority of Bucks County is located in the 0.1 zone with a small portion of the western edge in the 0.06 zone, indicating that the hazard is slight to moderate. However, earthquakes originating outside Pennsylvania can affect Bucks County, though they are not expected to cause significant damage. This was the most current data available when updating this plan.

Figure 4.3.2-1 Bucks County and Pennsylvania Seismic Hazard and Earthquake History (USGS 2014 & 2019).



4.3.2.2. *Range of Magnitude*

There are several different ways of describing the magnitude of an earthquake. One method measures peak ground acceleration. Peak ground acceleration is the maximum horizontal ground acceleration measured in centimeters per second per second (cm/sec^2). Peak ground acceleration can range from zero for an earthquake that is noticed by very few people to 350, which would be categorized as a catastrophic event. A peak ground acceleration of 10 cm/sec^2 means that the shaking is equivalent to about one percent of the acceleration due to gravity. Generally, ground acceleration must exceed 15 cm/sec^2 for significant damage to occur. Bucks County, as discussed above, is mostly located in the 0.1 peak ground acceleration zone.

Earthquake magnitude is also often measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake. Table 4.3.2-1 below summarizes Richter Scale Magnitudes as they relate to the spatial extent of impacted areas. 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 in areas where people live up to about 100 kilometers across.
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. Therefore, another way of measuring the intensity of an earthquake is the Modified Mercalli Intensity Scale. Measures on this scale range from I, an earthquake that is not generally noticeable, to XII, an earthquake that causes complete destruction. Table 4.3.2-2 below summarizes Modified Mercalli Intensity Scale impacts of earthquake events, measured in terms of earthquake intensity.

Table 4.3.2-2 Modified Mercalli Intensity Scale with Associated Impacts

SCALE	INTENSITY	DESCRIPTION OF EFFECTS	CORRESPONDING RICHTER SCALE MAGNITUDE
I	Instrumental	Detected only on seismographs	<4.2
II	Feeble	Some people feel it	<4.2
III	Slight	Felt by people resting; like a truck rumbling by	<4.2
IV	Moderate	Felt by people walking	<4.2
V	Slightly Strong	Sleepers awake; church bells ring	<4.8
VI	Strong	Trees sway; suspended objects swing; objects fall off shelves	<5.4
VII	Very Strong	Mild alarm, walls crack, plaster falls	<6.1
VIII	Destructive	Moving cars uncontrollable, masonry fractures, poorly constructed buildings damaged	<6.9
IX	Ruinous	Some houses collapse, ground cracks, pipes break open	<6.9
X	Disastrous	Ground cracks profusely, many buildings destroyed, liquefaction and landslides widespread	<7.3
XI	Very Disastrous	Most buildings and bridges collapse, roads, railways, pipes and cables destroyed, general triggering of other hazards	<8.1
XII	Catastrophic	Total destruction, trees fall, ground rises and falls in waves	>8.1

Recent earthquakes in Pennsylvania have been measured from IV to VI on the Modified Mercalli Intensity Scale. However, since the worst earthquake recorded in Pennsylvania was a magnitude 5.2, a worst-case scenario for this hazard would be if an earthquake of similar magnitude occurred in or around Bucks County near a populated area.

4.3.2.3. *Past Occurrence*

There have been 12 earthquake epicenters recorded in Bucks County up to the present, listed in Table 4.3.2-3. No earthquakes have occurred in Bucks County since the 2016 HMP Update. 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. These events are listed in Table 4.3.2-4. 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. In recent years, the majority of earthquake epicenters located in counties surrounding Bucks County have been around a magnitude of 2.

Table 4.3.2-3 Earthquake epicenters identified in Bucks County (USGS, 2021a)

MUNICIPALITY	DATE	MAGNITUDE
Bristol Township	12/27/1961	3.3
Upper Southampton Township	3/2/1980	2.8
Ivyland Borough	3/5/1980	3.1
Northampton Township	3/11/1980	2.8
Warwick Township	5/2/1980	3
Langhorne Borough	5/2/1980	2.8
Penndel Borough	5/12/1982	2.4
Perkasie Borough	2/2/1989	Unknown
Milford Township	5/15/1992	1.6
Village of Pineville	3/11/1997	1.6
Bucks County near New Jersey	10/1/2003	2.2
Greater Philadelphia Area (Bucks, Chester, Delaware, Montgomery and Philadelphia Counties)	10/25/2013	1.14

Table 4.3.2-4 Earthquake epicenters identified in counties surrounding Bucks County, 1724-2021 (USGS, 2021a)

COUNTY	DATE	MAGNITUDE
Philadelphia County	Unknown	0.2
Philadelphia County	Unknown	1.7
Montgomery County	Unknown	3.5
Montgomery County	Unknown	3.3
Lehigh County	Unknown	4.3
Lehigh County	Unknown	Unknown
Lehigh County	Unknown	3.1
Lehigh County	Unknown	Unknown
Lehigh County	Unknown	3.3
Philadelphia County	8/16/1724	Unknown
Philadelphia County	4/25/1772	Unknown
Philadelphia County	3/3/1758	Unknown
Philadelphia County	3/17/1800	Unknown
Philadelphia County	12/9/1811	Unknown
Philadelphia County	12/16/1811	Unknown
Philadelphia County	11/29/1800	Unknown
Philadelphia County	11/29/1780	Unknown
Philadelphia County	11/27/1755	Unknown

Table 4.3.2-4 Earthquake epicenters identified in counties surrounding Bucks County, 1724-2021 (USGS, 2021a)

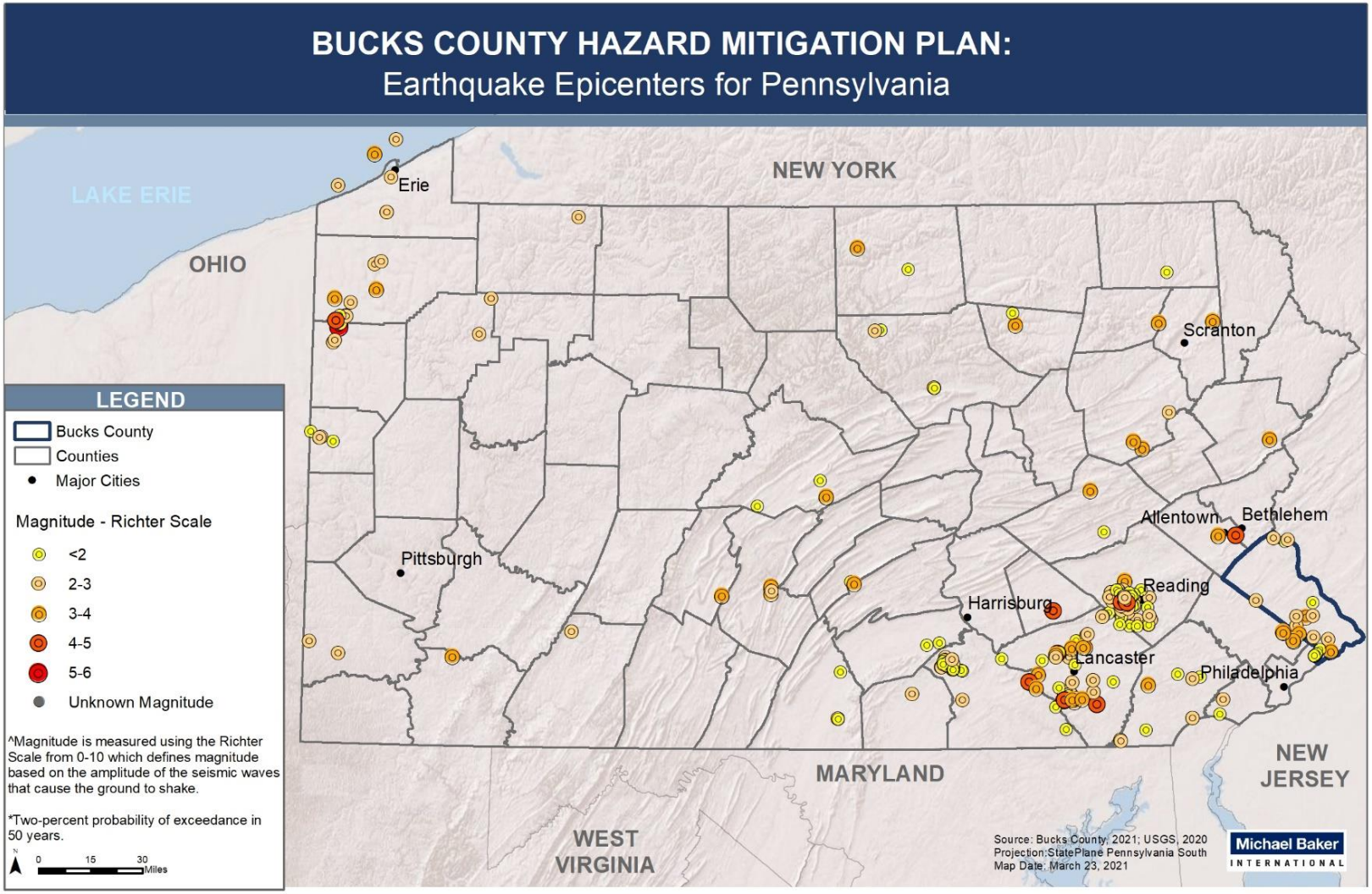
COUNTY	DATE	MAGNITUDE
Philadelphia County	11/22/1777	Unknown
Philadelphia County	11/14/1840	Unknown
Philadelphia County	11/12/1801	Unknown
Philadelphia County	11/11/1840	Unknown
Philadelphia County	10/30/1763	Unknown
Berks County	5/28/1906	Unknown
Berks County	6/9/1937	Unknown
Berks County	1/7/1954	3.2
Berks County	1/7/1954	Unknown
Berks County	1/7/1954	Unknown
Berks County	1/24/1954	Unknown
Berks County	8/11/1954	3.3
Berks County	9/24/1954	Unknown
Berks County	1/20/1955	Unknown
Berks County	6/25/1972	Unknown
Berks County	8/12/1973	Unknown
Montgomery County	3/5/1980	3.5
Montgomery County	3/11/1980	3.7
Berks County	5/10/1993	2.8
Berks County	5/10/1993	2.8
Berks County	5/11/1993	2
Berks County	5/11/1993	2.3
Berks County	5/11/1993	1.6
Berks County	5/11/1993	2.2
Berks County	5/11/1993	2
Berks County	5/11/1993	2.3
Berks County	5/11/1993	1.6
Berks County	5/11/1993	2.2
Berks County	5/13/1993	Unknown
Berks County	5/18/1993	2
Berks County	5/18/1993	2.1
Berks County	5/18/1993	2.1
Berks County	1/8/1994	2.5
Berks County	1/16/1994	4
Berks County	1/16/1994	4.6
Berks County	1/16/1994	2.9
Berks County	1/16/1994	4.2
Berks County	1/16/1994	4.6
Berks County	1/16/1994	2.9

Table 4.3.2-4 Earthquake epicenters identified in counties surrounding Bucks County, 1724-2021 (USGS, 2021a)

COUNTY	DATE	MAGNITUDE
Berks County	1/17/1994	2.7
Berks County	1/17/1994	2.4
Berks County	3/24/1994	2
Berks County	4/16/1994	2.3
Berks County	5/7/1994	2.5
Berks County	5/7/1994	2.5
Berks County	5/31/1994	2.4
Berks County	7/3/1994	2
Berks County	7/3/1994	2.3
Berks County	1/8/1995	2.5
Berks County	4/8/1995	2.6
Berks County	6/4/1995	2.7
Berks County	2/3/1996	2.3
Berks County	7/7/1996	2.3
Berks County	4/18/1999	1.9
Berks County	10/22/1999	1.9
Berks County	11/4/2003	2.7
Berks County	11/4/2003	2.4
Berks County	4/16/2006	1
Berks County	4/16/2006	1.0
Berks County	4/17/2006	1.2
Berks County	12/13/2006	2.5
Berks County	12/13/2006	2.4
Berks County	4/20/2007	2.1
Berks County	4/20/2007	1.6
Berks County	5/15/2007	2.1
Berks County	5/15/2007	2.1
Philadelphia County	5/28/2011	1.7
Philadelphia County	7/6/2011	0.4
Berks County	1/3/2018	0.9
Berks County	9/12/2018	1.9
Berks County	9/12/2018	1.7
Berks County	9/15/2018	1.0
Berks County	12/18/2018	1.3
Berks County	3/18/2019	1.1
Berks County	4/10/2019	1.6
Berks County	4/11/2019	1.0
Berks County	4/20/2019	0.9
Berks County	7/19/2019	2.2

Figure 4.3.2-2 shows earthquake epicenters from 1724 through 2021 in Bucks County and the Commonwealth of Pennsylvania as a whole.

Figure 4.3.2-2 Bucks County and Pennsylvania Seismic Hazard and Earthquake History (USGS 2014 & 2019).



4.3.2.4. *Future Occurrence*

The probability of an earthquake event occurring in Bucks County is very low. Bucks County does not sit on any fault lines; therefore, it is reasonable to believe that the County will not experience earthquake damage anytime soon. The future occurrence of earthquakes can be considered *unlikely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4.1-1).

4.3.2.5. *Vulnerability Assessment*

All structures and infrastructure in Bucks County are equally at risk of experiencing an earthquake. However, in a mild earthquake of the magnitude typically experienced in Pennsylvania, no structural damage is anticipated. In other cases, damages are expected to be limited, and examples of anticipated damages are broken dishes and windows and toppled file cabinets.

However, for earthquakes, the available history covers a period of less than 300 years, which is a relatively short period of time for an examination of earthquakes. Large earthquakes may only affect a location every several centuries or millennia. Environmental impacts of earthquakes can be numerous, widespread and devastating, particularly if indirect impacts are considered. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, avalanches, tsunamis, and dam failure. These secondary events could also result in disruptions to natural ecosystems, poor water quality, damage to vegetation, and the release of toxic materials and sewage. Impacts to infrastructure could include train derailments, pipeline failures, and utility interruptions. A very large earthquake affecting Bucks County might cause structural damage in dilapidated structures or structures that do not meet current building codes. Thus, the impact of an earthquake might range from negligible to catastrophic.

Structures identified as potentially at risk of damage due to an earthquake are older structures. All existing buildings have the potential to experience an earthquake. Given no history of damage in Bucks County due to earthquake, damages are estimated to be limited to the more dilapidated structures and structures with unreinforced masonry. As shown in Table 4.3.2-5, 26,783 homes were built prior to 1940 in Bucks County (US Census, 2019). Additionally, 108,873 (43.4%) homes are at least 50 years old.

Table 4.3.2-5 Year Structure Built in Bucks County (US Census, 2019)

YEAR	NUMBER OF HOMES	PERCENT OF HOMES
1939 or earlier	26,783	10.7%
1940-1949	8,605	3.4%
1950-1959	43,374	17.3%
1960-1969	30,110	12.0%
1970-1979	40,424	16.1%
1980-1989	37,754	15.1%

Table 4.3.2-5 Year Structure Built in Bucks County (US Census, 2019)

YEAR	NUMBER OF HOMES	PERCENT OF HOMES
1990-1999	34,121	13.6%
2000-2009	22,492	9.0%
2010-2013	3,513	1.4%
2014 or later	3,376	1.3%
TOTAL	250,552	

All future structures will also have the potential to experience an earthquake. However, given that new structures must meet current building codes and given the expected magnitude of earthquakes in the County, no property damages are anticipated.

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 85.2° F. In January, the coldest month, the average low in Bucks County is 21.2° F (BestPlaces, 2021).

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

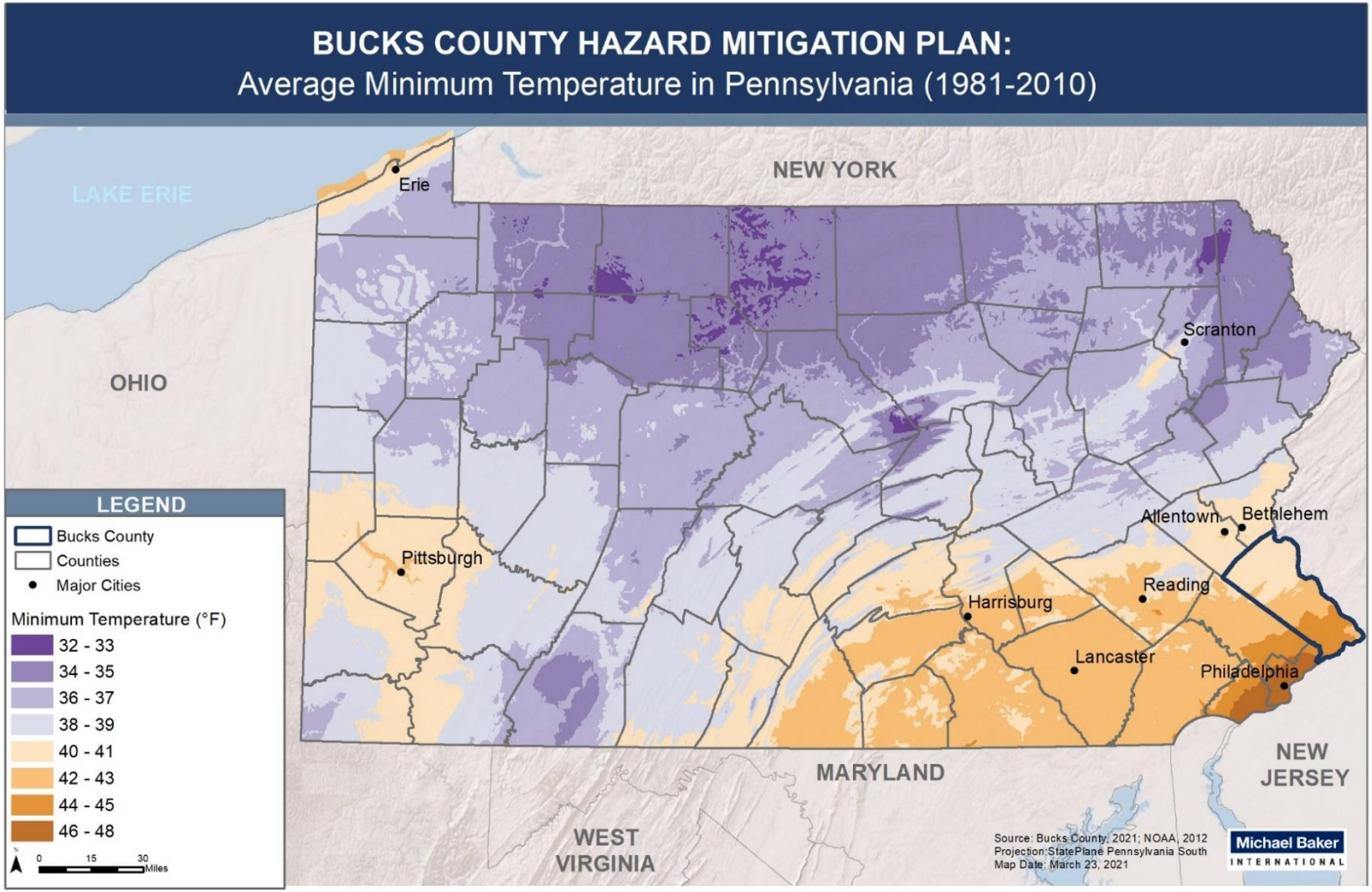
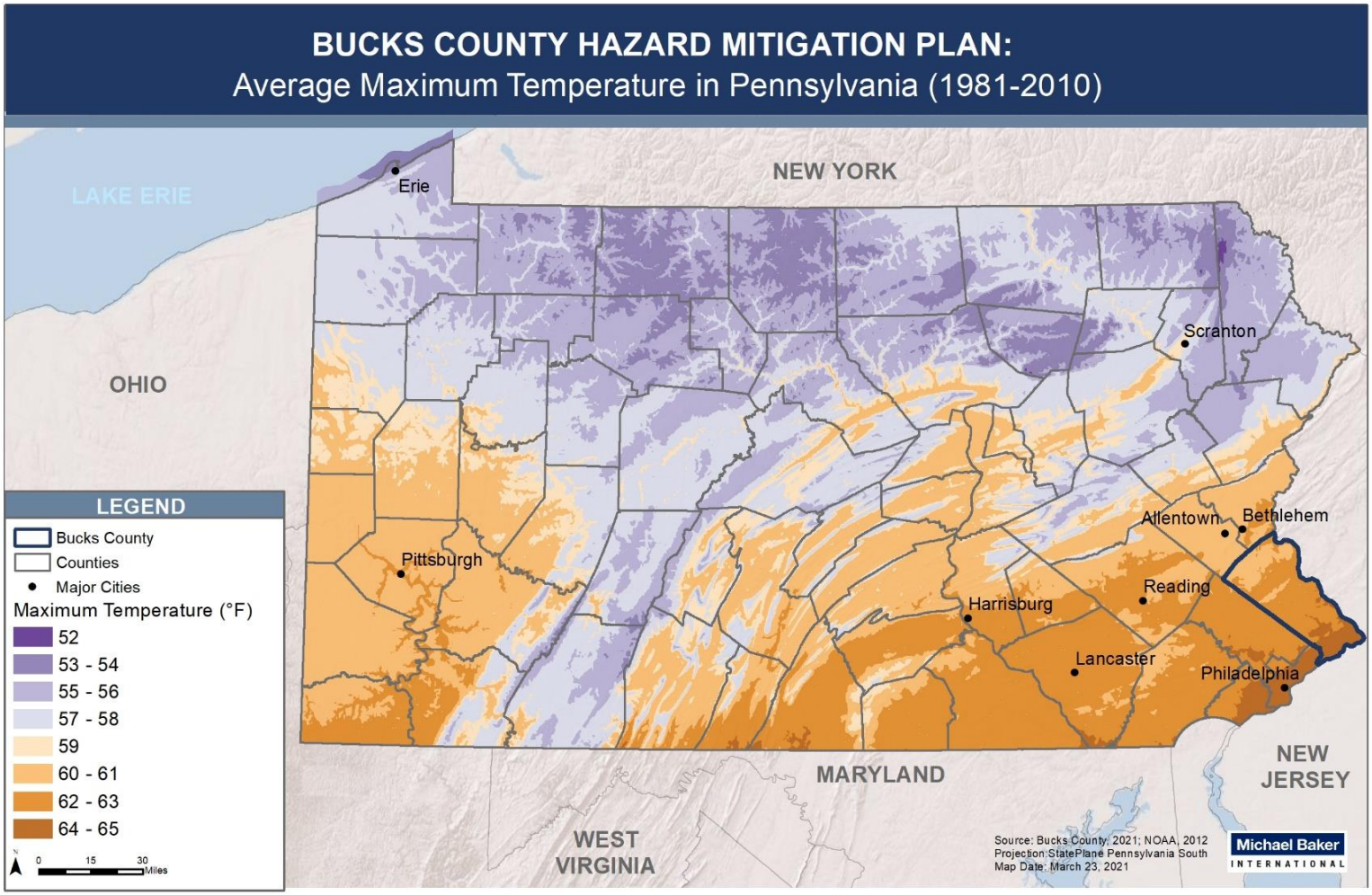


Figure 4.3.3-2 Average Maximum Temperature for Pennsylvania and Bucks County



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. Power failures during extreme heat scenarios can also place residents in danger. The inability to properly cool homes during a heat scenario can make residents more prone to heat stroke and exhaustion.

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, 2021b). 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. Similar 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, 2011a). 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 120,630 persons who are 65 and older (US Census, 2019), this results in 1,210 injuries and 120 deaths from a potential worst-case scenario. Table 4.3.3-1 shows the population over 65 years of age by municipality. 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.

Table 4.3.3-1 Population Over 65 by Municipality

MUNICIPALITY	POPULATION OVER 65	PERCENT OF TOTAL POPULATION
Bedminster Township	1,084	15%
Bensalem Township	9,610	16%
Bridgeton Township	288	26%
Bristol Borough	1,568	16%
Bristol Township	8,014	15%
Buckingham Township	3,964	20%
Chalfont Borough	593	14%
Doylestown Borough	2,398	29%
Doylestown Township	4,054	23%
Dublin Borough	266	12%
Durham Township	247	22%
East Rockhill Township	783	14%
Falls Township	4,557	14%
Haycock Township	497	24%
Hilltown Township	2,448	16%
Hulmeville Borough	110	12%
Ivyland Borough	74	8%
Langhorne Borough	454	27%
Langhorne Manor Borough	250	16%
Lower Makefield Township	5,779	18%
Lower Southampton Township	3,223	17%
Middletown Township	8,342	18%
Milford Township	1,933	19%
Morrisville Borough	1,204	14%
New Britain Borough	440	15%
New Britain Township	2,094	18%
New Hope Borough	664	26%
Newtown Borough	454	23%
Newtown Township	3,476	18%
Nockamixon Township	700	21%
Northampton Township	7,659	20%
Penndel Borough	302	10%
Perkasie Borough	1,261	15%
Plumstead Township	1,777	13%
Quakertown Borough	1,477	17%
Richland Township	2,052	15%
Richlandtown Borough	256	20%

Table 4.3.3-1 Population Over 65 by Municipality

MUNICIPALITY	POPULATION OVER 65	PERCENT OF TOTAL POPULATION
Riegelsville Borough	140	17%
Sellersville Borough	477	11%
Silverdale Borough	111	17%
Solebury Township	2,239	26%
Springfield Township	1,150	23%
Telford Borough	682	32%
Tinicum Township	1,292	33%
Trumbauersville Borough	123	13%
Tullytown Borough	383	18%
Upper Makefield Township	2,241	27%
Upper Southampton Township	3,717	25%
Warminster Township	8,240	25%
Warrington Township	3,847	16%
Warwick Township	2,444	17%
West Rockhill Township	1,304	25%
Wrightstown Township	404	13%
Yardley Borough	572	23%
TOTAL	113,718	18%

4.3.3.3. *Past Occurrence*

Table 4.3.3-1 describes events related to extreme heat and cold in Bucks County between 2000 and October 2020 as reported to the National Centers for Environmental Information Storm Events Database. The complete history of hazard events can be found in Appendix H. 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 4.3.3-2 Recorded Temperature Extremes in Bucks County and surrounding region (NOAA NCEI, 2021)

DATE	EVENT	TEMPERATURE (WIND CHILL)	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
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

Table 4.3.3-2 Recorded Temperature Extremes in Bucks County and surrounding region (NOAA NCEI, 2021)

DATE	EVENT	TEMPERATURE (WIND CHILL)	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
08/26/2001	Excessive Heat	99°F	22	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
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

Table 4.3.3-2 Recorded Temperature Extremes in Bucks County and surrounding region (NOAA NCEI, 2021)

DATE	EVENT	TEMPERATURE (WIND CHILL)	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
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
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

Table 4.3.3-2 Recorded Temperature Extremes in Bucks County and surrounding region (NOAA NCEI, 2021)

DATE	EVENT	TEMPERATURE (WIND CHILL)	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
2/14/2016	Cold/Wind Chill	-4°F	0	0	0	0
7/6/2016	Excessive Heat	95°F	3	0	0	0
7/15/2016	Excessive Heat	95°F	1	0	0	0
8/11/2016	Excessive Heat	92°F	6	0	0	0
6/13/2017	Excessive Heat	99°F	0	7	0	0
7/13/2017	Excessive Heat	101°F	0	0	0	0
7/1/2018	Excessive Heat	110°F	0	0	0	0
7/5/2018	Excessive Heat	110°F	1	0	0	0

Note: Unseasonably warm events were not included in this table, as they have been in previous versions of the plan because these events do not pose life threatening results to living things.

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 4.4.1-1). 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 (NOAA NCEI, 2021).

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 2021 Pennsylvania Climate Impacts Assessment, Pennsylvania is projected to see higher average temperatures over the course of the next several decades. Increasing annual and seasonal average temperatures are currently rated medium risk but are projected to be rated high risk for the mid-century. Across the state, annual average temperatures are projected to increase by about 5.9°F (3.3°C) by mid-century and 9.4°F (5.2°C) by the end-of-century. Some areas of the world may experience greater temperature changes than others. Predictions for smaller areas and shorter time periods become more uncertain (PADEP, 2021c).

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*

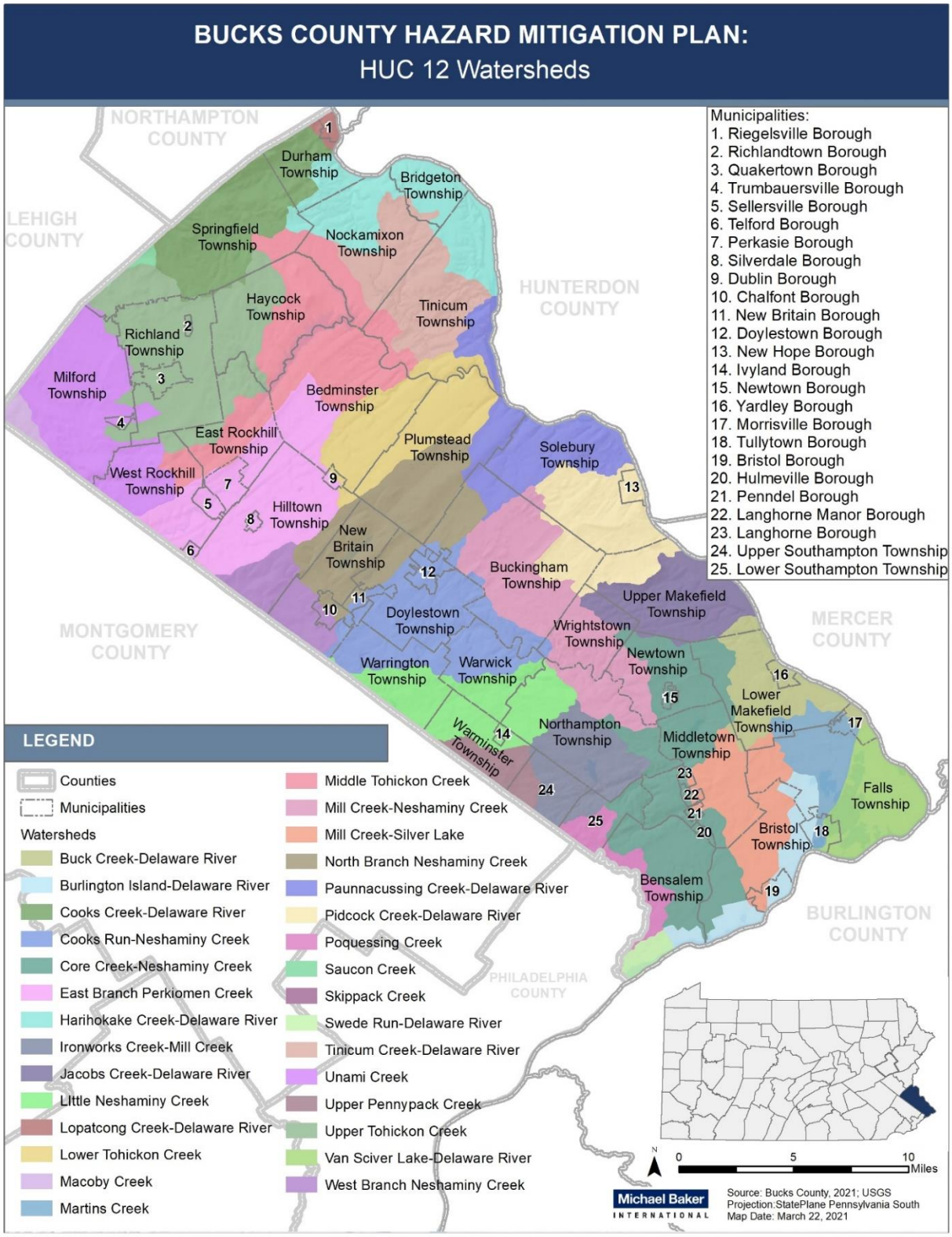
Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all natural hazards in Pennsylvania. Flooding occurs when excess water from snowmelt or rainfall fills a stream, causing it to overflow onto the stream banks and adjacent floodplains. Floodplains are lowlands adjacent to rivers, streams, and creeks that are subject to recurring floods.

Flash flood conditions can result from a large amount of rainfall over a short time span. Though, a small amount of rain can also 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 impervious surfaces such as large parking lots, paved roadways, or other densely developed areas.

Snow melt combined with heavy rains can cause frozen rivers to swell, which can break the ice layer on top of a river. If this occurs, large chunks can float downstream, piling up in narrow passages and near other obstructions such as bridges and dams causing an ice jam.

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.

Figure 4.3.4-1 Bucks County HUC 12 Watershed Map (USGS, 2021b).



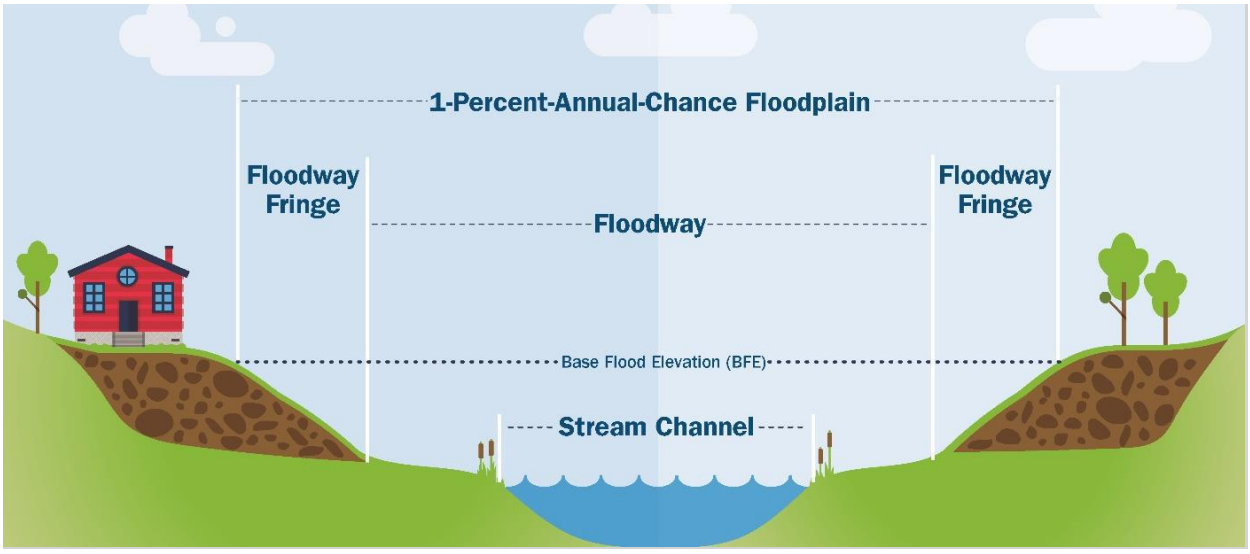
Bucks County manages Act 167 Stormwater Management Plans for nine different watersheds within its boundaries. These identify and prioritize "general" and "detailed" drainage obstructions or flooding problem areas. An obstruction refers to structures of conditions in the flow of water downstream, which, under certain conditions can cause flooding. Problem areas are identified through a variety of issues, including sedimentation, erosion, flooding, landslide, water pollution, Flood Insurance Study (FIS) bridge backwater data, and non-attaining streams. Some plans include obstructions within the problem area count. The number of obstructions and/or problem areas identified throughout the watersheds are listed in Table 4.3.4-1 below. While stormwater problems exist throughout the entire County, the highest concentrations of problem areas were identified in areas with more urbanization. Each problem area includes a photograph of the location of concern, a description of the problem including probable causes if identified, and suggested solutions. Several problems require further investigation to determine optimal solutions and associated costs; these areas are noted accordingly in the plan.

Table 4.3.4-1 Obstructions and Problem Areas identified in Act 167 Stormwater Management Plans in Bucks County

HUC-10 WATERSHED	OBSTRUCTIONS	PROBLEM AREAS	CITATION
Delaware River North Watershed	458	-	Bucks County Planning Commission, 2002a
Delaware River South Watershed	-	423	Bucks County Planning Commission, 2004a
East Branch Perkiomen Creek Watershed	-	101	Bucks County Planning Commission, 2004b
Perkiomen Creek Headwaters	24	23	Lehigh Valley Planning Commission, 2009
Neshaminy Creek Watershed	995	153	Bucks County Planning Commission, 2010
Saucony Creek Headwaters	35	1	Lehigh Valley Planning Commission, 2010
Tohickon Creek Watershed	343	-	Bucks County Planning Commission, 2002b
Pennypack Creek Watershed	300+	-	Temple University Center for Sustainable Communities, 2011
Poquessing Watershed	-	142	Philadelphia Water Department, 2012

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 10-percent-annual chance of occurring in a given year is smaller than the floodplain associated with a flood that has a 0.2-percent-annual chance of occurring. The National Flood Insurance Program (NFIP), for which Flood Insurance Rate Maps (FIRM) are published, identifies the risk associated with the 1-percent-annual chance flood. This 1-percent-annual chance flood event is used to delineate the *Special Flood Hazard Area* (SFHA) and to identify *Base Flood Elevations* (BFE). Figure 4.3.4-2 illustrates these terms. The SFHA serves as the primary regulatory boundary used by FEMA, the Commonwealth of Pennsylvania, and Bucks County local governments when determining risk associated with flooding.

Figure 4.3.4-2 Diagram Identifying Special Flood Hazard Area, 1% Annual Chance (100-Year) Floodplain, Floodway and Flood fringe.



The effective countywide FIRM and Flood Insurance Study (FIS) report were published for Bucks County on March 21, 2017 (FEMA, 2017a; FEMA, 2017b). This remains the most recent flood hazard data, which was used to update this flood hazard profile. The FIRM and FIS for the entire county can be obtained from the FEMA Map Service Center (http://www.msc.fema.gov) and can be used to identify the expected spatial extent and elevation of flooding from a 1-percent and 0.2-percent-annual chance event. All but four municipalities in the County have identified special flood hazard areas (SFHAs). The following municipalities do not have identified SFHAs: Dublin, Ivyland, Richlandtown, and Telford Boroughs (FEMA, 2017b). Figure 4.3.4-3 shows the location of approximate and detailed (include BFEs) SFHAs in Bucks County.

The countywide FIS conducted by FEMA identifies areas of principal flood problems (FEMA, 2017b). The principal flood problems within Bucks County are along Delaware River, Neshaminy Creek, and the streams of Brock, Wilver, and Buck Creeks. Flooding was a yearly occurrence along the Delaware River between 1901-1904 and 1933-1936. Between 1900 and 1955, nineteen major flood events occurred, with multiple flooding events occurring in 1924 and 1936. Late winter and early spring are typically when the Delaware River basin floods, but the four greatest flooding events on record have happened during different seasons of the year, indicating the area is vulnerable to floods year-round. Due to the low topography and vegetation-heavy geography around Delaware River, the floods are wide and deep with high amounts of debris. The August 1955 flood on the Delaware River, the worst flood on record, had a flow of 329,000 cubic feet per second (cfs) at Trenton, New Jersey. The same flooding event on Neshaminy Creek had a peak discharge of 49,300 cfs which was also the highest flow rate ever recorded. The minor streams had minor flooding events for the 1955 flood.

Major storms can cause localized inundation of structures along streams and creeks across the County including:

Countywide

- Delaware River

Lower Bucks

- Anne Creek
- Black Ditch
- Blair Mill Run
- Blair Mill Run Tributary (Tributary 02463 to Blair Mill Run)
- Brock Creek
- Buck Creek
- Chubb Run
- Core Creek
- Croydon Run
- Croydon Tributary
- Hough's Creek Tributary A to Neshaminy Creek
- Poquessing Creek
- Poquessing Creek Tributary No. 2
- Poquessing Creek Tributary No. 3
- Queen Anne Creek (Newportville)
- Rock Run
- Rock Run Tributary East Branch
- Silver Creek No. 1
- Silver Creek No. 2
- Southampton Creek
- Tributary No. 1
- Tributary No. 1 Ironworks Creek Tributary B to Little Neshaminy Creek

Central Bucks

- Aquetong Creek
- Cafferty Run
- Cafferty Run Tributary
- Cooks Run
- Coppernose Run
- Cuttalossa Creek
- Geddes Run
- Geddes Run Tributary
- Tributary 1 to Mill Creek
- Jericho Creek Tributary D to Neshaminy Creek
- Lahaska Creek Tributary No. 1 of Queen Anne Creek
- Paunacussing Creek Tributary No. 1
- Paunacussing Creek Tributary No. 2
- Pidcock Creek
- Pine Run No. 1
- Pine Run No. 2
- Primrose Creek
- Primrose Creek Tributary No. 1
- Rabbit Run
- Railroad Creek
- Robin Run

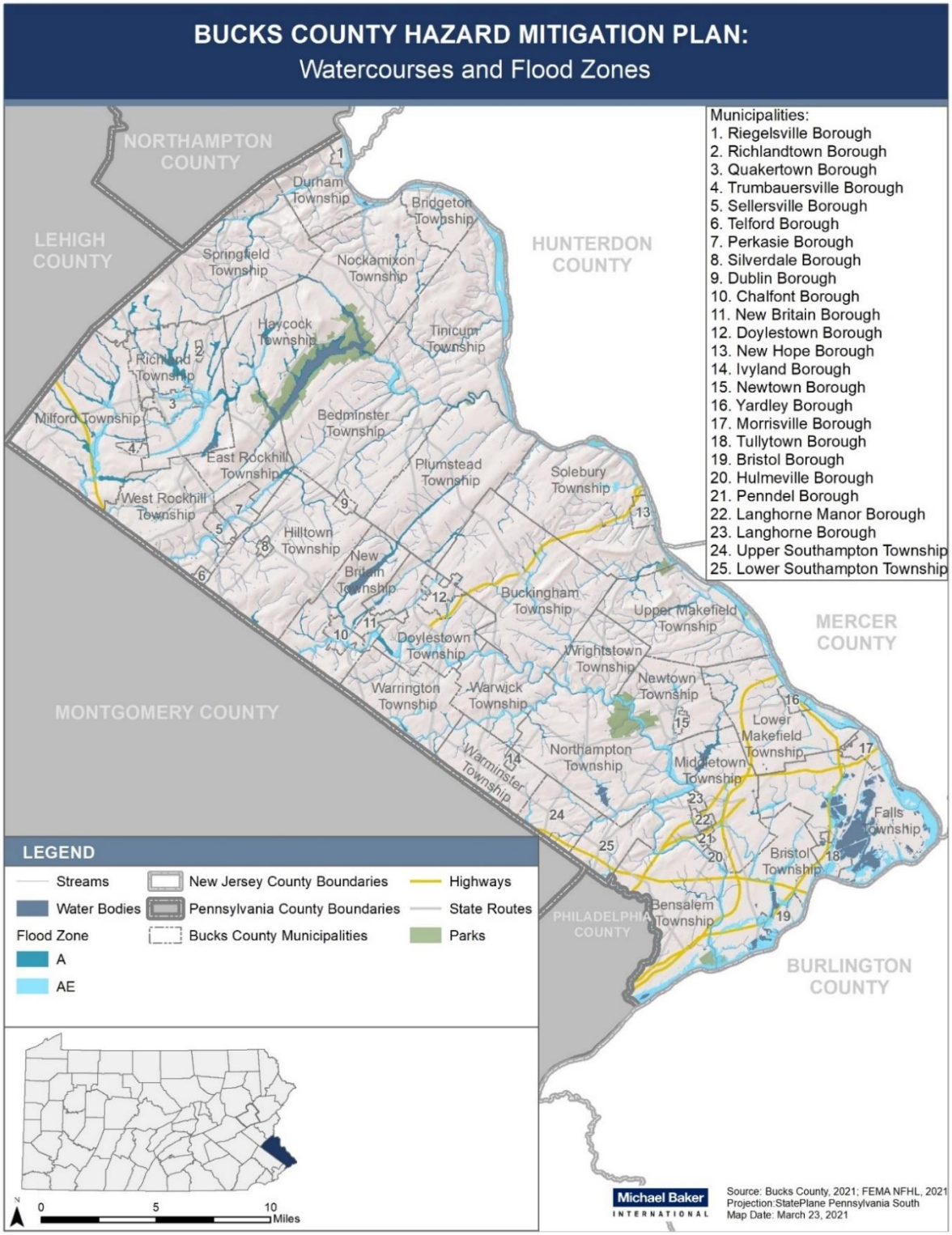
Upper Bucks

- Beaver Run
- Cabin Run
- Cooks Creek

- Deep Run
- Gallows Run
- Gallows Run Tributary No. 2
- Haycock Creek Tributary A to Little Neshaminy Creek
- Kimples Creek Tributary No. 1 of Martins Creek
- Licking Creek Tributary No. 1 to Lahaska Creek
- Perkiomen Creek
- Pleasant Spring Creek
- Ridge Valley Creek
- Three Mile Run
- Tohickon Creek

It should also be noted that flooding is not only caused by heavy rain events. Flooding can also occur from high tides and sea level rise, specifically in the Delaware River area. Additionally, as described in the Dam Failure Hazard Profile (Appendix G), there are 13 state regulated, high-hazard dams located within the County and eight federally owned, high hazard dams in or upstream of the County. If any one of these dams were to fail, there could be loss of life and property damage resulting from flooding within the dam inundation areas. Flood risk is also associated with levee failure. The United States Army Corps of Engineers (USACE) identifies four levee systems in Bucks County through the National Levee Database: Morrisville, North Branch Neshaminy Creek Levee, Rohm and Haas Plant Levee System, and West Branch Neshaminy Creek Levee (USACE, 2021a).

Figure 4.3.4-3 Map Showing the Location of Watercourses and Flood Zones Throughout Bucks County



4.3.4.2. *Range of Magnitude*

Flooding in Bucks County has mainly been caused by heavy rainfall. Some areas have experienced rain events bringing more than three to as many as eight inches of rain to the area within a day. In Bucks County, there are seasonal differences in how floods are caused. In the winter and early spring (February to April), major flooding has occurred from intense rainfall on dense snowpack throughout contributing watersheds, although the snowpack is generally moderate during most winters. 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, as detailed in Section 4.3.6, the County occasionally experiences intense rainfall from tropical storms in late summer and early fall.

Floods are considered hazards when people and properties may be affected. Injuries and deaths can occur when people are swept away by flood currents or bacteria and disease are spread by moving or stagnant floodwaters. 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.

Several factors determine the severity of floods, including rainfall intensity and duration, topography, ground cover and rate of snowmelts. Water runoff is greater in areas with steep slopes and little or no vegetative ground cover. Ditches of roads, valleys of hills, land with natural or man-made low topographical areas, and poor draining soils can all attribute to localized flooding outside of a mapped floodplain. Flooding can also be exacerbated through the process of urbanization. Increased development of impermeable surfaces such as buildings and pavement or lack of appropriately sized flood water detention basins leads to localized flooding. How and when a community was built can also contribute to the severity of a flood event. Flooding may be caused or exacerbated in older communities built prior to stormwater management requirements. Communities where this is the case may want to consider mitigation actions focused on retrofitting and incorporating stormwater management initiatives.

Flooding in Bucks County can be worsened if the flow of water is obstructed in some way such as by an undersized culvert. If undersized culverts trap debris they can create a dam, which would increase flooding in upstream municipalities. Flooding can also be worsened by bridge washouts, like the damages and washouts brought about by Hurricane Floyd in September 1999, or Tropical Storm Allison in June 2001. Strong thunderstorms that bring heavy rain downpours can also wash bridges out, like the August 2003 event that washed out County Line Road bridge in West Rockhill Township. More extensive event narratives can be found in the Structure Collapse (Infrastructure) profile, Section 4.3.15. Both culvert and bridge

washouts can cause damage to transportation infrastructure, making response and recovery actions more difficult.

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 (BCEMA, 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). Although floods can cause damage to property and loss of life, floods are naturally occurring events that benefit riparian systems. Such benefits include groundwater recharge and the introduction of nutrient rich sediment improving soil fertility. However, the destruction of riparian buffers through development, 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.

Dams, levees, and reservoirs act as flood protection measures in Bucks County. There are 137 dams in the County; however, 13 of these are high hazard dams. Please refer to the Dam Failure hazard profile in Appendix G for more information on dams. As previously mentioned, there are four levee systems in the County.

4.3.4.3. *Past Occurrence*

Bucks County has a long history of flooding problems. The Delaware River boarders the southeast edge of the County as well as many streams, creeks, and tributaries. This topography has contributed to numerous major floods and localized flash flooding (FEMA, 2017b). Table 4.3.4.-2 describes events related to flooding and flash floods in Bucks County between 2000 and November 2020 as reported to the National Centers for Environmental Information Storm Events Database. The complete history of hazard events can be found in Appendix H. Estimated property damages include every loss to any type of facility (residential, commercial, agricultural, or industrial) and include structure, content, and crop damages. Not included in this listing or appendix are severe flood events that occurred prior to 1993 as they are not available on the Storm Events Database. Note that property damage values are estimates based on best available information from NCEI's database. "Countywide" indicates several locations in the County were affected.

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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
8/4/2001	Croydon. 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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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
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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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
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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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
9/28/2008	Kintnersville 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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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
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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED 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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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
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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED 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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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
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

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
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
7/6/2015	SELLERSVILLE. Flash Flood - Thunderstorms with very heavy rain caused flash flooding of smaller creeks as well as flooding of roadways in Upper Bucks County from Perkasie east into Nockamixon and Tinicum Townships. Water was crossing roadways in Perkasie. One cooperative weather observer in Perkasie reported 2.05 inches of rain within two hours. Doppler Radar storm total estimates neared 4 inches farther to the east close to Lake Nockamixon.	None Reported
8/21/2015	WAMINSTER. Flash Flood - Thunderstorms with heavy downpours caused flash flooding of roadways and smaller streams in southern Bucks County. Event precipitation totals included 2.61 inches in Penndel, 2.57 inches in Langhorne, 2.55 inches in Richboro, 2.42 inches in Bensalem, and 2.32 inches in Warminster. Much of this rain fell within a very short time period of about one hour.	None Reported
7/8/2016	NEW HOPE. Flash Flood - Several roads closed due to flash flooding with some debris washed into roadways.	None Reported
7/8/2016	WASHINGTON CROSSING. Flash Flood - Several roads were closed due to flash flooding with rocks and debris washing up on to roads.	None Reported
7/25/2016	CORNWELLS HEIGHTS. Flash Flood - An underpass of interstate 95 at Station avenue flooded rapidly. A SEPTA bus became stuck in the flood waters. Water also led to flooding in Cornwall Apartments.	None Reported
7/24/2017	ZION HILL. Flood - A foot of water on the road. A stalled frontal boundary was the focus for several rounds of thunderstorms that produced damaging winds and flooding in spots. Over 8,000 people lost power.	None Reported

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
8/3/2017	WEST BRISTOL. Flood - Several roads with water a foot or so deep in spots. A hot and humid air mass with weak boundaries led to slow moving strong to severe thunderstorms with damaging winds, hail and flooding. A few thousand people lost power.	None Reported
1/15/2018	MORRISVILLE. Flood - Several roads were closed due to minor flooding by an Ice Jam. Minor Flooding occurred along the Delaware River due to an Ice Jam. Flood stage is 20.0 feet and the river was between 19 and 20 feet throughout most of Monday. Lower Makefield township was impacted with a few roads flooded. Roads closed included River, West Trenton, and Richard.	None Reported
4/16/2018	LANGHORNE. Flood - The Neshaminy Creek At Langhorne rose above flood stage of 9.0 feet. The maximum height was 10.29 feet. A strong backdoor cold front moved from northeast to southwest across the area late Saturday afternoon April 15th into Sunday morning April 16th. Not only was there a significant drop in temperature coinciding with the passage of the front, but also a stark difference between high temperatures on Saturday and Sunday. The backdoor front became stationary south of the region then moved northward as a warm front Sunday night into Monday morning. Meanwhile, a strong cold front approached from the west and swept across the area Monday afternoon and evening, along with an attendant area of low pressure. This robust storm system tapped large amounts of moisture, which was lifted along the warm front as overrunning precipitation, and along the cold front as a line of showers and thunderstorms. As a result, heavy rainfall occurred across the region. A widespread 1 to 3 inches of rainfall occurred, with localized amounts over 4 inches. This led to flooding across portions of the area. Along the coast, an extended period of onshore flow occurred, beginning with east-northeast winds Saturday Night, which then shifted to the southeast on Sunday Night into Monday Morning April 16th. By Monday morning and afternoon, tidal flooding made its way up the Delaware River to Philadelphia as a result of the onshore flow.	None Reported

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
5/27/2018	FOUNTAINVILLE. Flash Flood - Numerous roads in Doylestown were flooded and impassable. The Doylestown airport received 3.75 inches of rain in 80 minutes.	None Reported
5/27/2018	LANGHORNE. Flash Flood - The Neshaminy Creek exceeded its flood stage at Langhorne.	None Reported
8/11/2018	SPINNERSTOWN. Flash Flood - Widespread flash flooding occurred in Milford Township. Five water rescues took place and eight individuals were evacuated from their homes. Many roads were closed due to the flooding.	None Reported
9/25/2018	STANWOOD. Flash Flood - Roadway flooding in Bensalem Township. A family was rescued from their vehicle that was trapped in flood waters on Galloway Road.	None Reported
9/25/2018	MORRISVILLE. Flash Flood - A quick 1 to 2 inches of rain fell in parts of far southeastern Pennsylvania during the late afternoon and early evening of September 25. Widespread roadway flooding in Morrisville.	None Reported
11/2/2018	TRUMBAUERSVILLE. Flash Flood - Widespread roadway flooding in Milford Township and in Trumbauersville.	None Reported
5/29/2019	CHURCHVILLE. Flash Flood - Widespread roadway flooding in Warminster Township, Upper Southampton Township and Lower Southampton Township. Many roads became impassable due to the flash flooding.	None Reported
5/29/2019	KEELERSVILLE. Flash Flood - Minor flooding occurred along the East Branch of the Perkiomen Creek at and in the vicinity of the Dublin river gauge.	None Reported
5/29/2019	CORNWELLS HEIGHTS. Flash Flood - Several water rescues took place in Bensalem Township, Bristol Township and Middletown Township.	None Reported
5/29/2019	RUSHLAND. Flash Flood - Moderate flooding occurred along the Neshaminy Creek at and in the vicinity of the Penns Park river gauge.	None Reported
5/29/2019	LEVITTOWN. Flash Flood - The local fire department pulled a male teenager out of the flood swollen Mill Creek in Middletown Township. The individual was kayaking with another male teenage when he fell out of the kayak. The victim was pulled from the creek but later died at Children's Hospital in Philadelphia. A law enforcement official indicated that the creek's high and fast moving water likely contributed to the victims death.	None Reported

Table 4.3.4-2 Flood and Flash Flood Events Impacting Bucks County from 2000-2020 (NOAA NCEI, 2021).

DATE	LOCATION & DESCRIPTION	REPORTED DAMAGE ($)*
6/19/2019	CROYDON. Flash Flood - Several roadways in the Croydon section of Bristol Township were impassable. A few water rescues took place. State Road was damaged by the flood waters.	None Reported
7/6/2019	MECHANICSVILLE. Flash Flood - Heavy rain caused roadway flooding in the Lahaska area. Some roads became impassable.	None Reported
7/11/2019	TELFORD. Flash Flood - A water rescue took place at the intersection of Bethlehem Pike and Cherry Road in Hilltown Township.	None Reported
7/11/2019	PERKASIE. Flash Flood - Moderate flooding occurred along the East Branch of the Perkiomen Creek above Perkasie.	None Reported
7/11/2019	RICHBORO. Flash Flood - Minor flooding occurred along the Neshaminy Creek in the Penns Park area.	None Reported
10/31/2019	ZION HILL. Flash Flood - PA Route 309 was closed in Springfield Township due to flash flooding.	None Reported
7/6/2020	CORNWELLS HEIGHTS. Flash Flood - Three vehicles were submerged in flood waters on Willow Court in Bensalem Township.	None Reported
8/4/2020	KEELERSVILLE. Flash Flood - Major flooding occurred on the East Branch of the Perkiomen Creek in the Dublin and Perkasie area.	None Reported
8/4/2020	RICHBORO. Flash Flood - Moderate flooding occurred along the Neshaminy Creek in the Penns Park and Rushland area.	None Reported
8/7/2020	PERKASIE PENRIDGE AR. Flash Flood - Moderate flooding occurred along the East Branch of the Perkiomen Creek in the Perkasie and Dublin area.	None Reported
8/13/2020	CARVERSVILLE. Flash Flood - Widespread roadway flooding occurred in Buckingham Township. Several roads were closed including Mill Road, Forest Grove Road, Lower Mountain Road, PA Route 413, New Hope Road and Smith Road.	None Reported
8/13/2020	CROSS KEYS. Flash Flood - North Broad Street was closed at Sandy Ridge Drive in Doylestown due to flooding.	None Reported

**Reported damages may be underestimated and do not necessarily reflect total loss.*

The NFIP identifies properties that frequently experience flooding. Floods are the most common and costly natural disaster. 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 loss to flood is to purchase flood insurance through the NFIP.

Since 1983, the primary 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" (i.e. issue) and service the NFIP's Standard Flood Insurance Policy under their own names.

Today, nearly 60 WYO insurance companies issue and service the NFIP under their own names (FEMA, 2021b). Just under 5 million federal flood insurance policies are in force. These policies represent over $1.3 trillion in flood insurance coverage for homeowners, renters, and business owners throughout the United States and its territories. As of April 2021, Pennsylvania had a total of 50,372 policies in force across the commonwealth, 3,508 of which were in Bucks County (FEMA, 2021c).

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. All but four participating municipalities in Bucks County are in the Regular Program. The four municipalities that do not participate in the NFIP – Dublin, Ivyland, Richlandtown, and Telford Boroughs – do not have SFHAs within their jurisdiction.

The minimum floodplain management requirements include:

- Review and permit all development in the Special Flood Hazard Area (SFHA);

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

Table 4.3.4-3 below indicates municipal participation in the NFIP. All municipalities but four in Bucks County are actively participating in the NFIP. One municipality – Trumbauersville Borough – was sanctioned by the NFIP in May 2000. While Trumbauersville Borough currently maintain an active FIRM, they do not actively participate in the NFIP program.

Table 4.3.4-3 Bucks County Municipal Participation in the National Flood Insurance Program (FEMA, 2021d) (FEMA, 2021e).

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	03/21/17
Bridgeton Township	PARTICIPATING	420182	9/30/77	3/16/15
Bristol Borough	PARTICIPATING	420183	12/18/79	3/21/17
Bristol Township	PARTICIPATING	420984	9/29/78	3/21/17
Buckingham Township	PARTICIPATING	420985	3/15/79	3/21/17
Chalfont Borough	PARTICIPATING	420184	12/28/76	3/21/17
Doylestown Borough	PARTICIPATING	421410	6/1/84	3/21/17
Doylestown Township	PARTICIPATING	420185	9/29/78	3/21/17
Dublin Borough	NOT PARTICIPATING	-	-	-
Durham Township	PARTICIPATING	420186	8/15/78	3/16/15
East Rockhill Township	PARTICIPATING	420187	8/1/77	3/16/15
Falls Township	PARTICIPATING	420188	9/30/80	3/21/17
Haycock Township	PARTICIPATING	421127	9/3/80	3/16/15
Hilltown Township	PARTICIPATING	420189	1/30/81	3/21/17
Hulmeville Borough	PARTICIPATING	420190	9/30/77	3/21/17
Ivyland Borough	NOT PARTICIPATING	-	-	-
Langhorne Borough	PARTICIPATING	421074	7/2/80	3/16/15
Langhorne Manor Borough	PARTICIPATING	422336	2/15/84	3/16/15
Lower Makefield Township	PARTICIPATING	420191	9/30/77	3/21/17
Lower Southampton Township	PARTICIPATING	420192	3/15/77	3/21/17

Table 4.3.4-3 Bucks County Municipal Participation in the National Flood Insurance Program (FEMA, 2021d) (FEMA, 2021e).

COMMUNITY	PARTICIPATION STATUS	CID	INITIAL FIRM IDENTIFIED	CURRENT EFFECTIVE MAP DATE
Middletown Township	PARTICIPATING	420193	12/4/79	3/21/17
Milford Township	PARTICIPATING	422337	6/1/82	3/16/15
Morrisville Borough	PARTICIPATING	420194	9/30/77	3/16/15
New Britain Borough	PARTICIPATING	420986	4/2/79	3/21/17
New Britain Township	PARTICIPATING	420987	9/30/77	3/21/17
New Hope Borough	PARTICIPATING	420195	12/15/77	3/16/15
Newtown Borough	PARTICIPATING	420196	12/18/79	3/21/17
Newtown Township	PARTICIPATING	421084	12/18/79	3/21/17
Nockamixon Township	PARTICIPATING	420197	11/2/77	3/16/15
Northampton Township	PARTICIPATING	420988	2/15/80	3/21/17
Penndel Borough	PARTICIPATING	422678	5/18/99	3/16/15
Perkasie Borough	PARTICIPATING	420198	3/1/77	3/16/15
Plumstead Township	PARTICIPATING	420199	9/29/78	3/21/17
Quakertown Borough	PARTICIPATING	420200	7/5/77	3/16/15
Richland Township	PARTICIPATING	421095	6/15/81	3/16/15
Richlandtown Borough	NOT PARTICIPATING	-	-	-
Riegelsville Borough	PARTICIPATING	420201	4/17/78	3/16/15
Sellersville Borough	PARTICIPATING	420203	2/15/78	3/16/15
Silverdale Borough	PARTICIPATING	422338	1/5/84	3/16/15
Solebury Township	PARTICIPATING	420202	4/15/77	3/16/15
Springfield Township	PARTICIPATING	420204	1/3/79	3/16/15
Telford Borough	NOT PARTICIPATING	-	-	-
Tinicum Township	PARTICIPATING	420205	2/1/79	3/16/15
Trumbauersville Borough	SANCTIONED	422681	5/18/99	3/16/15
Tullytown Borough	PARTICIPATING	420206	2/1/80	3/21/17
Upper Makefield Township	PARTICIPATING	420207	10/17/78	3/21/17
Upper Southampton Township	PARTICIPATING	420989	4/3/78	3/21/17
Warminster Township	PARTICIPATING	420990	3/1/78	3/16/15
Warrington Township	PARTICIPATING	420208	9/29/78	3/21/17
Warwick Township	PARTICIPATING	420209	9/29/78	3/16/15
West Rockhill Township	PARTICIPATING	421123	7/5/84	3/16/15
Wrightstown Township	PARTICIPATING	421045	8/15/78	3/21/17
Yardley Borough	PARTICIPATING	420210	8/1/77	3/16/15

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. Four communities in Bucks County are currently participating in the CRS: Lower Makefield Township, Upper Makefield Township, Warwick Township, and Yardley Borough (FEMA, 2020).

Information on NFIP premiums and coverage, prior claims, and substantial damage claims provide additional information on past flood occurrences. Table 4.3.4-4 lists this information for each community in Bucks County.

Table 4.3.4-4 Bucks County NFIP Policies and Claims Information (FEMA, 2021d) (FEMA, 2021f)

COMMUNITY	POLICIES IN FORCE	TOTAL PREMIUM AND COVERAGE	PRIOR CLAIMS	TOTAL AMOUNT OF PAID CLAIMS	SUBSTANTIAL DAMAGE CLAIMS
Bedminster Township	16	$4,539,367.00	7	$53,199	0
Bensalem Township	135	$39,228,103.00	265	$4,397,410	22
Bridgeton Township	75	$16,567,381.00	209	$7,009,292	43
Bristol Borough	180	$55,257,760.00	53	$1,891,196	3
Bristol Township	478	$117,792,977.00	290	$5,434,568	14
Buckingham Township	50	$15,366,438.00	30	$572,281	1
Chalfont Borough	38	$12,031,217.00	11	$162,590	1
Doylestown Borough	30	$10,580,545.00	14	$233,147	0
Doylestown Township	53	$15,921,460.00	36	$199,086	0
Dublin Borough*	-	-	-	-	-
Durham Township	23	$5,821,435.00	77	$2,839,014	10
East Rockhill Township	9	$4,149,164.00	5	$19,279	0
Falls Township	83	$22,510,408.00	108	$951,720	6
Haycock Township	11	$3,409,309.00	10	$159,177	1
Hilltown Township	18	$4,098,746.00	6	$9,554	0
Hulmeville Borough	33	$8,926,323.00	117	$1,834,951	11
Ivyland Borough*	-	-	-	-	-
Langhorne Borough	0	0	68	$1,583,686	12
Langhorne Manor Borough	2	$700,837.00	13	$136,957	2
Lower Makefield Township	295	$90,355,319.00	216	$4,859,080	31
Lower Southampton Township	70	$19,858,104.00	156	$2,364,767	11
Middletown Township	238	$59,857,741.00	272	$5,341,730	46
Milford Township	28	$7,240,367.00	27	$211,490	1
Morrisville Borough	45	$8,947,274.00	17	$142,352	1
New Britain Borough	3	$962,149.00	0	$0	0
New Britain Township	35	$12,593,323.00	10	$199,162	1
New Hope Borough	209	$55,742,998.00	377	$15,306,038	26

Table 4.3.4-4 Bucks County NFIP Policies and Claims Information (FEMA, 2021d) (FEMA, 2021f)

COMMUNITY	POLICIES IN FORCE	TOTAL PREMIUM AND COVERAGE	PRIOR CLAIMS	TOTAL AMOUNT OF PAID CLAIMS	SUBSTANTIAL DAMAGE CLAIMS
Newtown Borough	6	$1,853,579.00	7	$14,882	0
Newtown Township	53	$15,910,675.00	15	$169,656	0
Nockamixon Township	11	$3,179,793.00	21	$892,601	6
Northampton Township	102	$30,956,743.00	99	$1,414,385	4
Penndel Borough	1	350762	0	$0	0
Perkasie Borough	25	$8,366,815.00	31	$1,713,840	1
Plumstead Township	32	$9,204,183.00	69	$2,404,477	11
Quakertown Borough	114	$28,614,217.00	49	$1,684,972	2
Richland Township	32	$8,699,003.00	21	$259,551	0
Richlandtown Borough*	-	-	-	-	-
Riegelsville Borough	67	$14,059,165.00	123	$2,331,312	12
Sellersville Borough	18	$3,969,618.00	72	$1,875,942	8
Silverdale Borough*	-	-	-	-	-
Solebury Township	109	$35,178,289.00	222	$7,670,540	33
Springfield Township	10	$3,736,352.00	28	$538,823	3
Telford Borough*	-	-	-	-	-
Tinicum Township	98	$27,071,222.00	286	$11,499,762	59
Trumbauersville Borough*	-	-	-	-	-
Tullytown Borough	5	$1,486,214.00	2	$6,887	0
Upper Makefield Township	163	$47,820,308.00	340	$13,748,474	74
Upper Southampton Township	70	$20,633,905.00	87	$1,739,841	8
Warminster Township	70	$19,601,122.00	59	$701,777	1
Warrington Township	85	$23,605,708.00	109	$2,119,866	11
Warwick Township	52	$15,992,586.00	20	$319,827	1
West Rockhill Township	9	$2,571,817.00	9	$56,690	0
Wrightstown Township	11	$3,296,842.00	12	$337,420	0
Yardley Borough	182	$45,844,771.00	767	$25,013,316	126
TOTAL	3,482	$964,462,434.00	4,842	$132,426,567	603
*Not identified on the NFIP Policy by State from 5/5/2021					

In addition to the past flood events, the NFIP identifies properties that experience frequent flooding and can be used to determine areas of higher risk. These properties are identified through the NFIP when they receive more than one payment for flood damages. The NFIP defines a Repetitive Loss (RL) property as "any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling ten-year period, since 1978." The RL data provided in Table 4.3.4-5 and throughout the plan represents the NFIP's definition of RL.

Under FEMA's Hazard Mitigation Assistance (HMA), in regard to mitigation grant funding, RL is defined as a structure that:

- Is covered by a contract for flood insurance made available under the NFIP; and
- Has incurred flood-related damage on two occasions, in which the cost of the repair, on the average, equaled or exceeded 25 percent of the market value of the structure at the time of each such flood event; and
- At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage (ICC). (Note: Homes are eligible for ICC coverage after the first loss, however the cost for ICC is part of all policies.)

A Severe Repetitive Loss property is a structure that:

- Is covered under a contract for flood insurance made available under the NFIP; and
- Has incurred flood related damage (i) For which four or more separate claims payments have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or (ii) For which at least two separate claims payments have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

As of March 2021, there are 912 repetitive loss properties and 225 severe repetitive loss properties in Bucks County. Yardley Borough has the most repetitive loss properties (152). Of these 912 repetitive loss structures properties in the County, the most are single family homes (724). Table 4.3.4-5 lists the number of repetitive loss and severe repetitive loss properties by jurisdiction and table 4.3.4-6 lists the properties by type in Bucks County. Data on the specific types of "non-residential" structures could not be obtained, but it is assumed to include primarily, but not limited to, commercial and industrial structures.

Table 4.3.4-5 Total Repetitive Loss and Severe Repetitive Loss Properties in Bucks County. Data from PA RL and SRL Inventory as of March 2021 (PEMA, 2021b).

MUNICIPALITIES	REPETITIVE LOSS PROPERTIES	SEVERE REPETITIVE LOSS PROPERTIES
Bensalem Township	39	10
Bridgeton Township	56	13
Bristol Borough	4	1
Bristol Township	23	2

Table 4.3.4-5 Total Repetitive Loss and Severe Repetitive Loss Properties in Bucks County. Data from PA RL and SRL Inventory as of March 2021 (PEMA, 2021b).

MUNICIPALITIES	REPETITIVE LOSS PROPERTIES	SEVERE REPETITIVE LOSS PROPERTIES
Buckingham Township	1	0
Chalfont Borough	1	0
Doylestown Borough	3	0
Doylestown Township	3	0
Durham Township	17	5
Falls Township	6	2
Haycock Township	1	0
Horsham Township	1	0
Hulmeville Borough	15	3
Hunlock Township	1	0
Langhorne Borough	9	3
Langhorne Manor Borough	2	0
Lower Makefield Township	36	12
Lower Moreland Township	1	0
Lower Southampton Township	20	3
Mercer Township	2	0
Middletown Borough	1	0
Middletown Township	40	13
Milford Township	4	0
Morrisville Borough	1	0
New Britain Township	1	0
New Hope Borough	80	15
Nockamixon Township	4	1
Northampton Township	14	6
Perkasie Borough	4	2
Plumstead Township	11	4
Quakertown Borough	6	0
Richland Township	4	1
Riegelsville Borough	39	0
Sellersville Borough	8	4
Solebury Township	44	13
Southampton Township	1	0
Springfield Township	4	2
Tinicum Township	63	19
Upper Makefield Township	71	29

Table 4.3.4-5 Total Repetitive Loss and Severe Repetitive Loss Properties in Bucks County. Data from PA RL and SRL Inventory as of March 2021 (PEMA, 2021b).

MUNICIPALITIES	REPETITIVE LOSS PROPERTIES	SEVERE REPETITIVE LOSS PROPERTIES
Upper Mt. Bethel Township	1	0
Upper Southampton Township	9	1
Warminster Township	8	1
Warrington Township	13	0
Warwick Township	1	1
West Rockhill Township	3	1
Wrightstown Township	2	0
Yardley Borough	183	59
Grand Total	861	226

Table 4.3.4-6 Total Repetitive Loss and Severe Repetitive Loss Properties in Bucks County by Land Use Type. Data from PA RL and SRL Inventory as of March 2021 (PEMA, 2021b).

MUNICIPALITY	TYPE					TOTAL
	SINGLE FAMILY	2-4 FAMILY	ASSMD CONDO	OTHER RESIDENT	NON-RESIDENT	
Bedminster Township	0	0	0	0	0	0
Bensalem Township	38	3	1	2	9	53
Bridgeton Township	50	2	0	0	4	56
Bristol Borough	3	0	0	0	1	4
Bristol Township	21	0	0	0	5	26
Buckingham Township	2	0	0	0	0	2
Chalfont Borough	1	0	0	0	0	1
Doylestown Borough	3	0	0	0	0	3
Doylestown Township	3	1	0	0	0	4
Dublin Borough	0	0	0	0	0	0
Durham Township	15	1	1	0	1	18

Table 4.3.4-6 Total Repetitive Loss and Severe Repetitive Loss Properties in Bucks County by Land Use Type. Data from PA RL and SRL Inventory as of March 2021 (PEMA, 2021b).

MUNICIPALITY	TYPE					TOTAL
	SINGLE FAMILY	2-4 FAMILY	ASSMD CONDO	OTHER RESIDENT	NON-RESIDENT	
East Rockhill Township	0	0	0	0	0	0
Falls Township	1	0	0	4	1	6
Haycock Township	1	0	0	0	0	1
Hilltown Township	0	0	0	0	0	0
Hulmeville Borough	15	0	2	1	2	20
Ivyland Borough	0	0	0	0	0	0
Langhorne Borough	6	0	1	0	2	9
Langhorne Manor Borough	2	0	0	0	0	2
Lower Makefield Township	39	1	1	0	0	41
Lower Southampton Township	12	0	1	0	7	20
Middletown Township	39	1	0	0	3	43
Milford Township	4	0	0	0	0	4
Morrisville Borough	1	0	0	0	0	1
New Britain Borough	0	0	0	0	0	0
New Britain Township	1	0	0	0	0	1
New Hope Borough	35	6	4	8	31	84
Newtown Borough	0	0	0	0	0	0
Newtown Township	1	0	0	0	0	1
Nockamixon Township	2	0	0	0	2	4
Northampton Township	9	0	1	0	4	14

Table 4.3.4-6 Total Repetitive Loss and Severe Repetitive Loss Properties in Bucks County by Land Use Type. Data from PA RL and SRL Inventory as of March 2021 (PEMA, 2021b).

MUNICIPALITY	TYPE					TOTAL
	SINGLE FAMILY	2-4 FAMILY	ASSMD CONDO	OTHER RESIDENT	NON-RESIDENT	
Penndel Borough	0	0	0	0	0	0
Perkasie Borough	0	0	0	1	3	4
Plumstead Township	11	0	0	0	0	11
Quakertown Borough	4	1	0	0	1	6
Richland Township	2	1	0	0	1	4
Richlandtown Borough	0	0	0	0	0	0
Riegelsville Borough	30	6	0	1	2	39
Sellersville Borough	4	1	1	0	2	8
Silverdale Borough	0	0	0	0	0	0
Solebury Township	36	2	1	0	7	46
Springfield Township	4	0	0	0	0	4
Telford Borough	0	0	0	0	0	0
Tinicum Township	57	2	3	0	2	64
Trumbauersville Borough	0	0	0	0	0	0
Tullytown Borough	0	0	0	0	0	0
Upper Makefield Township	71	0	0	1	0	72
Upper Southampton Township	13	0	0	0	0	13
Warminster Township	8	0	0	0	0	8
Warrington Township	22	0	0	0	1	23
Warwick Township	2	0	0	0	0	2

Table 4.3.4-6 Total Repetitive Loss and Severe Repetitive Loss Properties in Bucks County by Land Use Type. Data from PA RL and SRL Inventory as of March 2021 (PEMA, 2021b).

MUNICIPALITY	TYPE					TOTAL
	SINGLE FAMILY	2-4 FAMILY	ASSMD CONDO	OTHER RESIDENT	NON-RESIDENT	
West Rockhill Township	3	0	0	0	0	3
Wrightstown Township	1	1	0	0	0	2
Yardley Borough	152	14	3	6	10	185
TOTAL	724	43	20	24	101	912

PEMA began tracking mitigated repetitive loss properties for each county up to July 2017, the most recent mitigated property data, Bucks has a total of 102 mitigated properties: 90 single family properties, 2 2-4 family properties, 2 assumed condo properties, and 8 non-residential properties (PEMA, 2019).

4.3.4.4. *Future Occurrence*

In this plan, the term "Special Flood Hazard Area" is used rather than floodplain to clarify that the area under consideration is identified on the FIRM as having at least a 1-percent chance of flooding in any given year. Historically, the area with a 1-percent chance of flooding in any given year has been called the "100-year floodplain" or the "base flood" and the area with a 0.2-percent chance of flooding in any given year has been called the "500-year floodplain." As these terms can be misleading by suggesting that there will be a flood only every 100 or 500 years respectively, they are not used in this plan. The 1- and 0.2 percent-annual-chance-floods are delineated on the Bucks County FIRM. Areas subject to 2 percent- and 10 percent-annual-chance-events are not shown on FIRMs, however, water surface elevations associated with these events are included in the flood source profiles contained in the FIS Report. The most recent FIS for each county in Pennsylvania is available from the FEMA Map Service Center (http://www.msc.fema.gov)

Table 4.3.4-6 lists a range of flood recurrence intervals and associated probabilities of occurrence.

Table 4.3.4-7 Recurrence intervals and associated probabilities of occurrence (USGS, 2021c).

RECURRENCE INTERVAL	CHANCE OF OCCURRENCE IN ANY GIVEN YEAR (%)
10 year	10
50 year	2
100 year	1
500 year	0.2

In Bucks County, flooding occurs commonly and can occur during any season. However, the possibility of flooding is greatly reduced during the winter months. Although most severe floods are attributable to rainfall alone, the spring floods can be compounded by snowmelt and moving ice. The major floods in the late summer and fall are often associated with tropical storms moving up the Atlantic coastline.

As heavy precipitation events often lead to flooding events, changes to precipitation rates due to climate change can be precursors to changes in flood frequency and intensity. According to PEMA, Bucks County experienced a 7-8% increase in precipitation between 1901 and 2016. The trend of increased precipitation (in the form of heavy rainfall) is expected to continue as is a corresponding increase in flood events. The Pennsylvania Climate Impact Assessment predicts that the mean annual precipitation change for the eastern part of the state, including Bucks County, is projected to increase by 10-12% by 2041-2070 (PADEP, 2021a). Additionally, there has been an increase in North Atlantic hurricane activity over the last several decades due to natural variability and climate change which in turn magnifies the intensity of tropical cyclones. This hurricane activity has also been consistently occurring prior to the established hurricane season in the Atlantic. Since 2015 the NHC has identified at least one named storm

each year in May or earlier. These tropical storms often result in flood events in Pennsylvania and Bucks County.

Some increase in the severity and frequency of flooding may also result due to planned or recent development within the floodplains of the various streams, as well as increased intensity and frequency of rain events. Therefore, the future occurrence of floods in Bucks County can be characterized as *highly likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4.1-1).

4.3.4.5. *Vulnerability Assessment*

Flooding can lead to property loss as well as to loss of life. Flooding damages structures, including homes and businesses, vehicles, and infrastructure, including roadways. People who are surrounded by flood waters may at some point require evacuation, placing their lives and the lives of rescuers in danger. Flooding can disrupt the operation of businesses and schools. Recovery from flood damages can be time consuming and costly.

Flood vulnerability is described in terms of what community assets, structures, and infrastructure are situated in locations where flooding is anticipated. For purposes of assessing vulnerability, this plan focuses on those that are located within the SFHA. Please note that while other floods are possible, information about the extent and depths for the flood frequencies likely to be seen in this floodplain are available for all municipalities countywide, thus providing a consistent basis for analysis. Flood vulnerability maps for each applicable local municipality, showing the SFHA, addressable structures, critical facilities, and transportation routes within it, are included in Appendix D. Appendix D is For Official Use Only, and is not publicly available. These maps were created using FEMA Countywide data from the current effective FIRMS.

Table 4.3.4-7 displays the 2018 population estimates per municipality that lives within the SFHA. Bristol Township has the most people living in the SFHA (2,009). Riegelsville Borough has the largest percentage of people living in the SFHA (37%).

Some structures and infrastructure in each jurisdiction with SFHAs are at risk of flood damage. Table 4.3.4-7 also displays the total number of structures and critical facilities located within the SFHA. Approximately 2% of all addressable structures (6,285 structures) in Bucks County are located within the SFHA and are most vulnerable to flood losses. Bristol Township and Quakertown Borough also both have the most structures located in the SFHA (3 facilities in each municipality), and Tullytown Borough also has the highest percentage of structures located in the SFHA (29%) and are therefore most vulnerable to the 1%-annual-chance flood event. Most municipalities in Bucks County have 3% or less of their structures located in the SFHA. Municipalities with more than 3% of their structures in the SFHA are Bristol Borough, Bristol Township, Doylestown Borough, Lower Makefield Township, Morrisville Borough, Quakertown Borough, Richland Township, Sellersville Borough, Springfield

Township,Tullytown Borough, and West Rockhill Township. A complete listing of critical facilities is in Appendix E.

Table 4.3.4-8 shows the number of structures in the SFHA by generalized land use type. Unsurprisingly, most vulnerable structures are residential properties.

In May 2018, there were 3,896 NFIP policies in force. A total of 4,698 claims for flood damages have been made since 1978 for these structures. Cumulative NFIP payments for flood damages have exceeded $128 million (PEMA, 2019).

Historic resources including landmark buildings, historic structures and sites, commercial and residential districts, rural resources, archaeological and cultural sites, and the historic environment can be impacted by disaster events. Historic and cultural resources can have unique vulnerabilities to hazard events. Depending on the resource, vulnerability to certain hazards may be greater and/or less than that of other assets in the County. For example, historic paper documents may not be impacted by an earthquake or severe winter storms, but historic properties have the potential to be more significantly impacted by these events than newer structures constructed to comply with modern building codes and development regulations. Similarly, flooding may have a more significant impact on a historic property than other properties, but there may be less of an impact on historic sites such as monuments or cemeteries.

Table 4.3.4-8 Community Flood Vulnerability for Bucks County (Bucks County GIS, 2021) (US Census, 2019) (FEMA, 2017a).

MUNICIPALITY	TOTAL STRUCTURES IN MUNICIPALITY	STRUCTURES IN SFHA*	PERCENT OF STRUCTURES IN SFHA	TOTAL CRITICAL FACILITIES IN MUNICIPALITY	TOTAL CRITICAL FACILITIES IN SFHA	PERCENT CRITICAL FACILITIES IN SFHA	TOTAL ESTIMATED 2010 POPULATION	POPULATION IN SFHA†	PERCENT POPULATION IN SFHA
Bedminster Township	3,229	35	1%	14	0	0%	4,823	74	2%
Bensalem Township	19,450	402	2%	52	1	2%	58,691	500	1%
Bridgeton Township	782	217	28%	2	0	0%	592	175	30%
Bristol Borough	3,893	289	7%	15	1	7%	10,013	647	6%
Bristol Township	19,543	987	5%	52	3	6%	55,800	2,009	4%
Buckingham Township	8,315	37	0%	21	0	0%	19,708	79	0%
Chalfont Borough	1,674	68	4%	8	0	0%	6,847	176	3%
Doylestown Borough	3,236	43	1%	20	1	5%	10,032	144	1%
Doylestown Township	6,441	58	1%	27	0	0%	14,608	418	3%
Dublin Borough	595	0	0%	4	0	0%	3,681	0	0%
Durham Township	653	66	10%	1	0	0%	810	35	4%
East Rockhill Township	2,429	38	2%	9	0	0%	4,687	76	2%
Falls Township	11,540	88	1%	29	1	3%	34,962	134	0%
Haycock Township	1,227	50	4%	2	0	0%	2,562	50	2%
Hilltown Township	6,265	8	0%	14	0	0%	12,549	10	0%
Hulmeville Borough	392	50	13%	4	0	0%	2,879	236	8%
Ivyland Borough	371	0	0%	4	0	0%	3,004	0	0%
Langhorne Borough	544	0	0%	5	0	0%	2,771	1	0%
Langhorne Manor Borough	345	2	1%	5	0	0%	2,185	7	0%
Lower Makefield Township	13,037	425	3%	22	1	5%	30,449	572	2%
Lower Southampton Township	7,706	103	1%	21	0	0%	22,101	330	1%

Table 4.3.4-8 Community Flood Vulnerability for Bucks County (Bucks County GIS, 2021) (US Census, 2019) (FEMA, 2017a).

MUNICIPALITY	TOTAL STRUCTURES IN MUNICIPALITY	STRUCTURES IN SFHA*	PERCENT OF STRUCTURES IN SFHA	TOTAL CRITICAL FACILITIES IN MUNICIPALITY	TOTAL CRITICAL FACILITIES IN SFHA	PERCENT CRITICAL FACILITIES IN SFHA	TOTAL ESTIMATED 2010 POPULATION	POPULATION IN SFHA†	PERCENT POPULATION IN SFHA
Middletown Township	15,585	351	2%	40	0	0%	42,810	380	1%
Milford Township	4,370	112	3%	16	0	0%	9,245	161	2%
Morrisville Borough	3,134	101	3%	11	1	9%	7,517	174	2%
New Britain Borough	1,145	9	1%	5	0	0%	4,804	25	1%
New Britain Township	4,755	31	1%	18	0	0%	6,910	25	0%
New Hope Borough	1,385	278	20%	6	0	0%	3,197	430	13%
Newtown Borough	1,026	1	0%	6	0	0%	1,426	0	0%
Newtown Township	8,258	26	0%	28	0	0%	22,207	45	0%
Nockamixon Township	1,812	67	4%	10	0	0%	3,588	96	3%
Northampton Township	14,767	99	1%	29	0	0%	34,518	125	0%
Penndel Borough	719	1	0%	5	0	0%	2,734	100	4%
Perkasie Borough	3,381	36	1%	10	0	0%	9,274	110	1%
Plumstead Township	5,789	62	1%	18	0	0%	10,987	115	1%
Quakertown Borough	3,163	299	9%	17	3	18%	11,701	921	8%
Richland Township	6,250	168	3%	10	1	10%	8,055	100	1%
Richlandtown Borough	437	0	0%	3	0	0%	1,587	2	0%
Riegelsville Borough	453	174	38%	3	0	0%	868	317	37%
Sellersville Borough	1,887	39	2%	7	1	14%	4,103	98	2%
Silverdale Borough	336	0	0%	3	0	0%	2,267	0	0%
Solebury Township	4,297	153	4%	13	0	0%	6,379	170	3%
Springfield Township	2,696	42	2%	9	1	11%	5,138	68	1%
Telford Borough	676	0	0%	2	0	0%	3,219	0	0%

Table 4.3.4-8 Community Flood Vulnerability for Bucks County (Bucks County GIS, 2021) (US Census, 2019) (FEMA, 2017a).

MUNICIPALITY	TOTAL STRUCTURES IN MUNICIPALITY	STRUCTURES IN SFHA*	PERCENT OF STRUCTURES IN SFHA	TOTAL CRITICAL FACILITIES IN MUNICIPALITY	TOTAL CRITICAL FACILITIES IN SFHA	PERCENT CRITICAL FACILITIES IN SFHA	TOTAL ESTIMATED 2010 POPULATION	POPULATION IN SFHA†	PERCENT POPULATION IN SFHA
Tinicum Township	2,345	314	13%	11	0	0%	4,296	224	5%
Trumbauersville Borough	374	1	0%	4	0	0%	2,132	20	1%
Tullytown Borough	794	38	5%	7	2	29%	3,086	52	2%
Upper Makefield Township	3,748	258	7%	7	0	0%	6,723	346	5%
Upper Southampton Township	6,149	67	1%	18	0	0%	16,744	511	3%
Warminster Township	11,572	55	0%	31	0	0%	33,083	202	1%
Warrington Township	9,037	67	1%	25	0	0%	24,652	181	1%
Warwick Township	6,167	45	1%	16	0	0%	13,840	81	1%
West Rockhill Township	2,353	23	1%	10	1	10%	7,456	53	1%
Wrightstown Township	1,474	31	2%	9	0	0%	3,716	30	1%
Yardley Borough	1,349	371	28%	7	0	0%	3,233	789	24%
Grand Total	243,350	6,285	3%	743	18	2%	625,249	11,624	2%

** Calculated by overlaying Bucks County GIS structure data and FEMA's SFHA.*

† Calculated by selecting the 2010 Census Block Population that intersect the SFHAs in order to provide an approximation of populations living near the SFHA.

Table 4.3.4-9 Structure and Population Vulnerability to Floods in Bucks County (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Bedminster Township	3,229	1	4	0	0	5	1	0	23	35
Bensalem Township	19,450	16	74	9	2	189	0	0	110	402
Bridgeton Township	782	5	10	0	0	121	0	0	81	217
Bristol Borough	3,893	43	21	8	11	175	0	3	27	289
Bristol Township	19,543	21	84	11	18	642	0	2	203	987
Buckingham Township	8,315	1	3	0	2	13	0	1	17	37
Chalfont Borough	1,674	6	25	1	0	32	0	0	4	68
Doylestown Borough	3,236	17	4	0	0	18	0	0	4	43
Doylestown Township	6,441	6	16	0	3	17	0	0	16	58
Dublin Borough	595	0	0	0	0	0	0	0	0	0
Durham Township	653	2	4	3	0	25	0	0	31	66
East Rockhill Township	2,429	1	22	0	0	9	0	0	5	38
Falls Township	11,540	9	14	2	1	30	0	1	31	88
Haycock Township	1,227	0	23	0	0	10	0	0	16	50
Hilltown Township	6,265	0	6	0	0	0	0	0	2	8
Hulmeville Borough	392	2	11	0	0	29	0	1	7	50
Ivyland Borough	371	0	0	0	0	0	0	0	0	0
Langhorne Borough	544	0	0	0	0	0	0	0	0	0
Langhorne Manor Borough	345	0	2	0	0	0	0	0	0	2
Lower Makefield Township	13,037	1	52	0	3	219	0	2	148	425
Lower Southampton Township	7,706	11	10	9	0	50	0	0	23	103
Middletown Township	15,585	10	71	1	8	153	0	1	107	351
Milford Township	4,370	2	44	0	1	33	0	1	31	112

Table 4.3.4-9 Structure and Population Vulnerability to Floods in Bucks County (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Morrisville Borough	3,134	2	28	1	2	64	0	0	3	101
New Britain Borough	1,145	0	1	1	0	3	0	0	4	9
New Britain Township	4,755	1	14	1	0	6	0	0	9	31
New Hope Borough	1,385	71	13	0	2	156	0	6	30	278
Newtown Borough	1,026	0	1	0	0	0	0	0	0	1
Newtown Township	8,258	3	8	0	0	3	0	2	9	26
Nockamixon Township	1,812	3	16	0	0	7	0	1	36	67
Northampton Township	14,767	7	17	0	10	36	1	0	28	99
Penndel Borough	719	0	0	0	0	0	0	0	1	1
Perkasie Borough	3,381	6	15	1	0	7	0	0	7	36
Plumstead Township	5,789	7	9	0	1	16	0	0	29	62
Quakertown Borough	3,163	23	20	14	7	198	0	0	37	299
Richland Township	6,250	9	30	0	4	48	0	0	77	168
Richlandtown Borough	437	0	0	0	0	0	0	0	0	0
Riegelsville Borough	453	12	7	0	1	109	0	0	45	174
Sellersville Borough	1,887	9	11	0	2	15	0	0	2	39
Silverdale Borough	336	0	0	0	0	0	0	0	0	0
Solebury Township	4,297	10	16	0	5	68	0	2	51	153
Springfield Township	2,696	1	0	0	3	11	0	0	27	42
Telford Borough	676	0	0	0	0	0	0	0	0	0
Tinicum Township	2,345	5	21	0	9	138	0	0	137	314
Trumbauersville Borough	374	0	0	0	0	1	0	0	0	1
Tullytown Borough	794	8	3	4	0	8	0	1	14	38

Table 4.3.4-9 Structure and Population Vulnerability to Floods in Bucks County (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Upper Makefield Township	3,748	3	22	0	1	125	0	0	106	258
Upper Southampton Township	6,149	1	13	1	2	41	0	0	9	67
Warminster Township	11,572	2	13	0	1	36	0	0	3	55
Warrington Township	9,037	4	15	0	0	40	0	2	6	67
Warwick Township	6,167	1	8	0	3	18	2	1	11	45
West Rockhill Township	2,353	0	2	1	1	4	0	2	13	23
Wrightstown Township	1,474	1	5	0	0	11	0	1	13	31
Yardley Borough	1,349	21	8	1	6	252	0	1	81	371
TOTAL	243,350	364	816	69	109	3,191	4	31	1,674	6,285

Table 4.3.4-9 shows the number of manufactured homes located in the SFHA in each municipality. Manufactured homes are more vulnerable to flood risk because they can be washed out if the proper protection measures are not taken. FEMA recommends anchoring or elevation techniques to protect manufactured homes from flood risk. More information for these techniques can be found online: https://www.fema.gov/manufactured-mobile-home. Tinicum Township has the greatest number of manufactured homes in the SFHA (17) as well as the highest percentage of manufactured homes in the SFHA (55%). The remaining municipalities that have manufactured homes in the SFHA have one percent of total manufactured homes located in the SFHA. These are communities are Bensalem Township and Plumstead Township. Overall, there are a total of 30 manufactured homes located in the SFHA in Bucks County, accounting for 1% of the total manufactured homes within the planning area.

Table 4.3.4-10 Manufactured Home Flood Vulnerability in Bucks County (US Census, 2019) (FEMA, 2017a).

MUNICIPALITY	TOTAL MANUFACTURED HOMES	TOTAL MANUFACTURED HOMES IN SFHA	PERCENT MANUFACTURED HOMES IN SFHA
Bedminster Township	8	0	0%
Bensalem Township	748	7	1%
Bridgeton Township	0	0	0%
Bristol Borough	0	0	0%
Bristol Township	0	0	0%
Buckingham Township	635	0	0%
Chalfont Borough	0	0	0%
Doylestown Borough	0	0	0%
Doylestown Township	157	0	0%
Dublin Borough	0	0	0%
Durham Township	0	0	0%
East Rockhill Township	0	0	0%
Falls Township	1,279	4	0%
Haycock Township	0	0	0%
Hilltown Township	114	0	0%
Hulmeville Borough	0	0	0%
Ivyland Borough	0	0	0%
Langhorne Borough	0	0	0%
Langhorne Manor Borough	0	0	0%
Lower Makefield Township	0	0	0%
Lower Southampton Township	329	0	0%
Middletown Township	0	0	0%
Milford Township	34	0	0%
Morrisville Borough	0	0	0%

Table 4.3.4-10 Manufactured Home Flood Vulnerability in Bucks County (US Census, 2019) (FEMA, 2017a).

MUNICIPALITY	TOTAL MANUFACTURED HOMES	TOTAL MANUFACTURED HOMES IN SFHA	PERCENT MANUFACTURED HOMES IN SFHA
New Britain Borough	82	0	0%
New Britain Township	102	0	0%
New Hope Borough	0	0	0%
Newtown Borough	0	0	0%
Newtown Township	0	0	0%
Nockamixon Township	0	0	0%
Northampton Township	0	0	0%
Penndel Borough	0	0	0%
Perkasie Borough	0	0	0%
Plumstead Township	233	2	1%
Quakertown Borough	0	0	0%
Richland Township	416	0	0%
Richlandtown Borough	0	0	0%
Riegelsville Borough	0	0	0%
Sellersville Borough	0	0	0%
Silverdale Borough	0	0	0%
Solebury Township	0	0	0%
Springfield Township	0	0	0%
Telford Borough	0	0	0%
Tinicum Township	31	17	55%
Trumbauersville Borough	0	0	0%
Tullytown Borough	6	0	0%
Upper Makefield Township	0	0	0%
Upper Southampton Township	0	0	0%
Warminster Township	0	0	0%
Warrington Township	0	0	0%
Warwick Township	0	0	0%
West Rockhill Township	98	0	0%
Wrightstown Township	0	0	0%
Yardley Borough	0	0	0%
TOTAL	4,272	30	1%

Bucks County is also vulnerable to flood risk on Toxic Release Inventory facilities. Section 4.3.17 describes Bucks County risk to Hazardous Materials Release in depth.

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, is provided in Section 4.4.3: Potential Loss Estimates.

4.3.4.6. *Flood Vulnerability and Historic Resources*

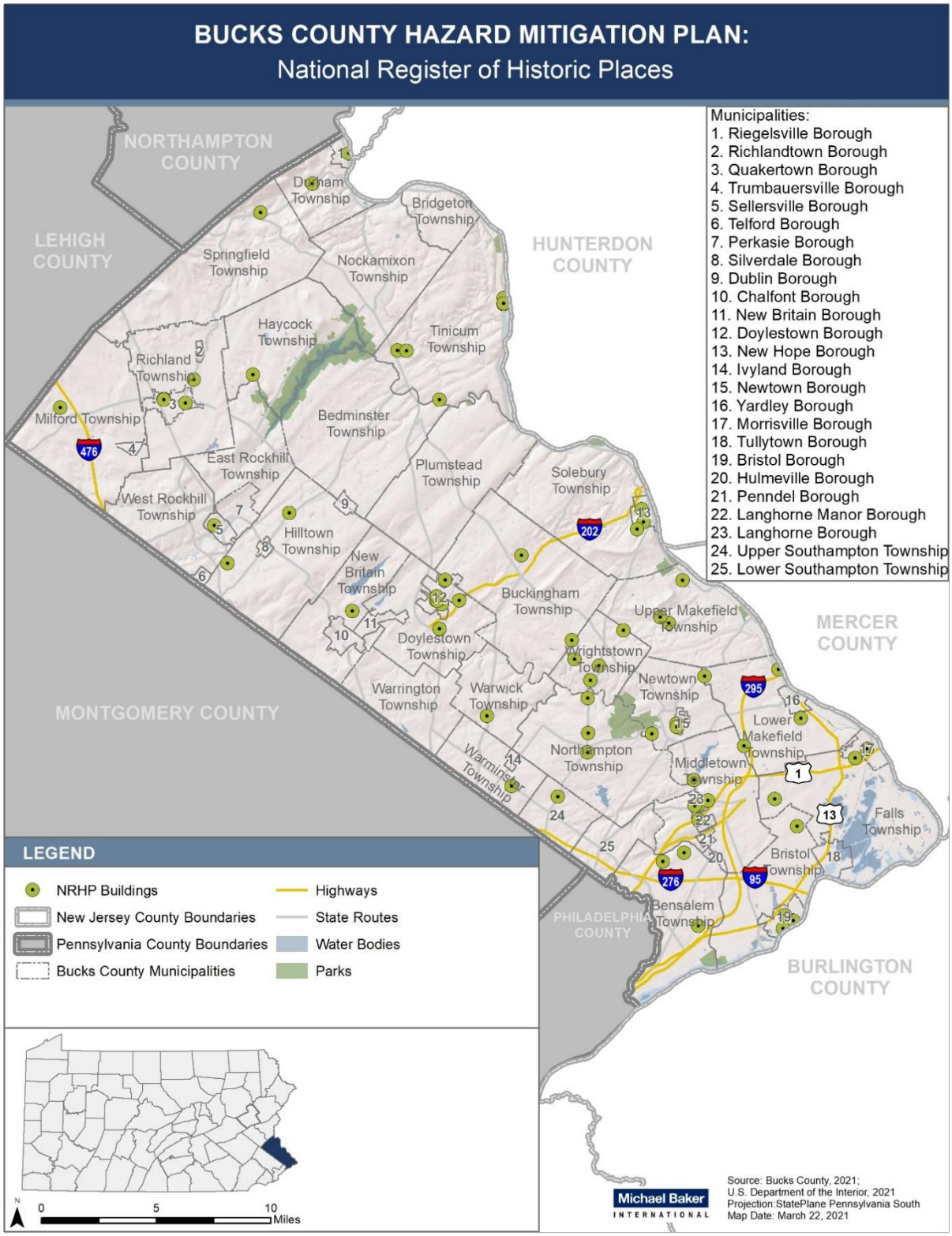
Flood vulnerability is described in terms of what community assets, structures, and infrastructure are situated in locations where flooding is anticipated. For purposes of assessing vulnerability, this plan focuses on assets that are in the Special Flood Hazard Area (SFHA), or the area that would be flooded by a 1-percent-annual-chance flood. This flood frequency was chosen because information about the extent and depth of the 1-percent-annual-chance flood is available for all municipalities countywide, thus providing a consistent basis for analysis.

Bucks County's older and historic places make important contributions to its communities' overall quality of life, economy, and sense of place. In the wake of several disasters in recent years including hurricanes Sandy and Irene and Tropical Storm Lee, the Pennsylvania State Historic Preservation Office (PA SHPO) and the Pennsylvania Emergency Management Agency (PEMA) are encouraging counties to integrate historic preservation considerations into local hazard mitigation plans. By prioritizing historic resources for mitigation, local officials and hazard mitigation planners can help preserve communities' historic built environments—and sense of place—for many years to come.

The Pennsylvania Historical and Museum Commission (PHMC) has been collecting information on historic resources in Pennsylvania for the greater part of a century. According to the PHMC's Cultural Resources Geographic Information System, Bucks County has 19 historic resources listed in the National Register of Historic Places and 371 historic resources that are eligible to be listed (PHMC, 2021a). The National Register of Historic Places is the nation's official list of properties recognized for their significance in American history, architecture, archeology, engineering, and culture. To be eligible, a property typically must be at least 50 years old, retain a high degree of integrity, and have some level of historic significance. To be officially listed, a property must be documented and evaluated according to uniform criteria established by the National Park Service. It is important to note that as of January 2021, the database was moved to "read-only" status, and is no longer updated with new historic resources, archaeological sites, surveys, or reports.

Currently, Bucks County has seven buildings located in the SFHA. Figure 4.3.4-4 shows the location of historic resources while Table 4.3.4-10 lists the number and type of flood-prone historic resources in each municipality. Bedminster Township, Buckingham Township, Haycock Township, Lower Makefield Township, Riegelsville Township, Springfield Township, and Tinicum Township all have one historic building located in their respective SFHA.

Figure 4.3.4-4 Map Showing the Location of Historic Resources in Relation to Water Bodies Throughout Bucks County



Historic districts may be of interest for hazard mitigation as they typically include a cluster of historic resources in a community. Bucks County has many historic districts that overlap with the SFHA. Table 4.3.4-10 provides a list of historic districts and whether they intersect the SFHA.

Table 4.3.4-11 Historic Districts and Their Vulnerability to Flood

HISTORIC DISTRICT NAME	DOES THIS DISTRICT INTERSECT THE SFHA?
Bristol Historic District	Yes
Bristol Industrial Historic District	No
Brownsburg Village Historic District	Yes
Buckmanville Historic District	No
Carversville Historic District	Yes
Center Bridge Historic District	Yes
Chalfont Historic District	Yes
Churchville Historic District	Yes
Cuttalossa Valley Historic District	Yes
Dolington Village Historic District	No
Doylestown Historic District	Yes
Dyerstown Historic District	Yes
Eakin, John, Farm	Yes
Fallsington Historic District	Yes
Fonthill, Mercer Museum and Moravian Pottery and Tile Works	No
Fordhook Farm	No
Forest Grove Historic District	No
Gardenville--North Branch Rural Historic District	Yes
Harriman Historic District	No
Holicong Village Historic District	Yes
Honey Hollow Watershed	Yes
Hulmeville Historic District	Yes
Ivyland Historic District	Yes
Langhorne Historic District	No
Lumberville Historic District	Yes
Mechanicsville Village Historic District	No
New Hope Village District	Yes
Newtown Historic District	Yes
Newtown Historic District (Boundary Increase)	Yes
Newtown Historic District (Boundary Increase: North and South Extensions)	No
Penns Park Historic District	No
Phillips Mill Historic District	Yes
Point Pleasant Historic District	Yes

Table 4.3.4-11 Historic Districts and Their Vulnerability to Flood

HISTORIC DISTRICT NAME	DOES THIS DISTRICT INTERSECT THE SFHA?
Quakertown Historic District	Yes
Ridge Valley Rural Historic District	Yes
Shaw Historic District	No
Spring Valley Historic District	Yes
Springdale Historic District	Yes
Springtown Historic District	Yes
Tyler, George F., Mansion	Yes
Uhlerstown Historic District	Yes
Upper Aquetong Valley Historic District	No
Village of Edgewood Historic District	No
Wycombe Village Historic District	Yes
Yardley Historic District	Yes

After Hurricane Sandy struck Bucks County in October 2012, the Pennsylvania Historical and Museum Commission (PHMC) received $1.5 million in grant funds to support repairs on historic properties that were damaged by Hurricane Sandy. The grant money is supporting the integration of mitigation planning into historic resource survey, the inclusion of historic properties into mitigation planning at both the state and local level, the development of model guidance related to historic properties, the opportunity for grants to property owners or nonprofit organizations to repair National Register eligible or listed historic properties damaged by the hurricane, and the offering of training and education programs related to disasters (PHMC, 2021b).

Table 4.3.4-12 Number of Flood-Prone Historical Resources by Municipality

MUNICIPALITY	BUILDINGS	DISTRICTS	SITES	STRUCTURES	TOTAL
Bedminster Township	1	0	0	0	1
Bensalem Township	0	0	0	0	0
Bridgeton Township	0	0	0	0	0
Bristol Borough	0	1	0	0	0
Bristol Township	0	0	0	0	0
Buckingham Township	1	2	0	0	1
Chalfont Borough	0	1	0	0	0
Doylestown Borough	0	0	0	0	0
Doylestown Township	0	0	0	0	0
Dublin Borough	0	0	0	0	0
Durham Township	0	0	0	0	0

Table 4.3.4-12 Number of Flood-Prone Historical Resources by Municipality

MUNICIPALITY	BUILDINGS	DISTRICTS	SITES	STRUCTURES	TOTAL
East Rockhill Township	0	0	0	0	0
Falls Township	0	0	0	0	0
Haycock Township	1	0	0	0	1
Hilltown Township	0	0	0	0	0
Hulmeville Borough	0	0	0	0	0
Ivyland Borough	0	0	0	0	0
Langhorne Borough	0	0	0	0	0
Langhorne Manor Borough	0	0	0	0	0
Lower Makefield Township	1	0	0	0	1
Lower Southampton Township	0	0	0	0	0
Middletown Township	0	0	0	0	0
Milford Township	0	0	0	0	0
Morrisville Borough	0	0	0	0	0
New Britain Borough	0	0	0	0	0
New Britain Township	0	0	0	0	0
New Hope Borough	0	1	0	0	0
Newtown Borough	0	0	0	0	0
Newtown Township	0	1	0	0	0
Nockamixon Township	0	0	0	0	0
Northampton Township	0	0	0	0	0
Penndel Borough	0	0	0	0	0
Perkasie Borough	0	0	0	0	0
Plumstead Township	0	2	0	0	0
Quakertown Borough	0	0	0	0	0
Richland Township	0	0	0	0	0
Richlandtown Borough	0	0	0	0	0
Riegelsville Borough	1	0	0	0	1
Sellersville Borough	0	0	0	0	0
Silverdale Borough	0	0	0	0	0
Solebury Township	0	3	0	0	0
Springfield Township	1	2	0	0	1
Telford Borough	0	0	0	0	0
Tinicum Township	1	1	0	0	1
Trumbauersville Borough	0	0	0	0	0

Table 4.3.4-12 Number of Flood-Prone Historical Resources by Municipality

MUNICIPALITY	BUILDINGS	DISTRICTS	SITES	STRUCTURES	TOTAL
Tullytown Borough	0	0	0	0	0
Upper Makefield Township	0	1	0	0	0
Upper Southampton Township	0	0	0	0	0
Warminster Township	0	0	0	0	0
Warrington Township	0	0	0	0	0
Warwick Township	0	0	0	0	0
West Rockhill Township	0	0	0	0	0
Wrightstown Township	0	0	0	0	0
Yardley Borough	0	0	0	0	0
Unknown	0	17	0	0	0
TOTAL	7	32	0	0	7

4.3.5. Hailstorm

4.3.5.1. *Location and Extent*

Hailstorm events can occur in all areas of Bucks County. Neither the duration of the storm nor the extent of the area affected by such an occurrence can be predicted. Hail precipitation is often produced at the front of a severe thunderstorm 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 (NOAA NSSL, 2021a).

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; as shown in Table 4.3.5-1. The size of hail is dependent on the strength of the upward air movement along the front of a thunderstorm, called the updraft. Hailstone nuclei are buoyed or lifted by the updraft and increase in size the longer the stone is held aloft. Weaker updrafts create smaller hailstones while strong updrafts provide a longer amount of time for hailstone nuclei to grow in diameter (NOAA NSSL, 2021a). Bucks County has experienced hail ranging in size from 0.75 to 2.00 inches in diameter (NOAA NCEI, 2021).

Table 4.3.5-1 Hailstone Size and Relationship to Updraft Speed (NOAA NSSL, 2021a).

HAILSTONE SIZE	MEASUREMENT (INCHES)	UPDRAFT SPEED (MPH)	ANTICIPATED DAMAGES TO BUILDING COMPONENTS
BB	< 0.25	< 24	Damage Seldom Results
Pea	0.25	24	Damage Seldom Results
Marble	0.50	35	Damage Seldom Results
Dime	0.70	38	Composition Shingles, HVAC coils, Light Gauge Aluminum Vents
Penny	0.75	40	Composition Shingles, HVAC coils, Light Gauge Aluminum Vents
Nickel	0.88	46	Wood Shingles, Single Pane Glass, Aged Skylights, Vegetation
Quarter	1.00	49	PVC Roofs, Aged Wood Shakes, Roof Coatings, EIFS
Half Dollar	1.25	54	Standing Seam Metal Roofs, Copings, Canvas Awnings, Auto Body
Walnut	1.50	60	Smooth Built-up, Modified Bitumen, TPO Roofs, Clay Tile, Slate
Golf Ball	1.75	64	Signage, Medium Gauge Metals
Hen Egg	2.00	69	Un-ballasted EPDM Roofs, Heavy Wood Shakes, Heavy Gauge Metals
Tennis Ball	2.50	77	All Roofs Including Gravel Surfaced Built-Up Roofs

Table 4.3.5-1 Hailstone Size and Relationship to Updraft Speed (NOAA NSSL, 2021a).

HAILSTONE SIZE	MEASUREMENT (INCHES)	UPDRAFT SPEED (MPH)	ANTICIPATED DAMAGES TO BUILDING COMPONENTS
Baseball	2.75	81	All Roofs
Teacup	3.00	84	All Roofs
Grapefruit	4.00	98	All Roofs
Softball	4.50	103	All Roofs

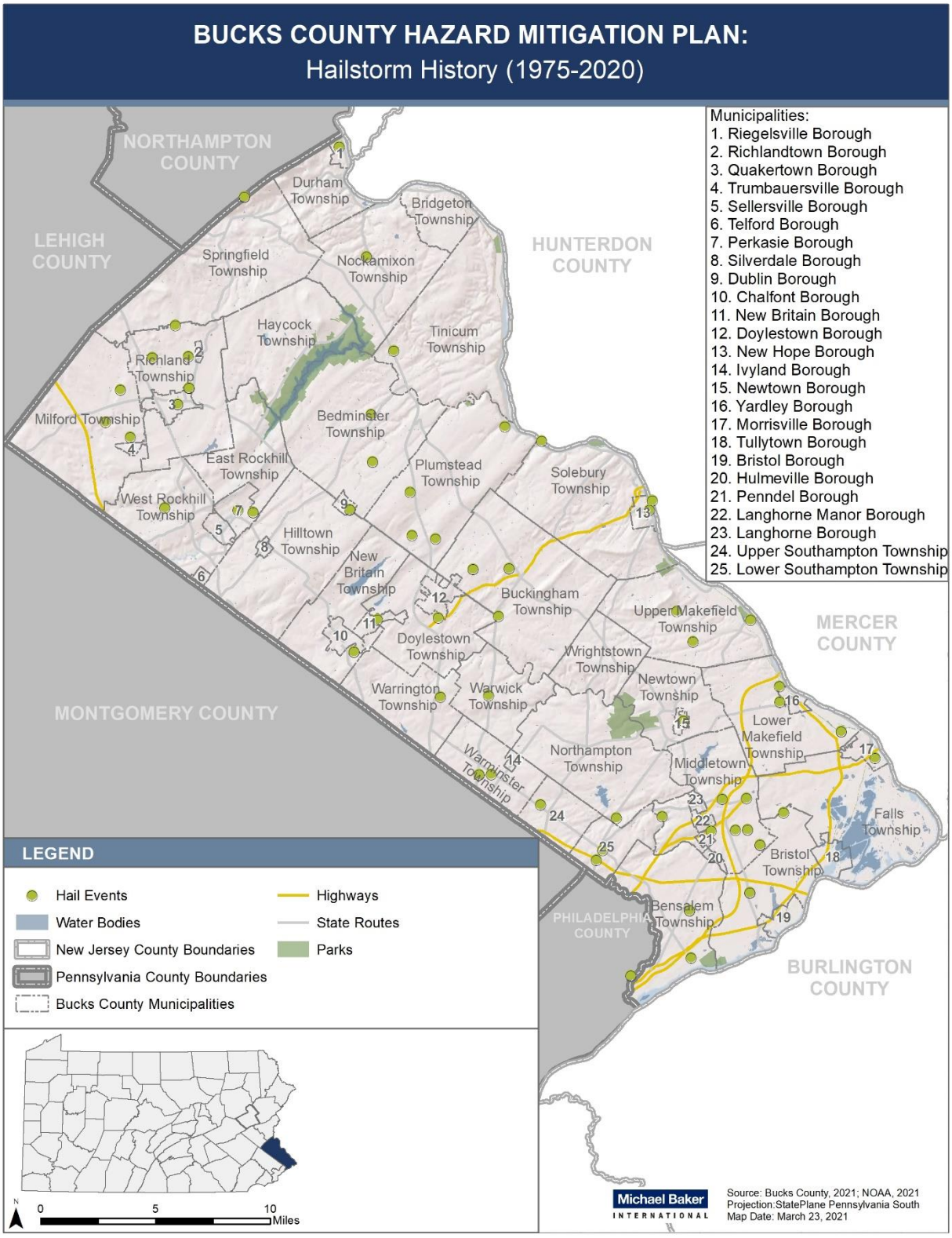
Hailstorms can cause significant damage to crops, livestock and property, depending on the size, duration, and intensity of hail precipitation. Automobiles and aircraft are particularly susceptible to damage. Also, people are at risk for serious injury if they don't seek immediate shelter. Since hail precipitation ususally occurs during thunderstorm events, the impacts of other hazards associated with thunderstorms (i.e. strong winds, intense precipitation, etc.) often occur simultaneously (NOAA NSSL, 2021a).

A potential worst-case scenario of a hailstorm would be if a storm carrying hail of over two inches were to occur over a prolonged period in a predominantly agricultural area. Because hail can cause significant crop damage, a storm of this magnitude would potentially destroy agricultural yeilds and result in significant lost revenue, as well as property damage and injuries.

4.3.5.3. *Past Occurrence*

Figure 4.3.5-1 shows a map of the number of recorded hailstorm events in Bucks County between 1975 and 2020. A hailstorm event is defined as a storm with hail of ¾ inches or greater in diameter. According to PEMA, approximately 96 percent of hailstorm events occurred during the months of April, May, June, July, August, and September. In addition, approximately 87% of historic events occurred during the afternoon or evening. Both results are consistent with the relationship between hail and thunderstorms, which most often occur during late spring, summer, and early fall months.

Figure 4.3.5-1 Number of Hailstorm Events in Bucks County from 1975-2020 (NOAA NCEI, 2021).



NOAA reports 87 hail events in Bucks County from 1950-2020. This includes damage estimates for all hailstorms reported by local field offices. PEMA determined that these events have caused a total of $400,000 in crop damage and no property damage has been reported due to hailstorms in Bucks County. No death or injuries have resulted as a hailstorm in the County during the 1950-2020 time period. Table 4.3.5-2 below provides a snapshot of events from 2000-2020. A full list of hail events from 1950-2020 can be found in Appendix H.

Table 4.3.5-2 Previous Hail Events in Bucks County Between 2000 and 2020 (NOAA NCEI, 2021).

LOCATION	DATE	MAGNITUDE (IN)	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
Quakertown	5/13/2000	2	0	0
Chalfont	5/13/2000	0.88	0	0
Levittown	5/13/2000	0.75	0	0
Chalfont	5/24/2000	0.88	0	0
Levittown	7/16/2000	0.75	0	0
Buckingham Station	5/2/2002	0.75	0	0
Warminster	5/31/2002	0.75	0	0
Southampton	5/31/2002	0.75	0	0
Langhorne	3/21/2003	2	0	0
Doylestown	5/18/2004	0.88	0	0
Milford Square	5/24/2004	1.75	0	0
Pt Pleasant	5/24/2004	1.5	0	0
Springtown	5/24/2004	1	0	0
Warminster	8/11/2004	1	0	0
Buckingham Station	8/4/2005	0.88	0	0
Trevose	6/29/2006	0.75	0	0
Perkasie	8/7/2006	0.75	0	0
Perkasie	8/26/2006	0.75	0	0
Warminster	8/26/2006	1	0	0
Andalusia	6/12/2007	0.88	0	0
Langhorne	6/12/2007	0.88	0	0
Ferndale	8/17/2007	1	0	0
Plumsteadville	5/31/2008	0.75	0	0
Quakertown	3/29/2009	0.88	0	0
Quakertown	6/15/2009	1.75	0	0
Morrisville	7/16/2009	1	0	0
Ferndale	7/26/2009	1.5	0	400,000
Ferndale	5/27/2010	0.75	0	0
Danboro	5/15/2011	1	0	0

Table 4.3.5-2 Previous Hail Events in Bucks County Between 2000 and 2020 (NOAA NCEI, 2021).

LOCATION	DATE	MAGNITUDE (IN)	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
Stoopville	6/1/2011	1	0	0
Perkasie	6/9/2011	0.75	0	0
New Britain	6/9/2011	0.75	0	0
Newtown	8/18/2011	1	0	0
Furlong	8/18/2011	0.75	0	0
Trevose	8/21/2011	0.88	0	0
Chalfont	5/24/2012	1	0	0
Argus	5/24/2012	1	0	0
Quakertown	5/24/2012	0.88	0	0
Dublin	6/29/2012	0.75	0	0
Warrington	7/4/2012	0.75	0	0
New Hope	7/28/2012	0.75	0	0
Washington Crossing	7/28/2012	0.88	0	0
Trumbauersville	6/19/2014	1	0	0
Springtown	8/21/2014	0.75	0	0
Jamison	6/21/2016	1	0	0
Yardley	8/18/2017	0.75	0	0
Quakertown	5/29/2019	1	0	0
California	5/29/2019	2	0	0
Bedminster	5/29/2019	1	0	0
Quakertown	5/29/2019	1.5	0	0
Lumberville	5/29/2019	1.75	0	0
California	5/29/2019	1	0	0
Stanwood Gardens	5/29/2019	1	0	0
Warminster	5/29/2019	0.75	0	0
Stanwood Gardens	5/29/2019	1	0	0
Langhorne Buehl Arpt	7/6/2020	0.75	0	0
Langhorne Manor	7/6/2020	0.88	0	0
Levittown	7/6/2020	1.25	0	0
Fairless Hills	7/6/2020	1	0	0
Levittown	7/6/2020	1.75	0	0
Stanwood Gardens	7/6/2020	1	0	0

Table 4.3.5-2 Previous Hail Events in Bucks County Between 2000 and 2020 (NOAA NCEI, 2021).

LOCATION	DATE	MAGNITUDE (IN)	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
Levittown	7/6/2020	1	0	0
Ottsville	7/6/2020	0.75	0	0
Note that countywide notes the event occurred in multiple locations.				

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 in the County 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. NOAA's Storm Prediction Center illustrates the probability of hail events across the United States estimated over a 30-year period (1982-2011) based on severe weather reports. According to the Storm Prediction Center hail events are most likely to occur in May, June and July with 1% probability of a hail event occurring. Therefore, the future occurrence of hailstorms in Bucks County can be considered *possible* as defined by the Risk Factor methodology probability criteria (See Table 4.4.1-1).

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 (multi-county) area. The area of damage due to these storms is relatively small, in that a single storm does not cause widespread devastation but may cause damage in a focused area of the storm.

As a hazard, damage to crops and vehicles are typically the most significant impacts of hailstorms. 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. However, crops such as corn and soybeans can be damaged to the point of total loss, particularly if an event occurs later in the growing season.

Potential losses from a hailstorm event can be derived from agricultural sales information as reported in the Drought hazard profile, Section 4.3.1. There are 824 farms located in Bucks County. These businesses sold approximately $75,757,000 in agricultural products in 2017, the majority of which came from crop sales, totaling $54,893,000 (72%) (USDA, 2017).

4.3.6. Hurricane, Tropical Storm, Nor'easter

4.3.6.1. *Location and Extent*

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 counterclockwise. Tropical storms impacting Bucks County develop in tropical or sub-tropical waters found in the Atlantic Ocean, Gulf of Mexico, or Caribbean Sea. Cyclones with maximum sustained winds of less than 39 miles per hour 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. 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.

Nor'easters are extra-tropical storms which typically develop from low-pressure centers off the Atlantic Coast during the winter months. Extra-tropical is a term used to describe a hurricane or tropical storm with a cyclone that has lost its 'tropical' characteristics. While an extra-tropical storm denotes a change in weather pattern and how the storm is gathering energy, it may still have northeast winds that are tropical storm or hurricane force. Nor'easters can also produce heavy precipitation in the form of rain, snow, or ice.

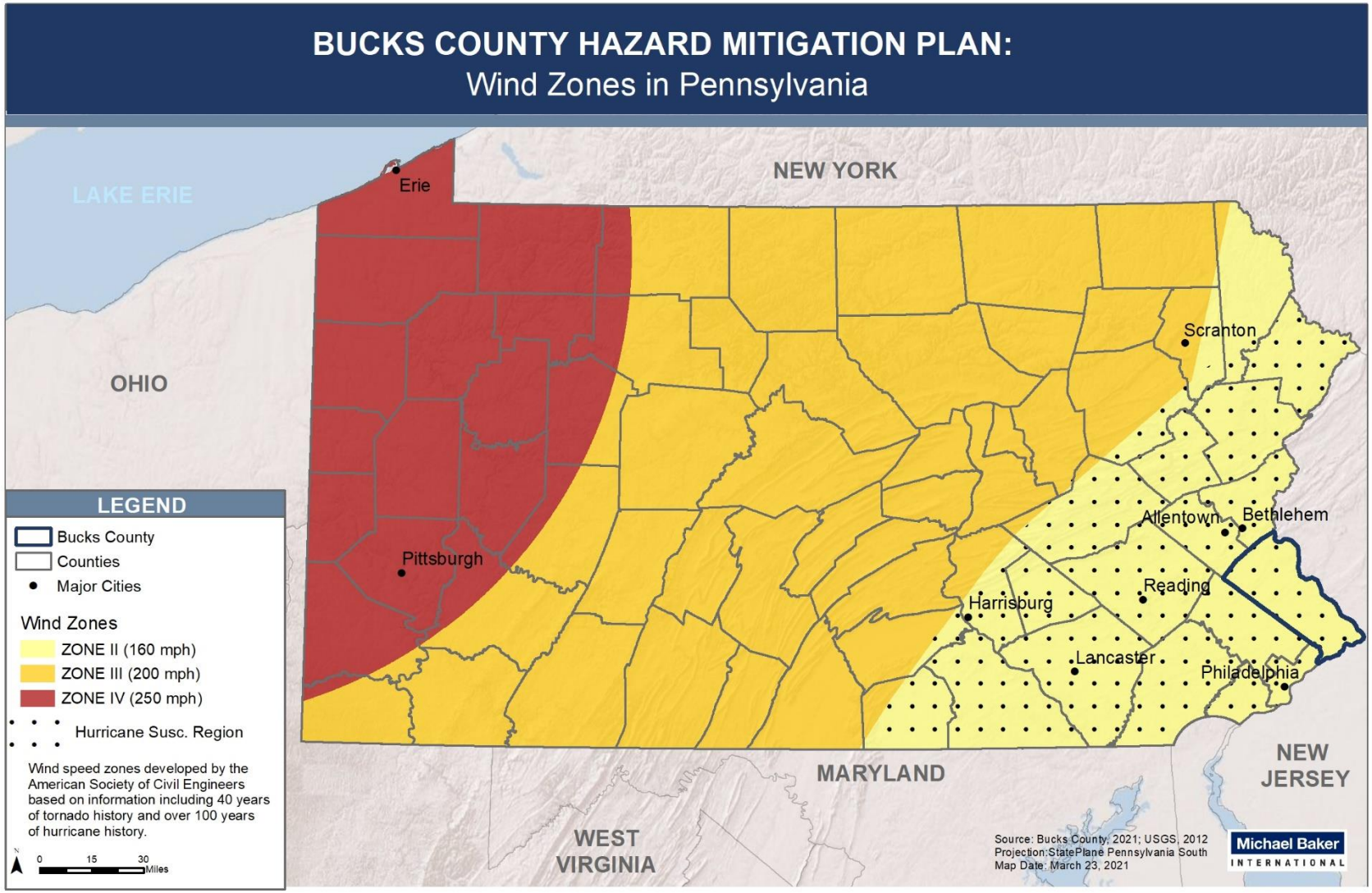
Hurricanes, tropical storms, and nor'easters are regional events that can impact areas as large as hundreds or thousands of miles across through the life the storm. Therefore, all communities within Bucks County are equally subject to the impacts of hurricanes, tropical storms, and nor'easters that track through or near the region. Areas in Bucks County which are subject to flooding, wind, and winter storm damage are particularly vulnerable in these situations.

The map below shows wind speed zones developed by the American Society of Civil Engineers. This information is based on 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 in Zone II which is classified as the 160-mph wind zone. This means design wind speeds for shelters and critical facilities should be able to withstand a three second gust of up to 160 mph, regardless of whether the gust is the result of a tornado, hurricane, tropical storm, or windstorm event. In Bucks County, all new residential and commercial structures are required to be constructed per the International Building Code, which requires structures to be designed to a 90-mph wind speed. Therefore, the impact to future development due to high wind events is expected to be moderate to extreme, depending on the magnitude of

wind speed. Figure 4.3.6-1 also illustrates that Bucks County falls entirely within the identified Hurricane Susceptibility Region.

Figure 4.3.6-1 Design Wind Speeds for Community Shelters Across the United States (FEMA, 2009).



4.3.6.2. *Range of Magnitude*

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 that can lead to damaging floods, and northeast winds, which, when combined with waterlogged soils can cause trees and utility poles to fall. Nor'easters can also bring damaging rain and wind but because they often occur during the winter months, they bring the additional threat of snow and ice associated with winter storms. Heavy snow can cause roof collapse in older homes, and ice presents a threat of slipping and tree branch collapse. More information on the range of magnitude of winter storms can be found in Section 4.3.14.

Tropical cyclones strengths are measured by windspeed; with the most common cause of death being storm surge. Bucks County does have the Delaware River, that may be affected by storm surge in Philadelphia and in the lowest ends of the County (per the MEOW modeling). However, the most frequent cause of extensive damage is wind; which can be anticipated based on 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 are the least common storm event (they comprise only 20 of all tropical cyclones making landfall), they account for the most damage in the United States (over 70 percent of damage). 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, 2021).

STORM CATEGORY	WIND SPEED (mph)	DESCRIPTION OF DAMAGES
1	74-95	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.

Table 4.3.6-1 Saffir-Simpson Scale Categories with Associated Wind Speeds and Damages (NHC, 2021).

STORM CATEGORY	WIND SPEED (mph)	DESCRIPTION OF DAMAGES
3	111-129	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4	130-156	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	>157	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

It is important to recognize the potential for flooding events during hurricanes, tropical storms, and nor'easters; the risk assessment and associated impact for these events is included in 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 manufactured 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.

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*

NOAA'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 30 nautical miles of Bucks County. Typically, when these storms reach Bucks County, they have lost their hurricane speed winds, so structural damage is usually not as bad as coastal communities may experience. 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 Tropical Storm Events with Centers of Circulation Within 30 Nautical Miles of Bucks County (NOAA NCEI, 2021)

YEAR	EVENT	STRENGTH IN / NEAR BUCKS COUNTY
2020	Isaias	Tropical Storm
2020	Fay	Tropical Storm
2012	Sandy	Extratropical Storm
2011	Irene	Tropical Storm
2008	Hanna	Tropical Storm
1996	Bertha	Tropical Storm
1988	Chris	Extratropical Storm
1971	Doria	Tropical Storm
1960	Brenda	Tropical Storm
1955	Diane	Tropical Storm
1952	Able	Tropical Storm
1945	Not Named	Extratropical Storm
1934	Not Named	Extratropical Storm
1929	Not Named	Extratropical Storm
1924	Not Named	Extratropical Storm
1915	Not Named	Tropical Storm
1903	Not Named	Category 1 Hurricane/Tropical Storm
1899	Not Named	Extratropical Storm
1893	Not Named	Tropical Storm
1888	Not Named	Tropical Storm
1874	Not Named	Tropical Storm
1872	Not Named	Tropical Storm
1867	Not Named	Tropical Depression/Extratropical Storm
1866	Not Named	Extratropical Storm
1863	Not Named	Tropical Storm
1861	Not Named	Tropical Storm

Tropical Storm Isaias passed through Bucks County on August 4, 2020. Bringing heavy rain and a confirmed EF2 tornado to the area, Isaias left 100,000 residents and businesses without power, downed trees, flooding, and property damage. The tornado hit Doylestown Hospital where the Children's Village, a preschool and daycare on the grounds of Doylestown Health campus, is located. Part of the roof at Children's Village was torn off while approximately 135

children were inside. Four children and two staff members were slightly injured during the incident. The hospital is considered a critical facility and it sustained minor damage and cars were flipped in its parking lot. The tropical storm brought five to seven inches of rain to Bucks. The lower end of the county saw more of heavy wind damage, and the upper end of the county saw higher amounts of flooding (King, 2020). After the storm, Governor Tom Wolf declared a disaster from Berks to Philadelphia, with counties approved for the U.S. Small Business Administration loans. With the disaster declaration, homeowners, renters, and businesses impacted by the flooding in Berks, Philadelphia, Bucks, Chester, Delaware, Lancaster, Lebanon, Lehigh, Montgomery, and Schuylkill counties became eligible for low-interest disaster loans (PEMA, 2020b).

It is important to note that a number of hurricane, tropical storm, and nor'easter events have impacted the County without tracking through it; these storm events include Tropical Storm Agnes (1972), Hurricane Floyd (1999), Tropical Storm Allison (2001), Tropical Depression Frances (2004), Tropical Depression Ivan (2004), Hurricane Katrina (2005), Hurricane Irene (2011), Tropical Storm Lee (2011), and Hurricane Sandy (2012). Each of these storm events resulted in a Presidential Disaster Declaration. In the last decade, 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.

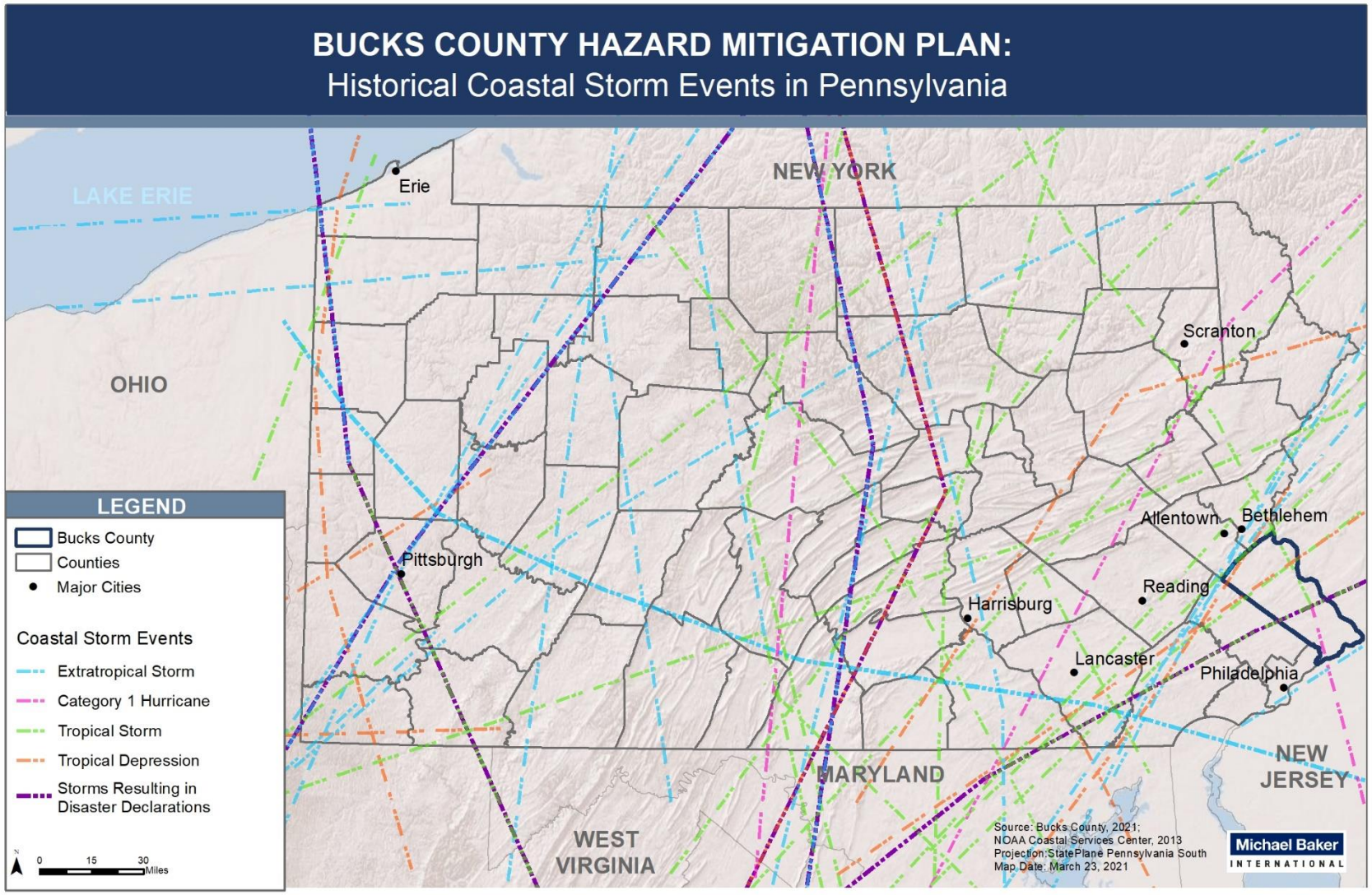
Figure 4.3.6-2 Photos of Hurricane Sandy Aftermath in Bucks County (Bucks County Courier Times, 2013).

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 the tracking the historic coastal storms which have passed through or near Bucks County. 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. The NOAA NCEI database does not track nor'easters as a separate weather event; they are tracked as high wind, heavy snow, and/or coastal flooding events, so a complete listing is not available. However, other sources provide record of nor'easters in the County. For instance, a nor'easter affected much of Pennsylvania and several other states between Washington, D.C. and Boston, Massachusetts from January 6-8, 1996, resulting in Presidential Disaster Declaration 1085. Blizzard conditions included heavy snow, strong winds, and very cold temperatures (NWS, 1996). About a week later, unseasonably high temperatures and rainfall melted the thick snowpack left by the Nor'easter and resulted in Presidential Disaster Declaration 1993 for flooding (NCEI, 2014). More recently, there was a nor'easter that took place on December 16, 2020 and brought a range of 3-6 inches of snow accumulation to Bucks County with an upwards of 8-9 inches of accumulation in the County. The heavy snow combined with high winds left power outages across Bucks County. More broadly, Bucks, Lehigh, and Northampton counties reported a total of 27 crashes and 154 disabled vehicles in a 20-hour timeframe (Blanchard, 2020).

Figure 4.3.6-3 Historical Coastal Storm Events Tracking in or Near Bucks County



4.3.6.4. *Future Occurrence*

Although hurricanes, tropical storms, and nor'easters can cause flood events consistent with 1 percent- and 0.2 percent- level frequency, their probability of occurrence is measured relative to wind speed. The future occurrence of hurricanes, tropical storms, and nor'easters can be considered *possible,* as defined by the Risk Factor Methodology probability criteria (see Table 4.4.1-1). It is difficult to assign a probability to the future occurrence of hurricanes, tropical storms, and nor'easters in Bucks County; however, the storm events are possible in the county.

Climate change can worsen the severity of hurricanes through increased rainfall totals and durations. There has been an increase in North Atlantic hurricane activity over the last several decades due to natural variability and climate change which in turn magnifies the intensity of tropical cyclones.

Although Bucks County is not likely to experience the severe high winds faced in more coastal communities during a nor'easter, the county is subject to heavy snow, ice, and blizzard conditions.

4.3.6.5. *Vulnerability Assessment*

A vulnerability assessment for hurricanes, tropical storms, and nor'easters focuses on the impacts of flooding and severe wind. Therefore, the assessment for flood-related vulnerability is addressed in Section 4.3.4. In addition, mobile/manufactured homes are vulnerable to hurricanes, tropical storms, and nor'easters. Section 4.3.12 discusses vulnerability to wind damage; Table 4.3.12-5 identifies the number of manufactured homes per community. 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*

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, erosion, earthquakes, and changes in groundwater levels. Mudflows, mudslides, rock falls, rockslides, and rock topples are all forms of a landslide. Landslides usually occur in areas of Bucks County with moderate to steep slopes and during high precipitation. 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 geologic instabilities that cause landslides to occur are often exacerbated by highway projects in which the earth is cut, and soil is loosened.

The USGS identifies all of Bucks County as falling into the low incidence and susceptibility zone (Figure 4.3.7-1). The *Low Incidence* zone, meaning that these areas have low susceptibility to landslides with a low incidence of occurrence. The other zones identified on the map are: *Low Incidence/Moderate Susceptibility* zone, meaning that these areas have moderate susceptibility to landslides with a low incidence of occurrence; *Low Incidence/High Susceptibility* zone, meaning that these areas have high susceptibility to landslides with a low incidence of occurrence; *Moderate Incidence* zone, meaning that this area has moderate susceptibility to landslides with a moderate incidence of occurrence; *Moderate Incidence/High Susceptibility* zone, meaning these areas have high susceptibility to landslides with a moderate incidence of occurrence; and *High Incidence* zone, meaning that these areas have high susceptibility to landslides with a high incidence of occurrence.

A slope greater than 7% (approximately around 15 degrees) needs special considerations for building roads according to common engineering practice, and a slope of 15% (approximately around 25 degrees) is generally unstable and highly sensitive to surface changes. Slopes greater than 25% are very unstable. Figure 4.3.7-2 identifies areas of differing slope degrees throughout Bucks County.

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 4.3.7-1 Map of General Landslide Hazard Areas in Bucks County

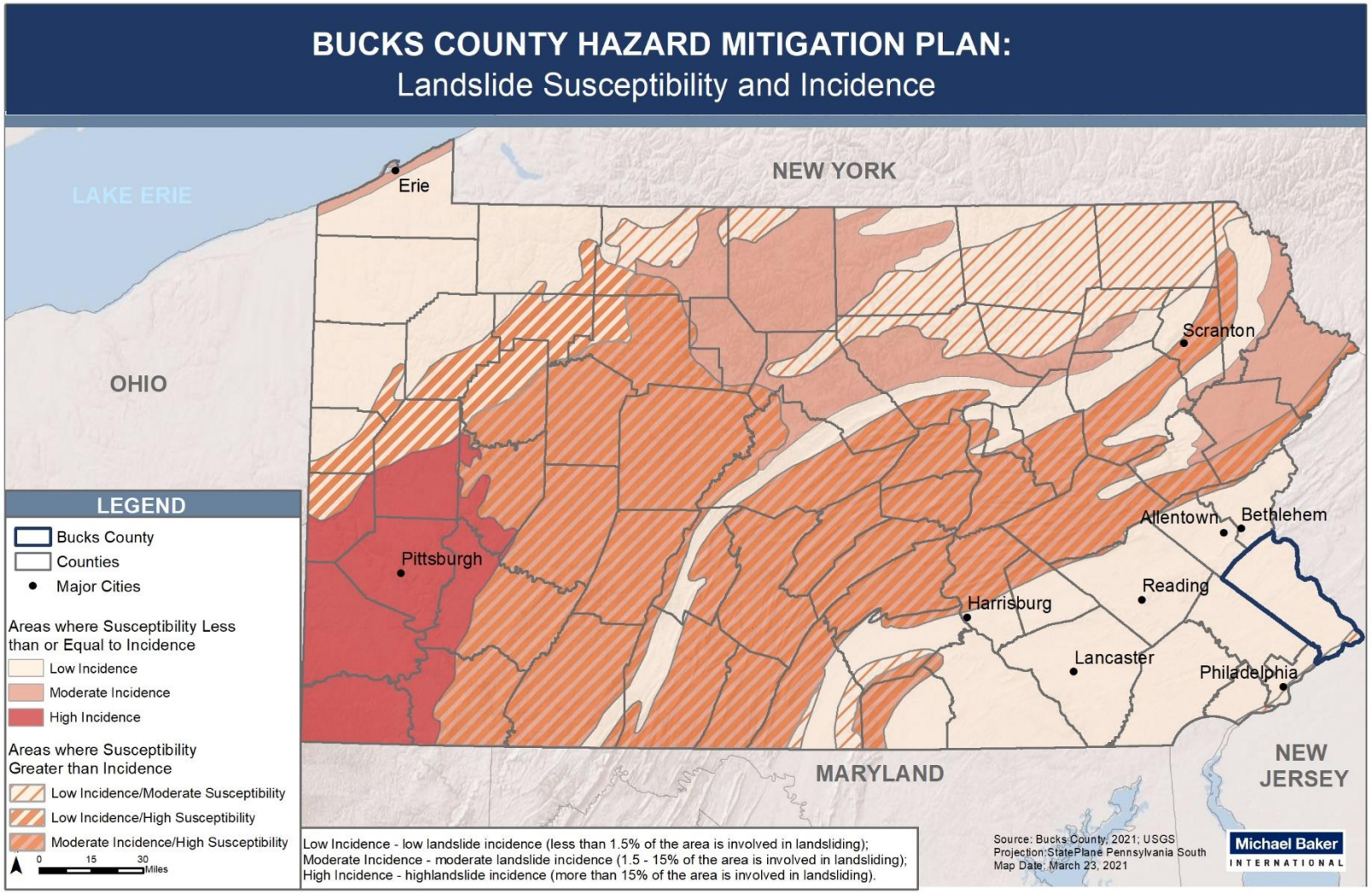
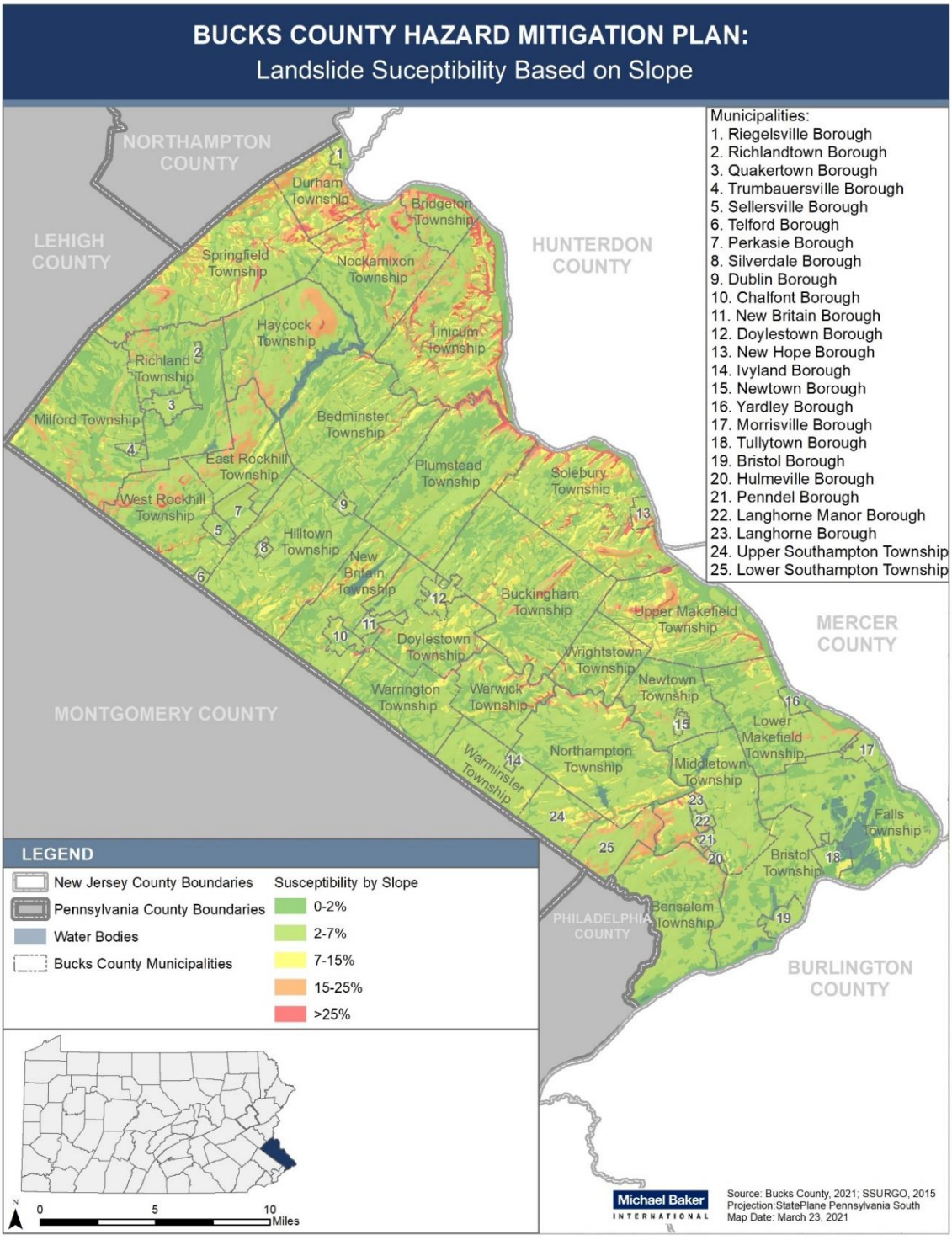


Figure 4.3.7-2 Map of General Landslide Susceptibility Based on Slope in Bucks County Municipalities



4.3.7.2. *Range of Magnitude*

Landslide velocity can vary from rapid to slow, and the amount of material moving in a landslide can range from a relatively small amount to a large amount. Landslides can include falling, sliding, or flowing of rocks and soil or a combination of these different types of motion.

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

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*

A comprehensive inventory of landslides events in Pennsylvania does not exist. The NOAA NCEI database captures landslides as they occur in conjunction with severe storms; the NOAA NCEI database reports several landslides and mudslides in Bucks County. In September 2008, State Route 611 in Durham Township was closed for over 24 hours when flash flooding caused a large mudslide on the highway. The event also caused a man-made rock fall when a 170-year-old stone wall collapsed under the weight of water cascading off steep cliffs that hug the southbound side of River Road. A nearby homeowner saw hundreds of rocks carried into his property by the floodwaters. Flooding in April 2011 caused a mudslide in Plumstead Township, partially blocking the intersection of State Route 32 and Point Pleasant Pike (NOAA NCEI, 2021). Additionally, flash flooding in August 2018 caused a landslide on the Pennsylvania Turnpike's Northeast Extension just North of Quakertown, closing a portion of the road for more than two hours (Salamone, 2018).

Since landslides often occur during periods of heavy rain or snowmelt, it is possible to examine the past occurrence of these events. At least 45 of these events have been recorded by the NOAA NCEI storm events database, listed in Table 4.3.7-1. 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.

Table 4.3.7-1 Heavy Rain and Heavy Snow Events in Bucks County (NOAA NCEI, 2021)

LOCATION	DATE	EVENT TYPE	LOCATION	DATE	EVENT TYPE
Countywide	1/24/1997	Heavy Rain	Countywide	10/10/2002	Heavy Rain
Countywide	5/25/1997	Heavy Rain	Countywide	5/26/2003	Heavy Rain
Countywide	6/1/1997	Heavy Rain	Dublin	6/20/2003	Heavy Rain
Countywide	7/23/1997	Heavy Rain	Telford	8/5/2003	Heavy Rain

Table 4.3.7-1 Heavy Rain and Heavy Snow Events in Bucks County (NOAA NCEI, 2021)

LOCATION	DATE	EVENT TYPE	LOCATION	DATE	EVENT TYPE
Countywide	9/11/1997	Heavy Rain	Countywide	4/13/2004	Heavy Rain
Countywide	12/29/1997	Heavy Rain	Countywide	7/12/2004	Heavy Rain
Countywide	1/23/1998	Heavy Rain	Countywide	3/28/2005	Heavy Rain
Countywide	2/23/1998	Heavy Rain	Countywide	7/8/2005	Heavy Rain
Countywide	3/8/1998	Heavy Rain	Quakertown	11/16/2006	Heavy Rain
Countywide	4/9/1998	Heavy Rain	Bristol	7/18/2007	Heavy Rain
Countywide	10/8/1998	Heavy Rain	Spinnerstown	9/6/2008	Heavy Rain
Countywide	1/3/1999	Heavy Rain	Lower Bucks (Zone)	12/10/2013	Heavy Snow
Springtown	8/13/1999	Heavy Rain	Countywide	1/2/2014	Heavy Snow
Countywide	8/25/1999	Heavy Rain	Countywide	1/21/2014	Heavy Snow
Doylestown	9/9/1999	Heavy Rain	Countywide	2/3/2014	Heavy Snow
Countywide	12/13/1999	Heavy Rain	Lower Bucks (Zone)	2/16/2015	Heavy Snow
Countywide	3/21/2000	Heavy Rain	Countywide	3/5/2015	Heavy Snow
Chalfont	4/21/2000	Heavy Rain	Lower Bucks (Zone)	3/20/2015	Heavy Snow
Countywide	9/14/2000	Heavy Rain	Stanwood, Stoopville, Langhorne	7/8/2016	Heavy Rain
Countywide	11/26/2000	Heavy Rain			
Countywide	3/29/2001	Heavy Rain	Warminster	7/13/2016	Heavy Rain
Countywide	5/26/2001	Heavy Rain	Cross Keys, Furlong	7/31/2016	Heavy Rain
Countywide	6/1/2001	Heavy Rain	Edgely	8/3/2017	Heavy Rain

4.3.7.4. *Future Occurrence*

Given that damage due to landslide in Bucks County has been minimal and more focused on road closures than damage, the future occurrence of landslides can be considered *likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4.1-1). 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 large-scale future landslide events in Bucks County is considered low due to the County's position over the Piedmont Province with the majority of the County over the Gettysburg-Newark Lowland Section, a general topography of rolling lowlands, shallow valleys, and isolated hills (DCNR, 2018). A small portion of Lower Bucks is located over the Piedmont Upland Section, which includes topography of broad, rounded to flat-topped hills and shallow valleys. The south edge of Bucks County is located in the Lowland and Intermediate Upland Section in the Atlantic Coastal Plain Province, which includes topography of flat upper terrace surface cut by shallow valleys. These are geological formations with low to isolated moderate locations of landslide potential.

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.

A landslide might cause a structure to collapse or might cause minor damages such as broken windows. A landslide might cause a roadway to be temporarily blocked. Transportation routes throughout the County located at the base or crest of cliffs should be considered vulnerable to this hazard.

Table 4.3.7-2 details the number of structures and critical facilities in each municipality that are in areas with steep slopes and may, therefore, experience damages should a landslide occur. According to PEMA, Bucks County is not among the top vulnerable Pennsylvania Counties to landslide by numbers of vulnerable people and buildings. There are no vulnerable populations, buildings, or exposed building values that are likely to be impacted by a landslide. However, smaller landslide events could still occur within the planning area. While the occurrence of a massive, devastating landslide is unlikely, the impacts can greatly impact a community.

Lower Southampton Township has the largest number of structures in steep slope areas over 15% (2,301), while Durham Township has the greatest percentage of structures in these areas (29%). This vulnerability assessment also measures the number and percentage of critical facilities in steep slope areas across Bucks County. Bensalem Township has the largest number of critical facilities in steep slope areas over 15% (4). New Hope Borough has the highest percentage of critical facilities (33%) in steep slopes areas of 15%. These municipalities are all more vulnerable to landslide events based on their existing topography and the location of their structures and critical facilities. It is much more likely that a landslide event will occur in a steep slope area over 15%. While all municipalities have some steep slope areas, those with the most structures and critical facilities on this geography are more likely to incur damages from a landslide event.

Table 4.3.7-3 lists 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 4.3.7-2 Landslide Vulnerability for Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES ON SLOPES OVER 15%	PERCENT STRUCTURES ON SLOPES OVER 15%	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES ON SLOPES OVER 15%	PERCENT CRITICAL FACILITIES ON SLOPES OVER 15%
Bedminster Township	3,229	42	1%	14	0	0%

Table 4.3.7-2 Landslide Vulnerability for Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES ON SLOPES OVER 15%	PERCENT STRUCTURES ON SLOPES OVER 15%	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES ON SLOPES OVER 15%	PERCENT CRITICAL FACILITIES ON SLOPES OVER 15%
Bensalem Township	19,450	1,527	8%	52	4	8%
Bridgeton Township	782	88	11%	2	0	0%
Bristol Borough	3,893	0	0%	15	0	0%
Bristol Township	19,543	128	1%	52	1	2%
Buckingham Township	8,315	235	3%	21	1	5%
Chalfont Borough	1,674	14	1%	8	0	0%
Doylestown Borough	3,236	9	0%	20	0	0%
Doylestown Township	6,441	193	3%	27	0	0%
Dublin Borough	595	0	0%	4	0	0%
Durham Township	653	190	29%	1	0	0%
East Rockhill Township	2,429	162	7%	9	0	0%
Falls Township	11,540	0	0%	29	0	0%
Haycock Township	1,227	155	13%	2	0	0%
Hilltown Township	6,265	147	2%	14	0	0%
Hulmeville Borough	392	95	24%	4	0	0%
Ivyland Borough	371	0	0%	4	0	0%
Langhorne Borough	544	26	5%	5	0	0%
Langhorne Manor Borough	345	81	23%	5	0	0%
Lower Makefield Township	13,037	566	4%	22	0	0%
Lower Southampton Township	7,706	2,301	30%	21	1	5%
Middletown Township	15,585	1,351	9%	40	0	0%
Milford Township	4,370	248	6%	16	0	0%

Table 4.3.7-2 Landslide Vulnerability for Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES ON SLOPES OVER 15%	PERCENT STRUCTURES ON SLOPES OVER 15%	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES ON SLOPES OVER 15%	PERCENT CRITICAL FACILITIES ON SLOPES OVER 15%
Morrisville Borough	3,134	20	1%	11	0	0%
New Britain Borough	1,145	0	0%	5	0	0%
New Britain Township	4,755	148	3%	18	0	0%
New Hope Borough	1,385	257	19%	6	2	33%
Newtown Borough	1,026	0	0%	6	0	0%
Newtown Township	8,258	238	3%	28	0	0%
Nockamixon Township	1,812	373	21%	10	0	0%
Northampton Township	14,767	135	1%	29	0	0%
Penndel Borough	719	12	2%	5	0	0%
Perkasie Borough	3,381	5	0%	10	0	0%
Plumstead Township	5,789	293	5%	18	0	0%
Quakertown Borough	3,163	0	0%	17	0	0%
Richland Township	6,250	292	5%	10	0	0%
Richlandtown Borough	437	0	0%	3	0	0%
Riegelsville Borough	453	5	1%	3	0	0%
Sellersville Borough	1,887	0	0%	7	0	0%
Silverdale Borough	336	0	0%	3	0	0%
Solebury Township	4,297	467	11%	13	0	0%
Springfield Township	2,696	349	13%	9	1	11%
Telford Borough	676	0	0%	2	0	0%
Tinicum Township	2,345	383	16%	11	1	8%

Table 4.3.7-2 Landslide Vulnerability for Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES ON SLOPES OVER 15%	PERCENT STRUCTURES ON SLOPES OVER 15%	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES ON SLOPES OVER 15%	PERCENT CRITICAL FACILITIES ON SLOPES OVER 15%
Trumbauersville Borough	374	0	0%	4	0	0%
Tullytown Borough	794	0	0%	7	0	0%
Upper Makefield Township	3,748	277	7%	7	0	0%
Upper Southampton Township	6,149	193	3%	18	0	0%
Warminster Township	11,572	29	0%	31	0	0%
Warrington Township	9,037	4	0%	25	0	0%
Warwick Township	6,167	96	2%	16	1	6%
West Rockhill Township	2,353	171	7%	10	0	0%
Wrightstown Township	1,474	42	3%	7	1	14%
Yardley Borough	1,349	0	0%	7	0	0%
TOTAL	243,350	11,347	5%	743	13	2%

Table 4.3.7-3 Structures in Landslide Zone by Land Use Type per Municipality for Bucks County (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Bedminster Township	3,229	0	1	0	0	28	0	0	12	42
Bensalem Township	19,450	21	45	1	20	1261	0	0	179	1527
Bridgeton Township	782	1	6	0	0	66	0	0	15	88
Bristol Borough	3,893	0	0	0	0	0	0	0	0	0
Bristol Township	19,543	4	5	0	2	107	0	0	10	128
Buckingham Township	8,315	0	5	0	10	200	0	1	19	235
Chalfont Borough	1,674	0	0	0	0	14	0	0	0	14
Doylestown Borough	3,236	1	2	0	0	6	0	0	0	9
Doylestown Township	6,441	0	5	0	1	183	0	0	3	193
Dublin Borough	595	0	0	0	0	0	0	0	0	0
Durham Township	653	1	1	0	1	145	0	1	41	190
East Rockhill Township	2,429	0	2	0	1	118	0	0	41	162
Falls Township	11,540	0	0	0	0	0	0	0	0	0
Haycock Township	1,227	0	14	0	3	102	0	0	35	155
Hilltown Township	6,265	0	0	0	0	139	0	1	7	147
Hulmeville Borough	392	3	0	0	1	85	0	0	6	95
Ivyland Borough	371	0	0	0	0	0	0	0	0	0
Langhorne Borough	544	0	4	1	0	20	0	0	1	26
Langhorne Manor Borough	345	1	0	0	2	75	0	0	3	81
Lower Makefield Township	13,037	0	10	0	1	532	0	0	23	566
Lower Southampton Township	7,706	58	19	3	14	2087	0	0	120	2301
Middletown Township	15,585	14	57	0	17	1020	0	0	241	1351

Table 4.3.7-3 Structures in Landslide Zone by Land Use Type per Municipality for Bucks County (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Milford Township	4,370	2	12	1	8	191	0	0	34	248
Morrisville Borough	3,134	0	1	0	0	17	0	0	2	20
New Britain Borough	1,145	0	0	0	0	0	0	0	0	0
New Britain Township	4,755	0	3	0	3	135	0	0	7	148
New Hope Borough	1,385	2	2	0	6	226	0	3	18	257
Newtown Borough	1,026	0	0	0	0	0	0	0	0	0
Newtown Township	8,258	2	0	0	1	230	0	0	4	238
Nockamixon Township	1,812	8	10	0	2	263	0	2	88	373
Northampton Township	14,767	12	4	1	2	109	0	0	7	135
Penndel Borough	719	0	4	0	0	7	0	0	1	12
Perkasie Borough	3,381	0	0	0	0	4	0	0	1	5
Plumstead Township	5,789	7	12	0	4	226	0	0	44	293
Quakertown Borough	3,163	0	0	0	0	0	0	0	0	0
Richland Township	6,250	130	0	1	3	129	0	0	29	292
Richlandtown Borough	437	0	0	0	0	0	0	0	0	0
Riegelsville Borough	453	0	0	0	0	4	0	0	1	5
Sellersville Borough	1,887	0	0	0	0	0	0	0	0	0
Silverdale Borough	336	0	0	0	0	0	0	0	0	0
Solebury Township	4,297	7	18	0	1	382	1	1	56	467
Springfield Township	2,696	5	8	1	0	253	0	0	82	349
Telford Borough	676	0	0	0	0	0	0	0	0	0
Tinicum Township	2,345	1	9	0	6	247	0	1	119	383

Table 4.3.7-3 Structures in Landslide Zone by Land Use Type per Municipality for Bucks County (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Trumbauersville Borough	374	0	0	0	0	0	0	0	0	0
Tullytown Borough	794	0	0	0	0	0	0	0	0	0
Upper Makefield Township	3,748	0	2	0	0	246	0	1	27	277
Upper Southampton Township	6,149	3	2	0	0	175	0	0	13	193
Warminster Township	11,572	0	0	0	0	29	0	0	0	29
Warrington Township	9,037	0	3	0	0	1	0	0	0	4
Warwick Township	6,167	1	41	0	3	37	0	1	13	96
West Rockhill Township	2,353	2	7	1	1	115	0	0	45	171
Wrightstown Township	1,474	1	0	0	1	32	0	2	6	42
Yardley Borough	1,349	0	0	0	0	0	0	0	0	0
TOTAL	243,350	287	314	10	114	9,246	1	14	1,353	11,347

4.3.8. Lightning Strike

Lightning is a rapid discharge of electrical energy in the atmosphere. When the charge difference between the ground and the cloud becomes too large, a conductive channel of air develops between the cloud and the ground, and a small amount of charge (step leader) starts moving toward the ground. When it nears the ground, an upward leader of opposite charge connects with the step leader. At the instant this connection is made, a powerful discharge occurs between the cloud and the ground. This discharge is seen as a bright flash of lightning. A bolt of lightning can reach temperatures approaching 50,000°F.

4.3.8.1. *Location and Extent*

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.

More than 100,000 thunderstorms occur in the United States each year, with lightning striking more than 25 million points on the ground during that same period. This causes an average of 20 fatalities and hundreds of injuries each year (NOAA NWS, 2021c). Lightning can occur with all thunderstorms, of which the entire county is susceptible. Lightning fatalities are most common during the summer and during the afternoon and evening.

4.3.8.2. *Range of Magnitude*

Because lightning damage is largely unreported, statistics vary considerably. The insurance industry, however, estimates 6.5 percent of all property/casualty claims are related to lightning strikes (CUNA, 2015). While it is difficult to quantify lightning losses, it is estimated that $4-5 billion in damage occurs each year. Likewise, the cost of lightning protection to safeguard critical equipment and facilities from lightning strikes during severe weather is enormous. In statistics kept from 1959-1994, Pennsylvania was reported to have the largest number of damage reports due to lightning of any state, with 1,441 (Curran, 1999).

Each year, lightning is responsible for the deaths of almost fifty people, injuries to several hundred more, and millions of dollars in property damage in the United States (NOAA NWS, 2021d). 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 strikes 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*

Records from the NCEI show that there were 507 lightning events in the 67 counties across Pennsylvania between 1950 and 2020 (NOAA NCEI, 2021). A lightning "event" is defined as a lightning strike that results in fatality, injury, and/or property or crop damage (NOAA NWS, 2016).

Calculated as both deaths and injuries, Pennsylvania ranked third among all states with 644 casualties from 1959 to 1994. This represents approximately 5% of casualties, which occurred throughout the U.S. over that 35-year period. Total deaths caused by lightning from 1959 to 2017 were collected for each state, ranking Pennsylvania ninth (134 deaths) in the country (NOAA NWS, 2018). In 2020 alone, Pennsylvania had 2 deaths from lightning strikes (NOAA NWS, 2021e).

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). In 2019, Pennsylvania ranked eighth in the nation for number of homeowner's insurance claims for lightning losses, with 2,838 claims. These claims valued approximately $27.3 million, with each claim costing an average of $9,600 (III, 2021).

As a result of lightning, 20 people in Bucks County have suffered injuries and property damages totaled over $3.53 million. Figure 4.3.8-1 depicts the historic yearly average of lightning strikes in Bucks County relative to other areas of the Commonwealth. Data on lightning strikes from 2000 to 2020 in Bucks County is presented as Table 4.3.8-1.The total list of the 62 previous events ranging from 1996 to 2020, as the Storm Events Database started recording events for Lightning in 1996, can be found in Appendix H.

Table 4.3.8-1 Past Lightning Strike Events in Bucks County (NOAA NCEI, 2021).

COUNTY	LOCATION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
Bucks County	Doylestown	5/13/2000	0	0	0	0
Bucks County	Milford Square	10/4/2000	0	0	$20,000	0
Bucks County	Quakertown	10/4/2000	0	0	$1,000	0
Bucks County	Perkasie	6/30/2001	0	7	$100,000	0
Bucks County	Perkasie	6/30/2001	0	0	0	0
Bucks County	Plumsteadville	5/2/2002	0	0	0	0
Bucks County	Bristol	6/6/2002	0	1	0	0
Bucks County	Bristol	7/19/2002	0	0	0	0
Bucks County	Woodside	8/2/2002	0	0	0	0
Bucks County	Quakertown	8/13/2003	0	0	0	0
Bucks County	Croydon	8/27/2003	0	0	0	0
Bucks County	Bristol	8/30/2003	0	0	$50,000	0
Bucks County	New Hope	8/21/2004	0	0	0	0

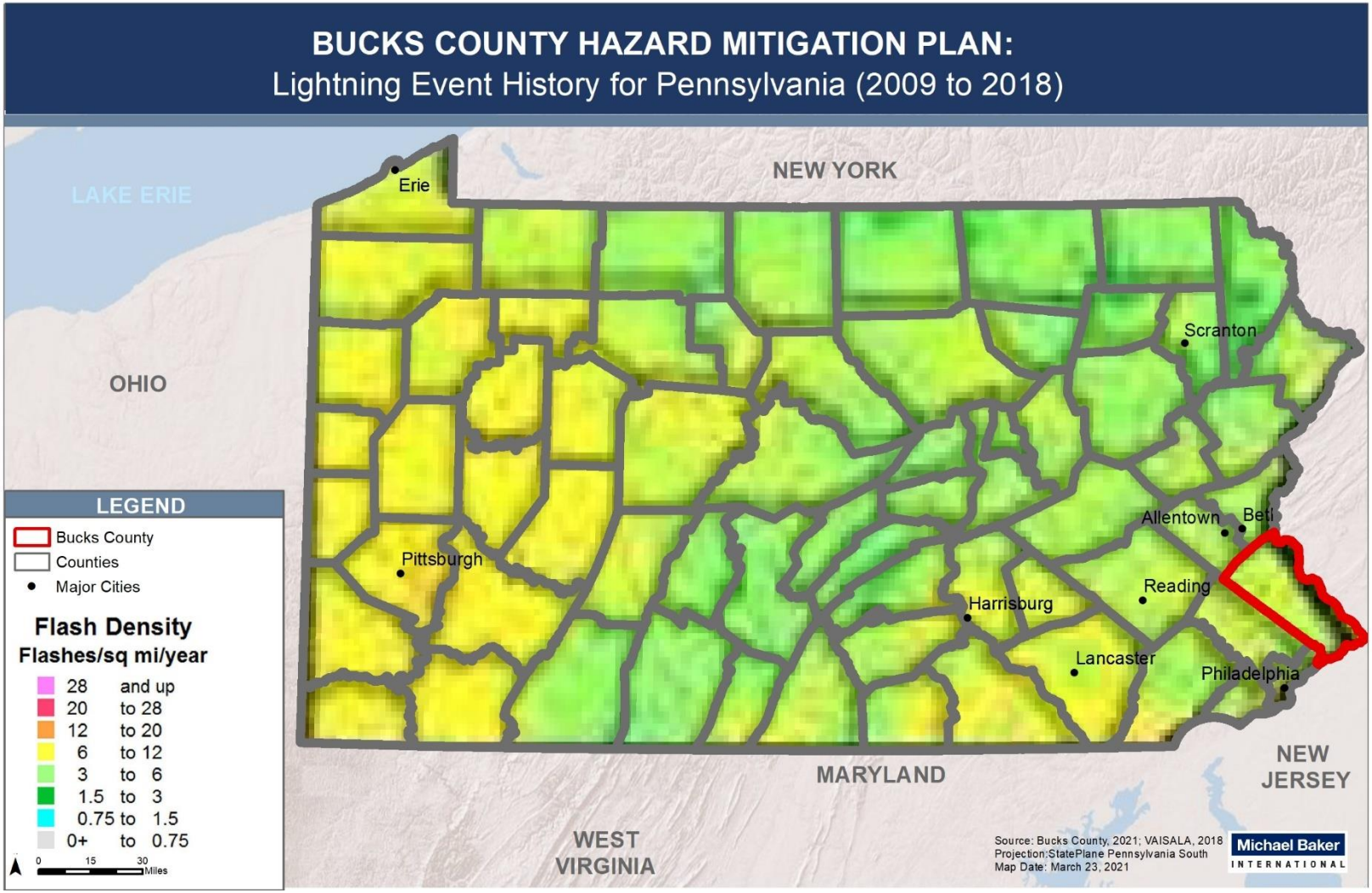
Table 4.3.8-1 Past Lightning Strike Events in Bucks County (NOAA NCEI, 2021).

COUNTY	LOCATION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
Bucks County	Warrington	6/29/2005	0	0	$250,000	0
Bucks County	Quakertown	7/1/2005	0	0	0	0
Bucks County	Wrightstown	7/27/2005	0	0	$200,000	0
Bucks County	Hilltown	8/8/2005	0	0	$1,000	0
Bucks County	Langhorne	8/14/2005	0	0	$1,000	0
Bucks County	Buckingham Station	8/14/2005	0	0	$25,000	0
Bucks County	Buckingham Station	8/7/2006	0	0	$100,000	0
Bucks County	Silverdale	5/16/2007	0	0	$1,000	0
Bucks County	Dolington	5/21/2008	0	0	$25,000	0
Bucks County	Doylestown	5/31/2008	0	0	$10,000	0
Bucks County	Yardley Farms	7/23/2008	0	0	$5,000	0
Bucks County	Yardley Farms	7/23/2008	0	2	0	0
Bucks County	Silverdale	7/27/2008	0	0	$100,000	0
Bucks County	Silverdale	8/18/2009	0	0	$10,000	0
Bucks County	Sellersville	3/14/2010	0	0	$10,000	0
Bucks County	Morrisville	5/31/2010	0	0	$10,000	0
Bucks County	Levittown	6/24/2010	0	0	$5,000	0
Bucks County	New Hope	7/12/2010	0	0	$500,000	0
Bucks County	West Bristol	5/16/2012	0	0	$250,000	0
Bucks County	Woodbourne	7/15/2012	0	0	$250,000	0
Bucks County	Wrightstown	7/28/2012	0	0	$5,000	0
Bucks County	Neshaminy	8/9/2012	0	0	$10,000	0
Bucks County	Blooming Glen	7/23/2013	0	0	$10,000	0
Bucks County	Brick Tavern	6/13/2014	0	0	$25,000	0
Bucks County	Trumbauersville	6/19/2014	0	0	$5,000	0
Bucks County	Trumbauersville	6/19/2014	0	0	$1,000	0
Bucks County	Farm School	6/19/2014	0	0	$2,000	0
Bucks County	Chalfont	6/19/2014	0	0	$100,000	0
Bucks County	Stanwood	7/2/2014	0	0	$500,000	0
Bucks County	Bristol Arpt	7/2/2014	0	0	$500,000	0
Bucks County	Doylestown	7/8/2014	0	0	$2,000	0
Bucks County	Newtown	7/23/2014	0	0	$1,000	0
Bucks County	Rockhill	7/25/2016	0	0	$10	0
Bucks County	Perkasie Penridge Ar	7/25/2016	0	0	$10	0
Bucks County	Springtown	7/25/2016	0	0	$10	0
Bucks County	Holland	8/7/2019	0	0	0	0

Table 4.3.8-1 Past Lightning Strike Events in Bucks County (NOAA NCEI, 2021).

COUNTY	LOCATION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE ($)	CROP DAMAGE ($)
Bucks County	Trevose	8/18/2019	0	9	0	0

Figure 4.3.8-1 Lightning Event History in Pennsylvania (2009-2018)



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).

The future occurrence of lightning and thunderstorm activity in Bucks County is anticipated, and the susceptibility to damage from these severe storms will remain unchanged. However, the probability of lightning strike events resulting in multiple casualties or extensive structural damage is considered *highly likely* according to the Risk Factor Methodology (see Table 4.4.1-1).

The number of lightning events is influenced by the frequency of a severe thunderstorm occurrence. Therefore, potential future changes in climate and weather conditions may impact the future occurrences of lightning strike. According to the 2021 Pennsylvania Climate Impacts Assessment Update, thunderstorms are projected to increase in frequency (PADEP, 2021c). However, the future occurrence of lightning activity is not forecasted as lightning strikes are frequent and widespread and forecasters' understanding of the cloud electrification process is incomplete (NOAA NSSL, 2021b).

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 – 2020, the NOAA NCEI Storm Events Database reported 387 lightning events in the state which caused 22 deaths, 178 injuries, property damage of $14,861,000, and $300,000 in crop damage (NOAA NCEI, 2021).

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 a disease affecting or attacking the population of an extensive region, including several countries, and/or continent(s). It is further described as an extensive epidemic. Generally, pandemic diseases cause sudden, pervasive illness in all age groups on a global scale. Infectious diseases are highly virulent and spread person-to-person.

Pandemic and infectious disease events cover a wide geographical area and can affect large populations, potentially including the entire population of the County. 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.

Bucks County is primarily concerned with the possibility of a pandemic flu outbreak. 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.

Different strands of influenza mutate over time and replace older stands of the virus and thus have drastically different effects. The H1N1 virus, colloquially known as swine flu, is of particular concern. This virus was first detected in people in the United States in April 2009. On June 11, 2009, the world health organization signaled that a pandemic of 2009 H1N1 flu was underway (CDC, 2009). Avian influenza, also known as bird flu, infects birds. A recent strain, H5N1, has caused concern due to its ability to pass from wild birds to poultry then on to people. This virus has killed more than half of the people infected with it, although the avian flu is less like to infect humans.

Prior to the beginning and during the 2021 Hazard Mitigation Plan Update process, a novel coronavirus spread into a worldwide pandemic. Named COVID-19, this type of coronavirus is a new virus that causes respiratory illness, is extremely contagious even prior to exhibiting symptoms or if the infected person is asymptomatic, and can be fatal. Flu-like in nature, symptoms of the virus include fever, cough, shortness of breath, and diarrhea. This virus became a great concern due to its high rates of transmission, and a high incidence of mortality. Severe reactions that requires immediate medical care include difficulty breathing, persistent pain or pressure in the chest, confusion, inability to wake up or stay awake, and discolored skin, lips or nail beds (CDC, 2021). In extreme COVID-19 cases that require hospitalization, patients require ventilators to support breathing and may pass away from

COVID-19 or COVID-19 related reasons. Governor Tom Wolf issued the first stay-at-home order on March 23, 2021 for seven counties, which was then expanded for all 67 counties on April 1st. Schools were moved to virtual settings, non-essential businesses were closed, and all essential state services were continued operation (WGAL News 8, 2020). Bucks County adopted all state-level restrictions and guidelines to slow the spread of the virus. On May 31, 2021, the stay-at-home order and any other mitigation order except face mask wearing for the Commonwealth of Pennsylvania will be lifted (Bucks County Health Department, 2021).People were advised to practice social distancing; only leaving the house for essentials like grocery shopping, and to avoid gathering even in small groups. Even when going on walks, people should remain six feet apart to slow the spread of transmission. At least three new variants of the virus have been detected globally, each reaching the United States by January 2021 (CDC, 2021a).

Starting January 2021, vaccines were being distributed in phases based off of vulnerable populations as well as those who are frequently exposed:

- Phase 1A: long-term care facility residents, health care personnel, persons ages 65 and older, persons ages 16-64 with high risk conditions defined by the CDC, and persons potentially exposed to infectious material that can transmit disease to healthcare personnel and patients, teachers, child care workers, and frontline groups.
- Phase 1B: Opened on April 5, 2021 – people in congregate settings that are not specified as long-term care facilities, persons receiving home and community-based services, correctional officers and other workers serving people in congregate care settings not included in Phase 1A, education workers not covered in Phase 1A – including those in higher education, U.S. Postal Service workers, manufacturing workers, clergy and other essential support for houses of worship, and public transit workers
- Phase 1C: Opened on April 12, 2021 – essential workers in transportation and logistics, water and wastewater, food service, housing construction, finance including bank tellers, information technology, communications, energy including nuclear reactors, legal services, federal, state, county, and local government workers including county election workers, elected officials, and members of the judiciary and their staff, media, public safety, and public health workers.
- Phase 2: Opened on April 13, 2021 – all individuals not previously covered who are 12 and older and do not have a contraindication to the vaccine are eligible (PA DOH, 2021a).

The three vaccines that received emergency approval by the U.S. Food and Drug Administration (FDA) include the Pfizer-BioNTech vaccine, the Johnson & Johnson-Janssen vaccine, and the Moderna vaccine. Each vaccine required a 15-30 minute on-site observation period after receiving the vaccine. The Pfizer-BioNTech and Moderna vaccines requires two shots for immunity; the Johnson & Johnson-Janssen vaccine is a one-shot vaccine. All three

vaccines take two weeks after the final shot to be considered fully effective against COVID-19 (CDC, 2021d). As Bucks County, and the rest of the nation, continue to get vaccinated during the pandemic, there have been issues with some of those who chose to receive the two-step vaccines with not returning to receive the second dose for full inoculation. In part to widespread misinformation, and a temporary pause in the Johnson & Johnson administration, there are individuals who are choosing not to receive the vaccine. There is a growing concern about a potential additional peak of COVID-19 infections and deaths in this unvaccinated population.

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 easily transmitted from person-to-person, but advances in medical technologies have greatly reduced the number of deaths caused by influenza over time. The magnitude of a pandemic may be exacerbated by the fact that an influenza pandemic will cause outbreaks across the United States, 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.

In terms of lives lost, the impact various pandemic influenza outbreaks have had globally over the last century has declined (Table 4.3.9-1). The severity of illness from the 2009 H1N1 influenza flu virus varied, with the gravest cases occurring mainly among those considered at high risk. High risk populations considered more vulnerable include children, the elderly, pregnant women, and chronic disease patients with reduced immune system capacity. These populations are described in more detail in Section 4.3.9.5. Most people infected with swine flu in 2009 recovered without needing medical treatment (CDC, 2010). Unlike a regular flu season, according to the Centers for Disease Control (CDC) the majority of the people who died, as many as 77%, were 18 to 64 years old with up to 11% of the deaths estimated in those 17 years old and younger.

The 1918 Spanish flu pandemic was the worst-case pandemic event in the 20th century for both Pennsylvania and worldwide. County data is unavailable, and mortality figures were probably under-reported, it is recorded that there were over 60,000 deaths in the Commonwealth (Shetty & Ahern, 2018). Infection rates were much worse in denser cities, which should be a high priority for response actions in future flu events.

In 2020 COVID-19, another worst-case pandemic began having worldwide impacts. As of June 2021 we are still facing impacts of the pandemic. Bucks County has faced varying impacts of the COVID-19 pandemic. It is believed that the virus originated in an open-air market in the Wuhan province of China in November 2019. Shortly afterwards, the virus began to spread to nearby countries including Japan and South Korea. By March 2020, the virus had

reached almost every country worldwide, with the most cases in the United States. At first, concern was focused on people who might be infected due to recent travel. However, community infections soon began to crop up in many cities and towns. This led to a statewide shutdown of schools and businesses and the cancellation of large events for the remainder of 2020. Only life sustaining services were permitted to remain open, including medical facilities, pharmacies, and grocery stores. People were advised to remain home as much as possible in an attempt to slow the transmission of COVID-19. State health officials note that the virus has infected all age ranges at about the same rate, and that no age group can be considered more or less vulnerable to infection. However, people with underlying health conditions and the elderly population are more vulnerable to the virus having serious, or even deadly, symptoms. New variants of the virus reached the United States in January 2021. The CDC notes that these variants spread more easily and quickly than other variants, which may lead to a rapid increase in COVID cases (CDC, 2021a). It is currently unknown how new variants will interact with existing vaccines.

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 and worldwide deaths are summarized in Table 4.3.9-1.

Table 4.3.9-1 List of Previous Significant Outbreaks of Influenza Over the Past Century (Global Security, 2009) (WHO, 2009).

DATE	PANDEMIC	WORLDWIDE DEATHS (APPROXIMATE)
1918-1920	Spanish Flu / H1N1	50 million
1957-1958	Asian Flu / H2N2	1.5-2 million
1968-1969	Hong Kong Flu / H3N2	1 million
2009 - 2010	Swine Flu / A/H1N1	12,000

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. There were 350,000 cases and 8,000 deaths 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 percent of the population of Pennsylvania was affected. In Bucks County there have been over 53,000 confirmed cases and 1,330 deaths as of July 19, 2021 (PA DOH, 2021). The first cases of the Hong Kong Flu in the United States were detected in September 1968 with deaths peaking between December 1968 and January 1969 (Global Security, 2009).

Table 4.3.9-2 lists the number of seasonal flu cases in Bucks County from the 2014/2015 flu season. There has been an increase in cases each flu season in recent years. The CDC marked the 2014-2015 flu season as severe, with over 590,000 hospitalizations, and an estimated 51,300 deaths across all ages (CDC, 2015). The 2017-2018 flu season was another severe season. The CDC reported that the H3N2 flu, along with other strains including H1N1, led to more cases, doctors' visits, hospital visits, and deaths than previous flu seasons. The CDC also noted that the flu became widespread in all states and jurisdictions at the same time. The CDC estimated that 45 million Americans were affected by the flu, and the country experienced around 61,000 influenza deaths (CDC, 2018). The sharp increase in cases for the 2019/2020 season may be related to COVID-19 (CDC, 2021b). The CDC notes that due to COVID, there was an overall increase in the number of flu tests. This reveals that there may be undetected cases in the county each year, so an increase in total tests very likely leads to an increase in number of flu cases (CDC, 2020). According to the Pennsylvania Department of Health (DOH), there were 3,604 confirmed cases in Bucks County during the most recent influenza season from September 2019 to March 2020 (PA DOH, 2021b).

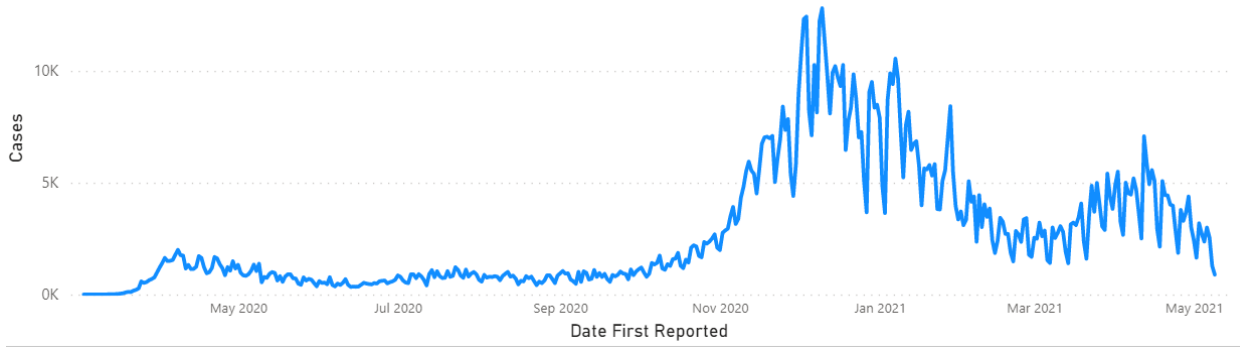
Table 4.3.9-2 Confirmed Flu Cases in Bucks County by Flu Season (PA DOH, 2021b)

FLU SEASON	NUMBER OF CONFIRMED CASES
2014/15	1,756
2015/16	1,359
2016/17	2,244
2017/18	4,148
2018/19	2,918
2019/20	3,604

The COVID-19 outbreak began in China in November 2019. According to a report published by the CDC on June 5, 2020, the first case of COVID-19 in the United States occurred on January 15, 2020 when a person traveled from Wuhan, China to Seattle and fell ill four days later. Small community spreading of the virus occurred during the second half of January and early February, prior to the more widespread outbreak of the virus in late February of 2020 (Jorden MA, Rudman SL, et al, 2020). The virus became more widespread the US in late February 2020, and most counties in Pennsylvania were affected by March 2020. As of May 10, 2021, there were more than 1,174,000 confirmed cases in Pennsylvania, with over 52,704 cases and 1,297 deaths reported in Bucks County (PA DOH, 2021c). Case numbers were expected to continue to peak in May 2020; however, the Commonwealth experienced the largest number of cases in December 2020, with over 1,700 cases. The Commonwealth is experiencing its third peak in cases as of April 2021, shown in Figure 4.3.9-1. As more people receive the vaccine it is expected that case numbers will decrease, though there is a growing concern about a potential additional peak of COVID-19 infections and deaths in the

intentionally unvaccinated population. Almost 300,000 people in Bucks County have been vaccinated (about 50 percent of the county population) (PA DOH, 2021).

Figure 4.3.9-1 Number of COVID-19 Cases in Pennsylvania from April 2020 to April 2021 (PA DOH, 2021c).



4.3.9.4. *Future Occurrence*

Future occurrences of pandemics and infectious diseases 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. While it is unlikely that pandemics and infectious diseases will affect the county, this hazard occurred recently in Spring 2020. It is impossible to predict this type of hazard. The best form of county response is to expect that these events can occur at any time and to constantly evaluate resources and update emergency response plans.

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 4.4.1-1).

4.3.9.5. *Vulnerability Assessment*

Certain population groups are at higher risk of pandemic flu infection. This population group includes people 65 years and older, children younger than five years old, pregnant women, and people of any age with certain chronic medical conditions. Such conditions include but are not limited to diabetes, heart disease, asthma and kidney disease (CDC, 2021c). Schools, colleges, convalescent centers, and other institutions serving those younger than five 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. All communities in Bucks

County are considered vulnerable to a pandemic event, with the likely greatest impact at the county level occurring in Doylestown, the county seat. As stated in previous plans, the highest concentration of schools, retirement homes, and senior centers are found in Bristol Township, Bensalem, and Middletown Township. There are some occupation-specific risks that may make some employees more vulnerable. For example, those working in direct patient care situations and front line essential jobs such as retail, are more likely to be exposed to a pandemic disease.

The environmental impacts of pandemics and infectious disease threats are still being determined. Many countries noted environmental benefits to everyone sheltering-in-place due to reduced commuting pollution and overall an increase in air quality. The County has identified "mask trash" from discarded face masks as a new form of litter that may have impacts on storm drains and otherwise still being determined. There will be significant economic and social costs beyond the possibility of disease-related 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. Research of COVID-19 suggests that public transportation has greatly increased the transmission of this and other past viruses, bringing this vulnerability to light.

Jurisdictional losses in a pandemic or infectious disease outbreak stem from lost wages and productivity, not losses to buildings or land. Losses are difficult to estimate because the exact rates of absenteeism and cost of treating a widespread disease will depend on the virus or bacterium in question, the availability of vaccination or treatment, and the severity of symptoms. For historical context, though, the Asian and Hong Kong Flu pandemics killed over 1.5 million people worldwide and caused an estimated $32 billion loss due to lost productivity and medical expenses (Saunders-Hastings & Krewski, 2016). With Pennsylvania's economy so integral to the national economy, economic losses from a pandemic or infectious disease threat could be significant.

It is expected that there will be immense losses due to the COVID-19 pandemic. Thousands of individuals were laid off across the commonwealth at non-essential businesses were forced to close. In just one week, over three million Americans filed for unemployment; the greatest amount ever. The accommodation and food services industry suffered the highest number of jobs lost. Professional services, construction, and manufacturing have all been subsidized at greater rates, allowing for lower amounts of jobs lost. Tourism and hospitality industries have suffered in high density areas; however, remote destinations in Bucks County are less susceptible to this trend as they are deemed safe to visit. The majority of COVID-19 aid

packages have been distributed to allow some industries to continue operations (Klein & Smith, 2021). It is currently unknown how COVID-19 will change the economic environment.

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, showed that the readings on Mr. Stanley Watras frequently exceeded expected radiation levels, yet only natural, non-fission-product radioactivity was detected on him. Radon levels in his home were detected around 2,500 pCi/L (pico Curies per Liter), much higher than the 4 pCi/L guideline of the Environmental Protection Agency or even the 67 pCi/L limit for uranium miners. As a result of this event, the Reading Prong section of Pennsylvania where Watras lived became the focus of the first large-scale radon scare in the world.

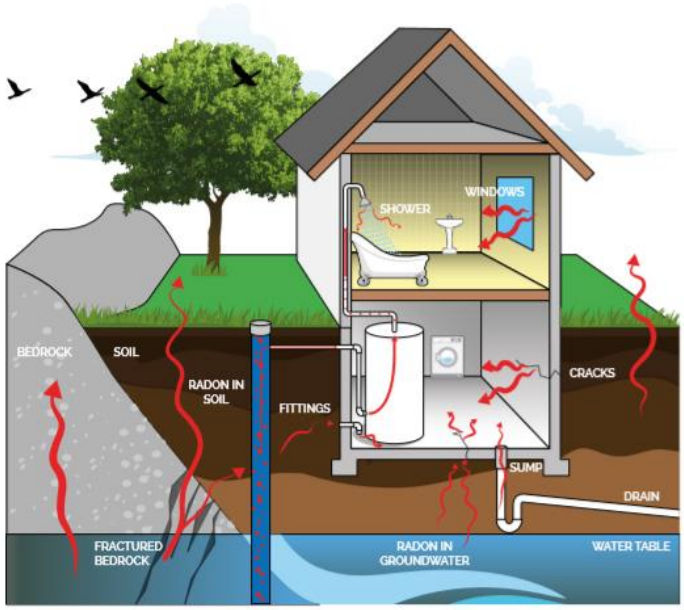
Radon is a gas that cannot be seen or smelled. It is a noble gas that originates by the natural radioactive decay of uranium and thorium. Like other noble gases (e.g., helium, neon, and argon), radon forms essentially no chemical compounds and tends to exist as a gas or as a dissolved atomic constituent 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 form their parent before decay is generally limited to distances of feet or tens of feet.

Three sources of radon are now recognized in houses (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 (Specification Online, 2019).



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 Bucks County – New Mitigation Actions pCi/L), then an appreciable fraction of the air may be drawn in from the soil or fractures bedrock through the foundation and slab beneath the house, or through cracks in openings for pipes, sumps, and similar features (see figure 4.3.10-1). 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 on 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.

Each county in Pennsylvania is classified as having a *low, moderate,* or *high* radon hazard potential. Bucks County is classified as having a high hazard, meaning that the predicted indoor radon level is greater than 4 pCi/L (see Figure 4.3.10-2).

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 parts per million (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 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 4.3.10-3 and 4.3.10-4 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.

The highest recorded basement radon readings in Bucks County were 4,022.0 pCi/L Coopersburg, 1,219.3 in East Greenville, 891.6 in Upper Gwynedd, and 803.2 in Richboro. First floor average radon levels were substantially lower than average test results for basements, but a few communities still exceeded the 4 pCi/L threshold, which is shown in Figure 4.3.10-4. Additionally, maximum first floor radon levels were much lower than those for basements, but all exceeded the threshold of action. Communities with no data available did not have a sufficient sample size.

Figure 4.3.10-2 Radon Hazard Zones in Pennsylvania

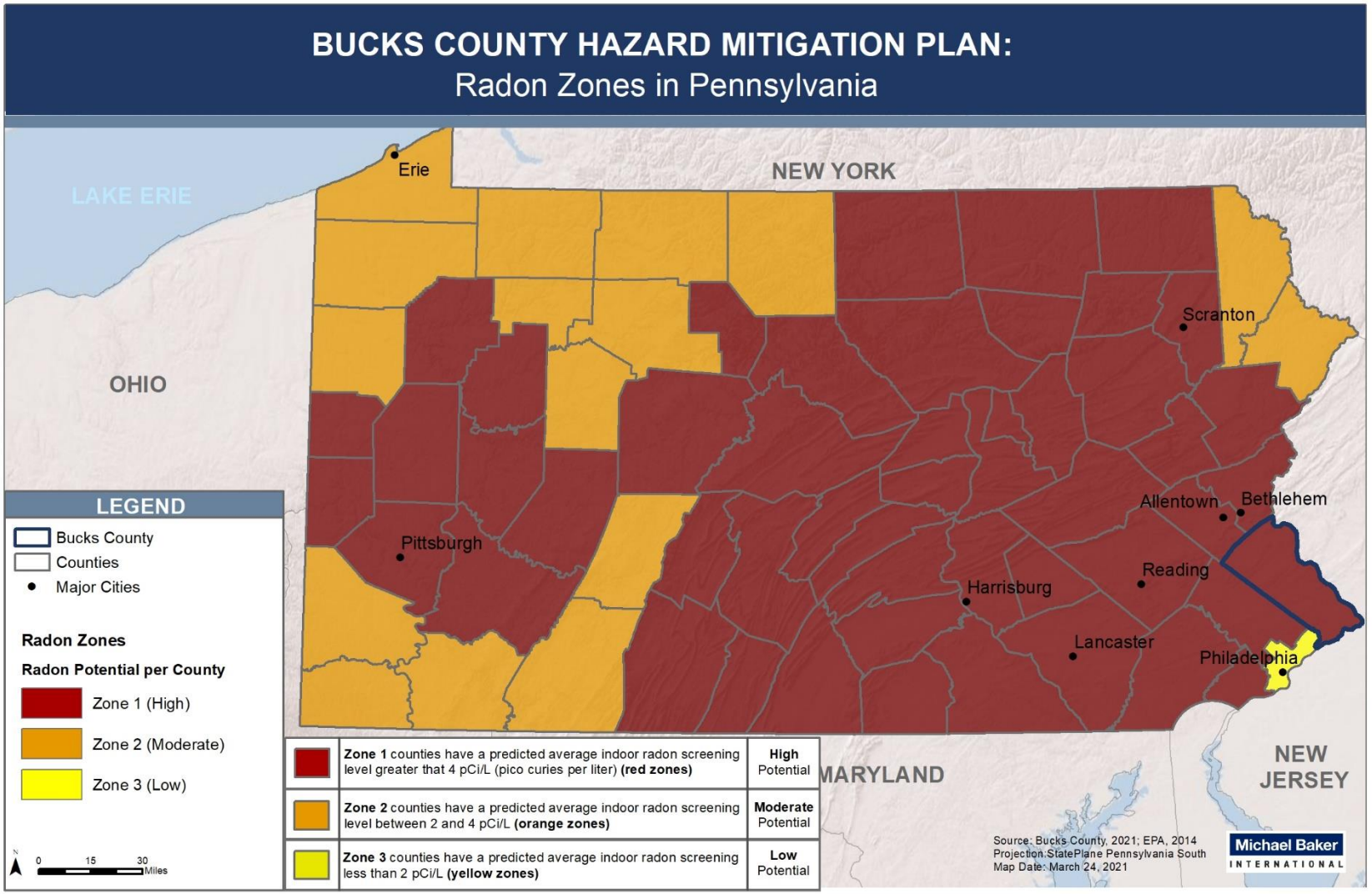


Figure 4.3.10-3 Bucks Average Basement Radon Test Results

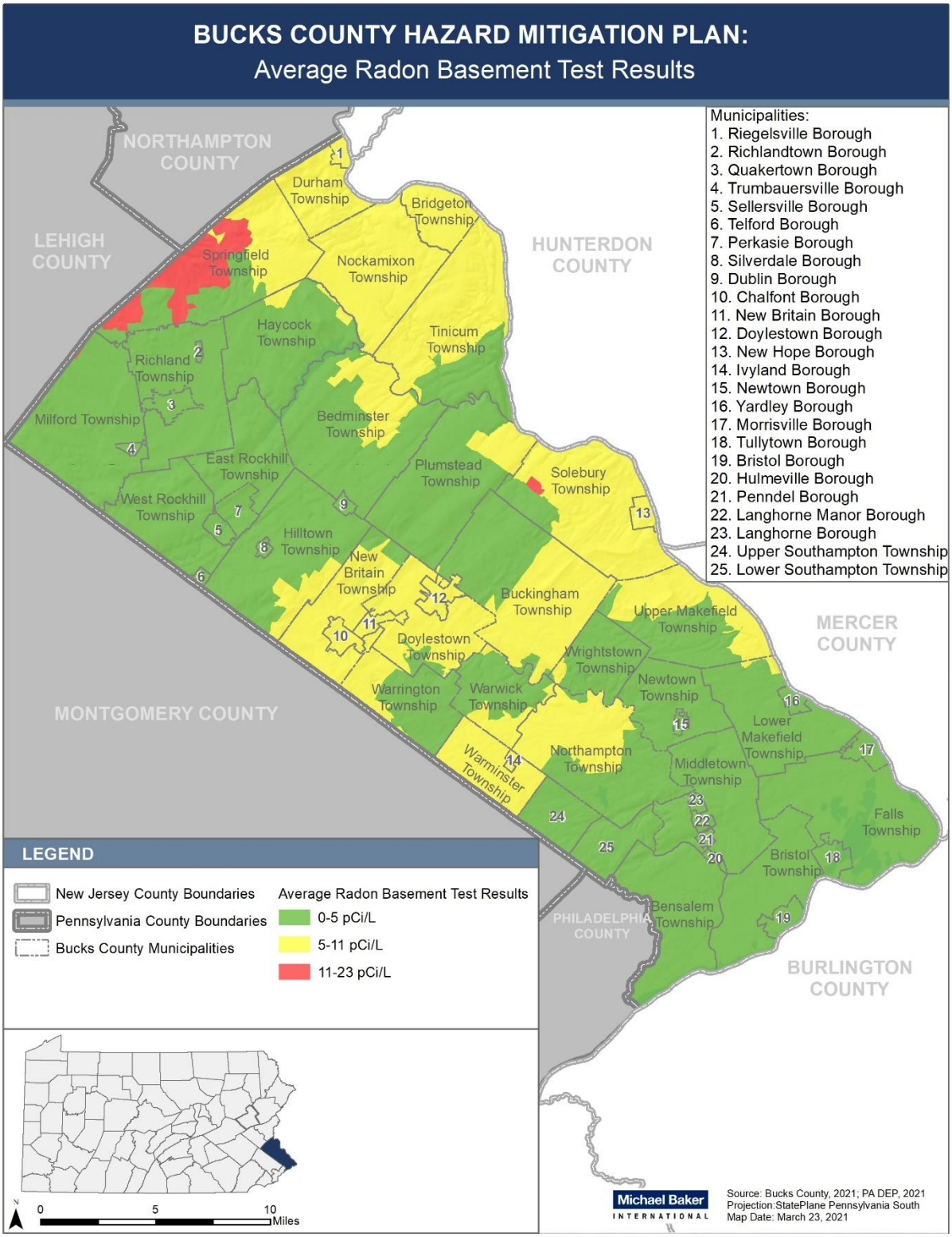
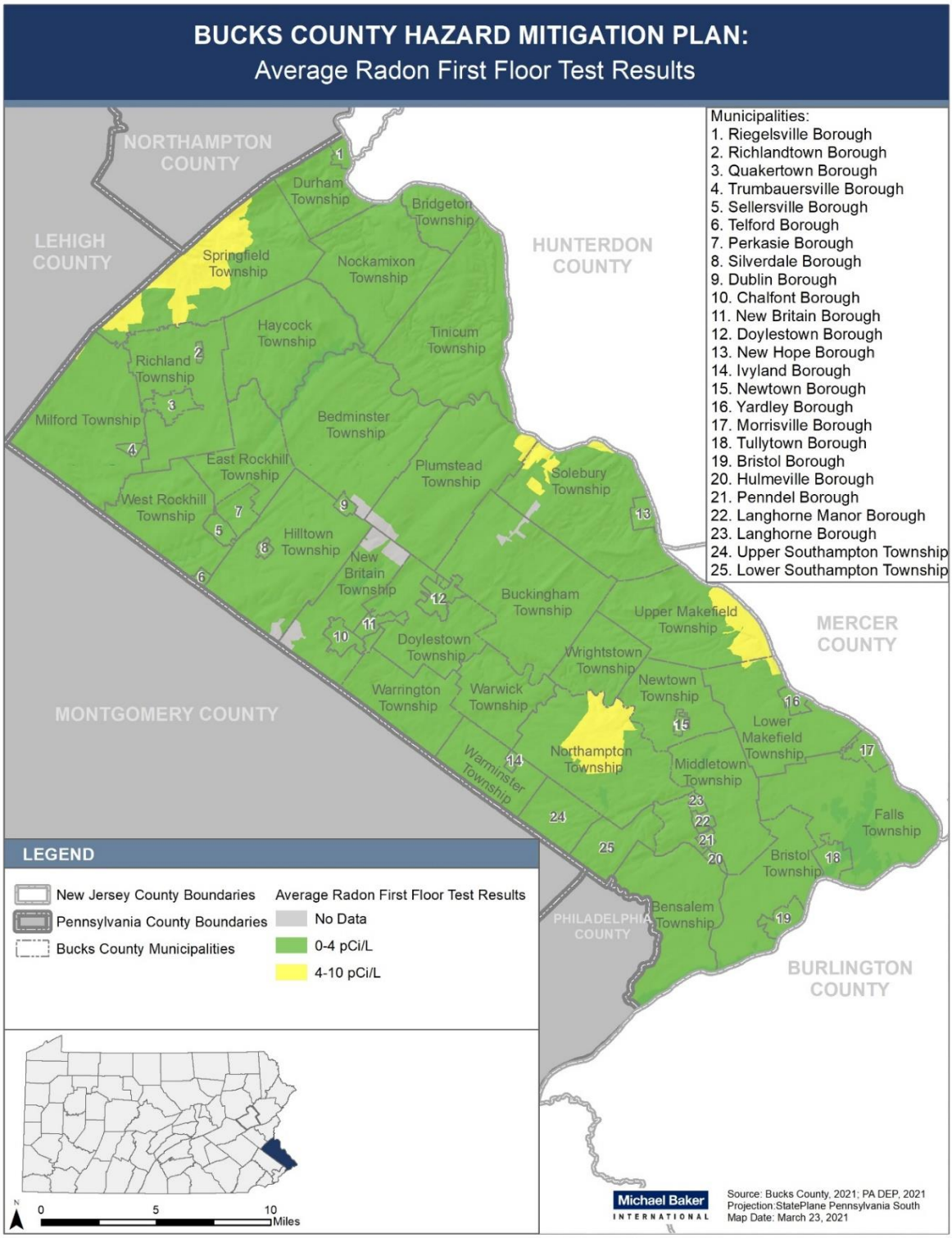


Figure 4.3.10-4 Bucks Average First Floor Radon Test Results



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 (US EPA, 2016). The main hazard is 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 4.3.10-1 shows the relationship between various radon levels, probability of lung cancer, comparable risks from other hazards, and action thresholds. As is shown in the table, 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 (US EPA, 2016).

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 of the risk of dying from food 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	

Table 4.3.10-1 Radon Risk for Smokers and Non-Smokers (US EPA, 2016).

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
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
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 provided residents high levels of exposure over a prolonged period without the resident being aware. This worst-case scenario exposure then could lead to large numbers 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, 2019).

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, all 59 ZIP codes have 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.

Table 4.3.10-2 Radon Level Tests and Results in Bucks County Zip Codes (PADEP, 2021b)

ZIP CODE	BASEMENT			FIRST FLOOR		
	NUMBER OF TESTS	MAXIMUM RESULTS (PCI/L)	AVERAGE RESULT (PCI/L)	NUMBER OF TESTS	MAXIMUM RESULTS (PCI/L)	AVERAGE RESULT (PCI/L)
18036	3,039	4,022.0	19.8	386	1,131.0	8.4
18041	494	138.1	4.9	114	14.8	2.4
18042	5,062	1,219.3	9.0	826	1,62.4	4.3
18054	462	53.6	4.6	96	19.8	2.5
18055	1,828	529.2	8.0	285	133.2	4.2
18073	1,048	125.5	4.6	177	34.3	2.2
18077	537	240.6	9.4	111	24.1	4.0
18901	14,012	427.8	5.6	3,828	155.8	3.4
18902	2,091	149.1	4.6	74	31.8	3.0
18913	124	502.0	16.0	50	96.0	9.3
18914	5,072	206.2	5.6	1,148	78.1	2.9
18915	187	33.1	3.2	35	6.6	2.1
18917	254	113.4	4.3	83	39.1	2.3
18920	150	42.3	7.6	39	12.8	3.0
18923	253	39.0	4.5	Insufficient Data		
18925	1,813	266.5	6.0	325	62.5	3.5
18927	162	33.5	5.1	43	8.7	2.5
18929	2,375	150.0	4.2	784	69.5	2.1
18930	299	54.9	6.5	67	14.6	3.3
18932	44	24.2	5.5	Insufficient Data		
18933	88	41.8	6.1	40	62.3	5.1
18934	70	16.2	4.1	Insufficient Data		
18938	5,083	216.6	6.3	1,340	58.9	3.2
18940	10,583	243.7	4.8	4,190	186.9	2.2
18942	425	51.6	5.5	103	21.3	3.1
18944	4,030	120.7	4.6	903	69.2	2.7
18947	1,423	84.5	4.5	368	54.2	2.4
18951	3,911	549.5	4.6	942	22.9	2.0
18954	3,245	803.2	8.1	846	144.3	5.0
18955	157	48.1	4.4	32	12.7	2.9
18960	1,652	364.1	4.2	372	28.0	2.1
18964	1,946	70.2	3.8	429	10.4	1.8
18966	8,320	505.0	5.0	2,943	170.8	2.9
18969	2,100	174.8	3.8	512	60.1	2.1
18972	410	115.0	6.1	121	14.0	2.6
18974	4,729	431.8	5.4	1,626	230.9	2.8
18976	3,591	174.0	4.3	812	59.6	2.4
18977	2,674	171.1	6.8	667	140.1	4.5

Table 4.3.10-2 Radon Level Tests and Results in Bucks County Zip Codes (PADEP, 2021b)

ZIP CODE	BASEMENT			FIRST FLOOR		
	NUMBER OF TESTS	MAXIMUM RESULTS (PCI/L)	AVERAGE RESULT (PCI/L)	NUMBER OF TESTS	MAXIMUM RESULTS (PCI/L)	AVERAGE RESULT (PCI/L)
19002	7,439	150.1	4.3	1,791	99.1	2.5
19006	4,453	176.0	4.6	1,160	37.5	2.5
19007	1,333	29.6	2.3	379	7.4	1.3
19020	3,911	341.4	3.7	1,587	94.9	2.2
19021	506	31.2	3.1	177	8.0	1.6
19030	687	34.9	3.6	507	24.8	2.5
19040	2,825	76.6	3.6	766	19.6	2.0
19044	2,619	155.0	4.2	1,003	38.4	2.1
19047	6,060	195.9	3.8	2,111	56.2	2.0
19053	2,296	83.1	4.3	617	40.7	2.4
19054	284	305.0	3.7	344	29.5	1.5
19055	71	68.9	4.9	208	16.2	1.3
19056	168	15.0	3.1	379	26.3	1.8
19057	129	16.2	2.4	304	22.9	1.5
19067	16,227	351.5	4.0	4,695	79.3	2.1
19114	1,078	31.9	2.3	362	11.3	1.3
19116	1,604	132.0	3.2	505	29.9	1.9
19154	1,053	39.1	1.6	295	10.7	1.2
19440	2,687	395.1	3.4	700	18.2	1.7
19446	11,375	891.6	4.3	3,145	113.0	2.0
19454	5,776	114.2	3.8	1,684	22.6	1.9

4.3.10.4. *Future Occurrence*

Radon exposure retains a significant probability given present soil, geologic, and geomorphic factors in Bucks County. Future occurrence of high radon level hazards can be considered *possible* by the Risk Factor Methodology probability criteria (See Table 4.4.1-1). 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 high vulnerability areas as shown in Figures 4.3.10-3 and 4.3.10-4, 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 additional risk, although this type of exposure is low and rare in Pennsylvania.

Proper testing for radon levels should be completed across Bucks County, especially in 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 EPA determines that an average radon mitigation system costs $1,200. The EPA also states that current state surveys show that 1 home in 5 has elevated radon levels. Using this methodology, radon loss estimation is factored by assuming that 20% of the buildings within the ZIP codes with elevated rest results have elevated radon values and each would require a radon mitigation system installed at the EPA estimated average of $1,200. According to the Pennsylvania State Hazard Mitigation Plan, Carbon County has 229,503 buildings in areas with high radon test results, while approximately 20%, or 45,901, of these buildings will be impacted. The estimated costs for radon mitigation total $55,080,720 (PEMA, 2019).

Radon exposure has minimal environmental impacts. Due to the relatively short half-life of radon, it tends to only affect living and breathing organisms such as humans or pets which are routinely in contained areas (i.e. basement or house) where the gas is released.

4.3.11. Subsidence, Sinkhole

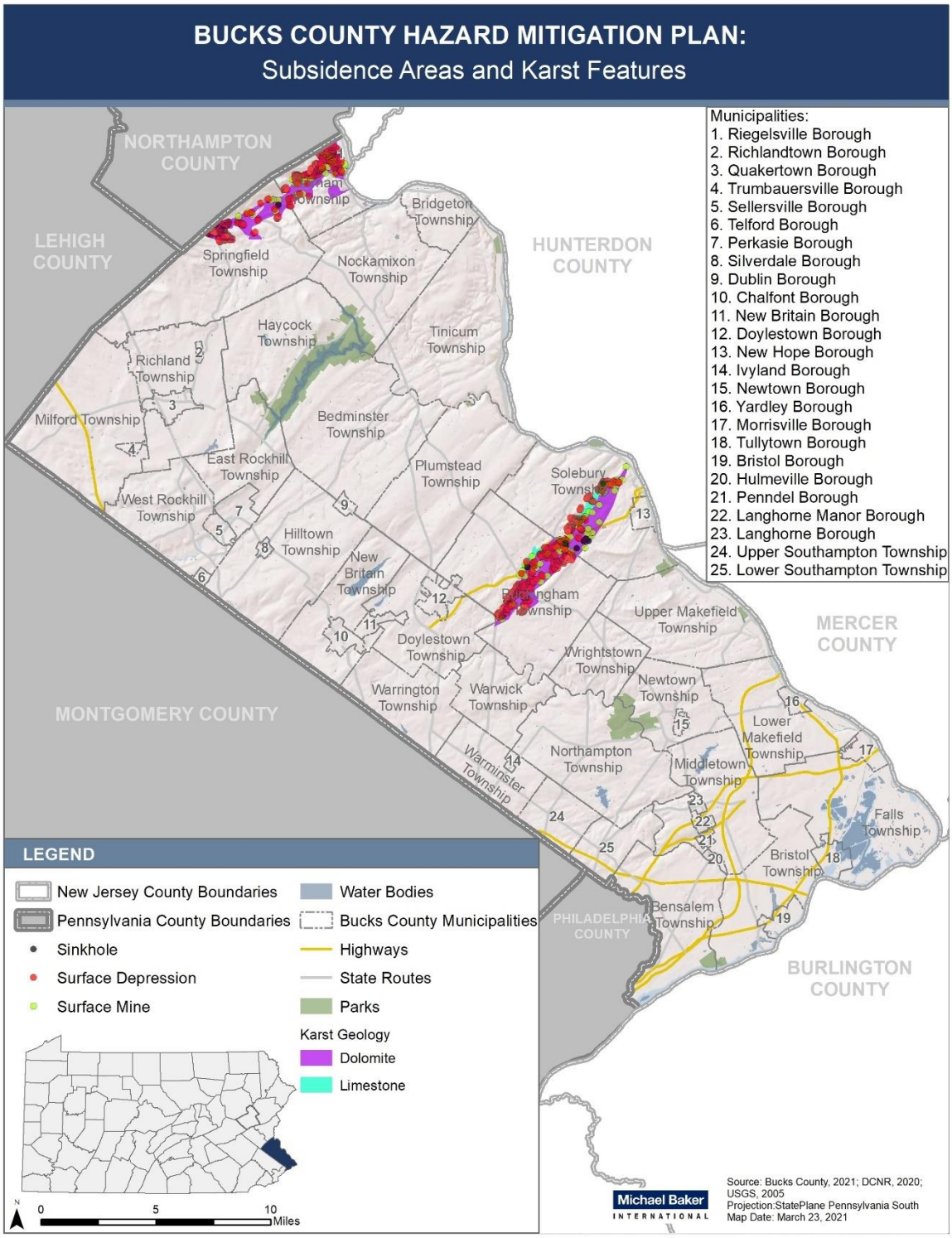
4.3.11.1. *Location and Extent*

There are two common causes of subsidence in Pennsylvania. Dissolution of carbonate rock such as limestone or dolomite, and mining activity. In the first case, water passing through naturally occurring fractures and bedding planes dissolves bedrock leaving voids below the surface. Eventually, overburden on top of the voids collapses, leaving surface depressions resulting in karst topography. Characteristic structures associated with karst topography include sinkholes, linear depressions, and caves. Collapse sometimes occurs only after a large amount of activity, or when a heavy burden is placed on the overlying material. This type of subsidence is fairly localized in extent.

In Pennsylvania, research has shown that subsidence may occur, but will not necessarily occur, in areas underlain by carbonate bedrock. Figure 4.3.11-1 shows that a small portion of Bucks County is underlain by carbonate bedrock (i.e., limestone). This stretch lies over parts of Buckingham and Solebury Township. Sinkholes in Pennsylvania are also often due to subsurface mining. There are two strips of underground mines: one in the northern area, and one stretching across the central part of the County on the existing carbonate bedrock. The northern area lies over parts of Durham and Springfield Townships and Riegelsville Borough.

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.

Figure 4.3.11-1 Locations with subsidence potential in Bucks County



4.3.11.2. *Range of Magnitude*

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 determine the magnitude of damage incurred. Based on the geologic formations underlying parts of Bucks County, subsidence and sinkhole events may occur gradually or abruptly. Events could result in minor elevation changes or deep, gaping holes in the ground surface. Subsidence and sinkhole events can cause severe damage in urban environments, although gradual events can be addressed before significant 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.

General recommendations have been published for site investigations prior to construction of buildings due to the potential for karst subsidence. These recommendations include thorough geotechnical investigations to identify un-collapsed karst features and potential excavation to solid rock prior to construction.

Groundwater in limestone and other similar carbonate rock formations can be easily polluted, because water moves readily from the Earth's surface down through solution cavities and fractures, thus undergoing very little filtration. Contaminants such as sewage, fertilizers, herbicides, pesticides, or industrial products are of concern.

Bucks County is located in three physiographic regions: the Gettysburg-Newark Lowland Section, the Piedmont Upland Section, and the Lowland and Intermediate Upland Section. The Gettysburg-Newark Lowland Section is characterized by rolling lowlands, shallow valleys, and isolated hills with mainly red shale, siltstone, and sandstone underlying rock types. The Piedmont Upland Section is characterized by broad, rounded to flat-topped hills and shallow valleys with mainly schist, gneiss, and quartzite underlying rock types with some saprolite rock as well. The Lowland and Intermediate Upland Section is characterized by flat upper terrace surface cut by shallow valleys located in the Delaware River floodplain with poorly consolidated sand and gravel underlain by schist, gneiss, and other metamorphic rocks as the underlying rock types. Many of these underlying rock types can contribute to karst topography.

The magnitude of land subsidence and sinkholes in Bucks County can be moderate as there have been past occurrences of land subsidence. Experience in Pennsylvania shows that subsidence may cause from a fraction of an inch to several feet of sagging of the surface of the earth and may occur within minutes or over several years.

According to the PADEP, structural damages due to subsidence range from slight damage requiring cosmetic repairs to severe damage requiring foundation replacement or other high cost repairs.

A worst-case scenario for subsidence and sinkholes would be if a sinkhole occurred under a densely populated part of the County or a critical facility such as a hospital. Not only could structural damage occur to the building(s), but there could also be injuries to people as well. In addition, any damage buildings or infrastructure would have to be closed in order to repair the structural damage, and this would reduce the community's capacity to complete day to day functions.

4.3.11.3. *Past Occurrence*

The Pennsylvania Department of Conservation and Natural Resources (DCNR) maintains an online *Sinkhole Inventory Database* of sinkholes throughout the Commonwealth. The database was last updated in May 2020 and includes the most recent data available at the time of drafting this plan. 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 2016 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 (DCNR, 2020a).

4.3.11.4. *Future Occurrence*

Based on geological conditions, subsidence events may possibly occur in the future for the areas in Bucks County underlain by carbonate rock, or by mines. Sinkholes and surface depressions are dependent on several variables, including land use and water management. Changes in these variables can affect the likelihood and frequency of future subsidence events. Overall, though, the probability of future subsidence and sinkhole events can be considered *possible* according to the Risk Factor Methodology (see Table 4.4.1-1).

4.3.11.5. *Vulnerability Assessment*

The secondary effects of sinkhole formation have the potential to cause significant impacts in communities underlain by surface-level limestone, including structural damage, damage to transportation systems, and damage to subsurface utility systems. Structures and critical facilities located over limestone and dolomite bedrock are considered vulnerable to sinkholes and are inventoried in Table 4.3.11-1. Solebury Township has the greatest number of structures on limestone (38), and the greatest percentage (1%). There is only one critical facility located on limestone, located in Solebury Township. Solebury Township and Buckingham Township are the only two communities within Bucks County vulnerable to limestone-related sinkholes. Springfield Township has also noted an additional vulnerability to subsidence. Currently, the Adelphia pipeline is being constructed and installed throughout the County, and will run through Springfield Township, which is a jurisdiction in Bucks County

that has karst topography. The disruption the construction of this pipeline may cause to the already karst area makes Springfield Township potentially even more vulnerable to subsidence as well as the potential impacts of liquid and gas pipelines. Table 4.3.11-2 identifies the number of structures in each municipality located in subsidence areas susceptible to subsidence by land use type. The land use type displaying the greatest vulnerability to subsidence is residential.

Table 4.3.11-1 Structures and critical facilities vulnerable to subsidence in Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES ON LIMESTONE	PERCENT STRUCTURES ON LIMESTONE	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES ON LIMESTONE	PERCENT CRITICAL FACILITIES ON LIMESTONE
Bedminster Township	3,229	0	0%	14	0	0%
Bensalem Township	19,450	0	0%	52	0	0%
Bridgeton Township	782	0	0%	2	0	0%
Bristol Borough	3,893	0	0%	15	0	0%
Bristol Township	19,543	0	0%	52	0	0%
Buckingham Township	8,315	22	0%	21	0	0%
Chalfont Borough	1,674	0	0%	8	0	0%
Doylestown Borough	3,236	0	0%	20	0	0%
Doylestown Township	6,441	0	0%	27	0	0%
Dublin Borough	595	0	0%	4	0	0%
Durham Township	653	0	0%	1	0	0%
East Rockhill Township	2,429	0	0%	9	0	0%
Falls Township	11,540	0	0%	29	0	0%
Haycock Township	1,227	0	0%	2	0	0%
Hilltown Township	6,265	0	0%	14	0	0%
Hulmeville Borough	392	0	0%	4	0	0%
Ivyland Borough	371	0	0%	4	0	0%
Langhorne Borough	544	0	0%	5	0	0%
Langhorne Manor Borough	345	0	0%	5	0	0%
Lower Makefield Township	13,037	0	0%	22	0	0%
Lower Southampton Township	7,706	0	0%	21	0	0%
Middletown Township	15,585	0	0%	40	0	0%

Table 4.3.11-1 Structures and critical facilities vulnerable to subsidence in Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES ON LIMESTONE	PERCENT STRUCTURES ON LIMESTONE	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES ON LIMESTONE	PERCENT CRITICAL FACILITIES ON LIMESTONE
Milford Township	4,370	0	0%	16	0	0%
Morrisville Borough	3,134	0	0%	11	0	0%
New Britain Borough	1,145	0	0%	5	0	0%
New Britain Township	4,755	0	0%	18	0	0%
New Hope Borough	1,385	0	0%	6	0	0%
Newtown Borough	1,026	0	0%	6	0	0%
Newtown Township	8,258	0	0%	28	0	0%
Nockamixon Township	1,812	0	0%	10	0	0%
Northampton Township	14,767	0	0%	29	0	0%
Penndel Borough	719	0	0%	5	0	0%
Perkasie Borough	3,381	0	0%	10	0	0%
Plumstead Township	5,789	0	0%	18	0	0%
Quakertown Borough	3,163	0	0%	17	0	0%
Richland Township	6,250	0	0%	10	0	0%
Richlandtown Borough	437	0	0%	3	0	0%
Riegelsville Borough	453	0	0%	3	0	0%
Sellersville Borough	1,887	0	0%	7	0	0%
Silverdale Borough	336	0	0%	3	0	0%
Solebury Township	4,297	38	1%	13	1	8%
Springfield Township	2,696	0	0%	9	0	0%
Telford Borough	676	0	0%	2	0	0%
Tinicum Township	2,345	0	0%	11	0	0%
Trumbauersville Borough	374	0	0%	4	0	0%
Tullytown Borough	794	0	0%	7	0	0%
Upper Makefield Township	3,748	0	0%	7	0	0%

Table 4.3.11-1 Structures and critical facilities vulnerable to subsidence in Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES ON LIMESTONE	PERCENT STRUCTURES ON LIMESTONE	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES ON LIMESTONE	PERCENT CRITICAL FACILITIES ON LIMESTONE
Upper Southampton Township	6,149	0	0%	18	0	0%
Warminster Township	11,572	0	0%	31	0	0%
Warrington Township	9,037	0	0%	25	0	0%
Warwick Township	6,167	0	0%	16	0	0%
West Rockhill Township	2,353	0	0%	10	0	0%
Wrightstown Township	1,474	0	0%	7	0	0%
Yardley Borough	1,349	0	0%	7	0	0%
TOTAL	243,350	60	0%	743	1	0%

Table 4.3.11-2 Structures by Land Use Subsidence Vulnerability in Bucks County (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INUDSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Bedminster Township	3,229	0	0	0	0	0	0	0	0	0
Bensalem Township	19,450	0	0	0	0	0	0	0	0	0
Bridgeton Township	782	0	0	0	0	0	0	0	0	0
Bristol Borough	3,893	0	0	0	0	0	0	0	0	0
Bristol Township	19,543	0	0	0	0	0	0	0	0	0
Buckingham Township	8,315	1	1	0	1	17	0	0	2	22
Chalfont Borough	1,674	0	0	0	0	0	0	0	0	0
Doylestown Borough	3,236	0	0	0	0	0	0	0	0	0
Doylestown Township	6,441	0	0	0	0	0	0	0	0	0
Dublin Borough	595	0	0	0	0	0	0	0	0	0
Durham Township	653	0	0	0	0	0	0	0	0	0
East Rockhill Township	2,429	0	0	0	0	0	0	0	0	0
Falls Township	11,540	0	0	0	0	0	0	0	0	0
Haycock Township	1,227	0	0	0	0	0	0	0	0	0
Hilltown Township	6,265	0	0	0	0	0	0	0	0	0
Hulmeville Borough	392	0	0	0	0	0	0	0	0	0
Ivyland Borough	371	0	0	0	0	0	0	0	0	0
Langhorne Borough	544	0	0	0	0	0	0	0	0	0
Langhorne Manor Borough	345	0	0	0	0	0	0	0	0	0
Lower Makefield Township	13,037	0	0	0	0	0	0	0	0	0
Lower Southampton Township	7,706	0	0	0	0	0	0	0	0	0
Middletown Township	15,585	0	0	0	0	0	0	0	0	0
Milford Township	4,370	0	0	0	0	0	0	0	0	0

Table 4.3.11-2 Structures by Land Use Subsidence Vulnerability in Bucks County (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INUDSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Morrisville Borough	3,134	0	0	0	0	0	0	0	0	0
New Britain Borough	1,145	0	0	0	0	0	0	0	0	0
New Britain Township	4,755	0	0	0	0	0	0	0	0	0
New Hope Borough	1,385	0	0	0	0	0	0	0	0	0
Newtown Borough	1,026	0	0	0	0	0	0	0	0	0
Newtown Township	8,258	0	0	0	0	0	0	0	0	0
Nockamixon Township	1,812	0	0	0	0	0	0	0	0	0
Northampton Township	14,767	0	0	0	0	0	0	0	0	0
Penndel Borough	719	0	0	0	0	0	0	0	0	0
Perkasie Borough	3,381	0	0	0	0	0	0	0	0	0
Plumstead Township	5,789	0	0	0	0	0	0	0	0	0
Quakertown Borough	3,163	0	0	0	0	0	0	0	0	0
Richland Township	6,250	0	0	0	0	0	0	0	0	0
Richlandtown Borough	437	0	0	0	0	0	0	0	0	0
Riegelsville Borough	453	0	0	0	0	0	0	0	0	0
Sellersville Borough	1,887	0	0	0	0	0	0	0	0	0
Silverdale Borough	336	0	0	0	0	0	0	0	0	0
Solebury Township	4,297	0	0	0	0	30	1	0	7	38
Springfield Township	2,696	0	0	0	0	0	0	0	0	0
Telford Borough	676	0	0	0	0	0	0	0	0	0
Tinicum Township	2,345	0	0	0	0	0	0	0	0	0
Trumbauersville Borough	374	0	0	0	0	0	0	0	0	0
Tullytown Borough	794	0	0	0	0	0	0	0	0	0

Table 4.3.11-2 Structures by Land Use Subsidence Vulnerability in Bucks County (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INUDSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Upper Makefield Township	3,748	0	0	0	0	0	0	0	0	0
Upper Southampton Township	6,149	0	0	0	0	0	0	0	0	0
Warminster Township	11,572	0	0	0	0	0	0	0	0	0
Warrington Township	9,037	0	0	0	0	0	0	0	0	0
Warwick Township	6,167	0	0	0	0	0	0	0	0	0
West Rockhill Township	2,353	0	0	0	0	0	0	0	0	0
Wrightstown Township	1,474	0	0	0	0	0	0	0	0	0
Yardley Borough	1,349	0	0	0	0	0	0	0	0	0
TOTAL	243,350	1	1	0	1	47	1	0	9	60

There are a few measures that can reduce the overall vulnerability to subsidence and sinkholes. Municipal governments may determine guidelines for construction in high-subsidence areas. A community can reduce its vulnerability to subsidence or sinkholes by implementing solutions such as land use controls, insurance programs, subsidence-resistant designs, or in the case of mine-related subsidence, conduct selective support or mine filling. If a sinkhole occurs on private property, it is normally the responsibility of the property owner to initiate repairs. Homeowners' insurance often does not cover damages attributed to subsidence. Since 1987, sinkhole insurance has been available within Pennsylvania and may serve to eliminate the financial burdens placed on the homeowner (PAID, 2021).

Careful planning is the least-costly and most effective method for reducing vulnerability to subsidence hazards. Municipalities can minimize the potential for sinkhole development through proper maintenance and updating of water utility lines. Zoning laws can also be enacted to regulate land development and transmission pipeline development within highly karst areas.

4.3.12. Tornado, Windstorm

4.3.12.1. *Location and Extent*

Tornadoes and potentially damaging high winds occur throughout Pennsylvania. Tornados and high winds may be experienced at any location in Bucks County.

A tornado, a violently rotating funnel-like vortex, is an extraordinary feature of severe thunderstorms. A condensation funnel does not need to reach to the ground for a tornado to be present; a debris cloud beneath a thunderstorm is all that is needed to confirm the presence of a tornado, even in the total absence of a funnel. 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.

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. May to August is the most likely time for tornadoes to occur in Pennsylvania. Tornado movement is characterized in two ways: direction and speed of the spinning winds and forward movement of the tornado/storm track. Rotational wind speeds of the vortex can range from 100 mph to more than 250 mph. In addition, the speed of forward motion can be zero to 45 or 50 mph.

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 often accompany tornadoes and are caused by the movement of air from areas of higher pressure to areas of lower pressure – the greater the difference in pressure, the stronger the winds. 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.

The destruction caused by tornadoes ranges from light to inconceivable depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damages to structures of light construction such as manufactured homes. The impact of tornado hazards is ultimately dependent on the population or amount of property present in the area in which the tornado occurs. Tornado events are often so severe that property loss or human fatality is typically inevitable if evacuation or proper construction standards are not implemented. The enhanced Fujita Tornado Scale (or the –EF-Scale) classifies U.S. tornadoes into six intensity categories, named EF0 to EF5, based upon the estimated maximum winds occurring within the funnel. The EF-Scale has subsequently become the definitive metric for estimating wind speeds within tornadoes based upon the damage done to buildings and structures.

4.3.12.2. *Range of Magnitude*

Since 2007 the EF Scale has been used in the United States to describe the magnitude of tornadoes. Prior to 2007, the Fujita Scale (F-Scale) was commonly used to describe magnitude. This scale is based on new information about the relationship between wind speed given in miles per hour (mph) and corresponding damages. The EF Scale categorized tornadoes from EF0 to EF5 with EF0 being the most commonly occurring type of tornado. The switch from the F-Scale to the EF Scale was made because the EF scale allows the ranges of windspeed in each category to be more accurate, and it takes into account more variables than the F-Scale. The strongest tornado recorded in Bucks County has been a category 2 or EF2 tornado. Table 4.3.12-1 lists the relationship between the EF- and F- Scales. The types of damages that can be expected with each category of tornado are described in Table 4.3.12-2.

Table 4.3.12-1 Enhanced Fujita Scale (EF-Scale) categories with associated wind speeds

FUJITA SCALE		ENHANCED FUJITA SCALE	
F NUMBER	3-SECOND GUST (MPH)	EF NUMBER	3-SECOND GUST (MPH)
0	45–78	0	65–85
1	79–117	1	86–110
2	118–161	2	111–135
3	162–209	3	136–165
4	210–261	4	166–200
5	262–317	5	OVER 200

Table 4.3.12-2 Expected Tornado Damages

F OR EF SCALE	EXAMPLES OF POSSIBLE DAMAGE
0	Light damage. Some damage to chimneys; broken tree branches; shallow-rooted trees pushed over; damage to sign boards.
1	Moderate damage. Surface peeled off roofs; manufactured homes pushed off foundations or overturned; moving autos pushed off roads.
2	Considerable damage. Roofs torn off frame houses; manufactured homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
3	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; cars lifted off ground and thrown.

Table 4.3.12-2 Expected Tornado Damages

F OR EF SCALE	EXAMPLES OF POSSIBLE DAMAGE
4	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown, and large missiles generated.
5	Catastrophic damage. Well-built houses swept completely away, leaving only the slab foundations.

Figure 4.3.6-1 in the Hurricane, Tropical Storm, and Nor'easter hazard profile 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 in Zone II, which is classified as a 160-mph wind zone. This meaning design wind speeds for shelters and critical facilities should be able to withstand a three second gust of up to 160 mph, regardless of whether the gust is the result of a tornado, hurricane, tropical storm, or windstorm event. In Bucks County, the jurisdictions have all adopted the Pennsylvania Uniform Construction Code, which includes the International Building Code (IBC) that requires all new residential and commercial structures to be designed to a 90-mph wind speed.

4.3.12.3. *Past Occurrence*

The most impactful tornado recorded in Bucks County was an F2 in July 1984 when 12 people were injured, and livestock were killed. Most injuries were a result of flying debris; however, three people were injured due to their automobile being picked up and thrown into a pond. Several houses and farm buildings were demolished. Four vehicles were totaled, with 40 more withstanding varying degrees of damage. Tornado magnitudes in Bucks County have never exceeded F2/EF2. F2/EF2 tornados have touched down in 1962, 1973, and 2020. The most recent tornado that moved through the County in 2020 reached wind speeds of up to 115 mph and traveled 20 miles through the County. Roofs were blown off buildings, trees were uprooted or snapped, cars were thrown around, siding was torn from homes and Doylestown Hospital and the associated Children's Village were hit (noted previously) (Seymour, 2020). Also, at least one home was moved from its foundation. Table 4.3.12-3 below summarizes previous tornado events in Bucks County.

Table 4.3.12-3 Previous Tornado Events Between 1950 and 2020 in Bucks County (NOAA NCEI, 2021).

LOCATION	DATE	MAGNITUDE	DEATH	INJURY	ESTIMATED DAMAGE ($)
Countywide	8/29/1950	F1	0	0	*$2,500*
Countywide	9/3/1961	F1	0	0	*$25,000*

Table 4.3.12-3 Previous Tornado Events Between 1950 and 2020 in Bucks County (NOAA NCEI, 2021).

LOCATION	DATE	MAGNITUDE	DEATH	INJURY	ESTIMATED DAMAGE ($)
Countywide	5/24/1962	F2	0	0	*$25,000*
Countywide	6/29/1973	F2	0	0	*$25,000*
Countywide	7/13/1975	F1	0	0	*$25,000*
Countywide	6/29/1982	F1	0	0	*$25,000*
Countywide	3/21/1983	F1	0	0	*$25,000*
Countywide	8/29/1983	F1	0	0	*$25,000*
Countywide	4/5/1984	F1	0	0	*$25,000*
Countywide	11/16/1989	F0	0	0	*$2,500,000*
Countywide	11/16/1989	F1	0	1	*$2,500,000*
Countywide	7/5/1990	F1	0	0	*$250,000*
Countywide	1/14/1992	F1	0	0	*$0*
Countywide	7/31/1992	F1	0	0	*$2,500*
Neshaminy	9/27/1993	F1	0	0	*$5,000,000*
Hilltown	6/6/1994	F1	0	0	*$50,000*
Silverdale	9/11/1997	F0	0	0	*$5,000*
Ottsville	5/19/2019	EF1	0	0	*$0*
Cornwell Heights	8/4/2020	EF2	0	6	*$0*
Belmont Hills	8/4/2020	EF2	0	6	*$0*

High winds moving in a straight line are the movement of air from areas of higher pressure to areas of lower pressure. As the difference in pressure increases, the strength and speed of the winds increase. As previously mentioned, windstorms are generally defined as having sustained straight-line wind speeds of 40 mph or greater that last for one hour or longer, or winds of 58 mph (i.e. 50 knots) or greater for any duration. In 2015-2020 alone, windstorm events caused two injuries and $31,110 in property damage. Previous high wind events in the County from 2000-2020 are summarized in Table 4.3.12-4, the full list of previous high wind events from 1950-2020 is found in Appendix H. From 1950-2020, no deaths, 13 injuries, $1,383,000 in property damage, and no crop damage has been the result of high winds in the County.

Table 4.3.12-4 Previous Windstorm Events Greater than 50 Knots in Bucks County Between 2000 and 2020 (NOAA NCEI, 2021).

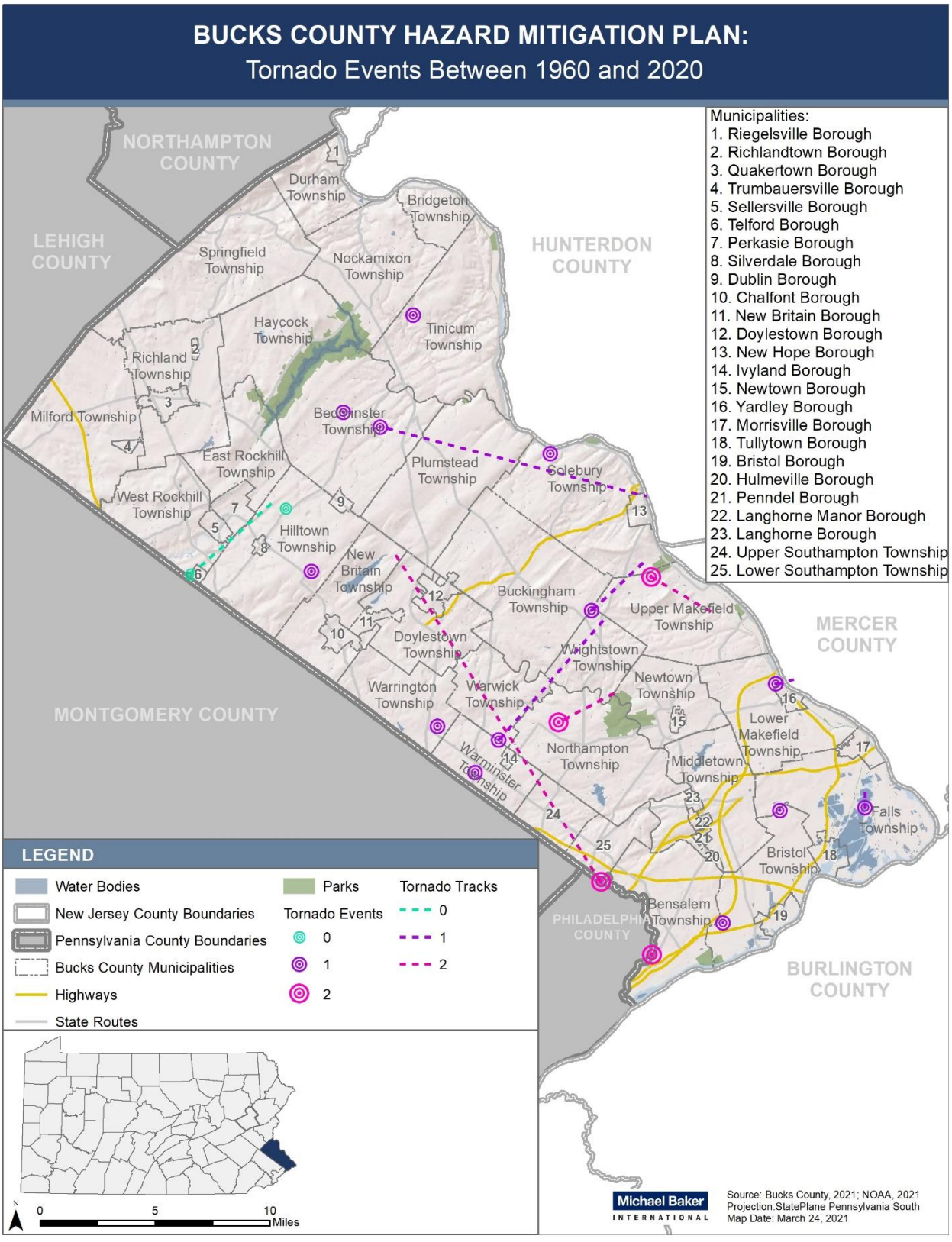
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
2000					1					1			2

Table 4.3.12-4 Previous Windstorm Events Greater than 50 Knots in Bucks County Between 2000 and 2020 (NOAA NCEI, 2021).

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
2001				2		3	2	2					9
2002			1	2	5	7	2	1					18
2003						1	2	5	1	1			10
2004					3	3	3	4					13
2005	1				1	1	2	2					7
2006		1				1	6	1					9
2007					3	7	1						11
2008			1			3	2						6
2009					1	3	3	1		1		1	10
2010					4	1	2				3		10
2011				1	1	2	3	3					10
2012					6		6	4	2			4	22
2013	2	1	1			1		1		1	2		9
2014	2		2		3	2	6						15
2015	1	4	1										6
2016		1	1				5	2					9
2017		2				4	1	7					14
2018			2	2							1		5
2019		2		3	4	5	10	3		7			34
2020		4	1	4		14	11	21			9		64
TOTAL	6	15	10	14	32	58	67	57	3	11	15	5	293

Figure 4.3.12-1 below identifies locations that tornado activity has occurred throughout the County.

Figure 4.3.12-1 Tornadoes That Have Touched Down in Bucks County



4.3.12.4. *Future Occurrence*

Twenty tornadoes were reported for Bucks County for the entire 1950–2020 period in NCEI. Therefore, the annual probability of being in the path of a tornado in Bucks County is relatively minor. While the chance of being hit by a tornado is small, the damage that results when the tornado arrives can be potentially devastating. According to NCDC, there have been over 300 wind events in Bucks County between 1950 and 2020. The probability of tornadoes and windstorms in Bucks County can be considered *possible* as defined by the Risk Factor Methodology probability criteria (see Table 4.4.1-1).

4.3.12.5. *Vulnerability Assessment*

For tornadoes or high winds, aged and dilapidated structures or structures not built to applicable building codes are more susceptible to damage. Manufactured homes and campgrounds are especially susceptible to damage due to tornado or high wind. Strong winds can rip roofs off of any dilapidated structures and overturn manufactured homes. Past experience with tornadoes in Bucks County shows that death and injury are indeed possibilities.

Vulnerability to the effects of a tornado or high wind is somewhat dependent upon the age of a structure because as building codes become more stringent, buildings are capable of enduring greater wind forces.

In Bucks County, high winds occur annually. The most common detrimental effects are interruptions in power supply and communications services due to downed wires and blocked roadways due to downed trees. Most severe power failures or outages are regional events. With the loss of power, electrical-powered equipment and systems will not be operational. Examples include lighting, HVAC and ancillary support equipment, communication systems, ventilation system, refrigerators, sterilizers, and medical equipment. This can cause food spoilage, loss of heat or air conditions, basement flooding (sump pump failure), lack of light, loss of water (well pump failure), lack of phone service, or lack of internet. While it is most often a short-term nuisance rather than a catastrophic hazard, utility interruptions can cause challenges for communications and response, particularly in more rural areas of the county. A worst-case scenario for utility interruption in Bucks County would involve a power outage during winter snow or ice storms, which have the potential to cause power outages for prolonged periods of time.

High winds often occur during hurricanes, tropical storms, and nor'easters. Information about potential annualized losses due to hurricane winds can be found in Section 4.3.6.

All structures and infrastructure might be exposed to the effects of a tornado or other high winds. Depending upon the severity of a tornado or high wind, any existing structures might be damaged to some extent. Any future structures might be exposed to tornados or high winds as this hazard does not occur in specific locations. However, future buildings will be

somewhat protected from the effects of tornado or high wind as they will meet the most current State building code requirements for bracing and roof design.

Manufactured housing (i.e. manufactured homes or trailers) is particularly vulnerable to high winds and tornadoes. The U.S. Census Bureau defines manufactured homes as "movable dwellings, eight feet or wider and 40 feet or longer, design to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (US Census, 2019)." They can include multi-wide and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their lightweight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage.

Table 4.3.12-5 below lists the number of manufactured housing units per municipality in Bucks County. Falls Township, Bensalem Township, and Buckingham Township are the most vulnerable, having 1,279, 748, and 635 manufactured homes, respectively. Doylestown Township, Hilltown Township, Lower Southampton Township, New Britain Township, Plumstead Township, and Richland Township all have over 100 manufactured homes as well. Falls Township and Buckingham Township have the highest proportions of manufactured homes, with 11% and 8% manufactured homes respectively.

Table 4.3.12-5 Estimated Manufactured Homes Per Municipality (Bucks County GIS, 2021).

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN MANUFACTURED HOME PARCELS	PERCENT MANUFACTURED HOMES
Bedminster Township	3229	8	0%
Bensalem Township	19,450	748	4%
Bridgeton Township	782	0	0%
Bristol Borough	3,893	0	0%
Bristol Township	19543	0	0%
Buckingham Township	8315	635	8%
Chalfont Borough	1,674	0	0%
Doylestown Borough	3236	0	0%
Doylestown Township	6441	157	2%
Dublin Borough	595	0	0%
Durham Township	653	0	0%
East Rockhill Township	2,429	0	0%
Falls Township	11,540	1279	11%
Haycock Township	1227	0	0%
Hilltown Township	6265	114	2%
Hulmeville Borough	392	0	0%
Ivyland Borough	371	0	0%

Table 4.3.12-5 Estimated Manufactured Homes Per Municipality (Bucks County GIS, 2021).

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN MANUFACTURED HOME PARCELS	PERCENT MANUFACTURED HOMES
Langhorne Borough	544	0	0%
Langhorne Manor Borough	345	0	0%
Lower Makefield Township	13037	0	0%
Lower Southampton Township	7706	329	4%
Middletown Township	15,585	0	0%
Milford Township	4,370	34	1%
Morrisville Borough	3,134	0	0%
New Britain Borough	1,145	82	7%
New Britain Township	4,755	102	2%
New Hope Borough	1,385	0	0%
Newtown Borough	1,026	0	0%
Newtown Township	8258	0	0%
Nockamixon Township	1,812	0	0%
Northampton Township	14767	0	0%
Penndel Borough	719	0	0%
Perkasie Borough	3381	0	0%
Plumstead Township	5,789	233	4%
Quakertown Borough	3163	0	0%
Richland Township	6250	416	7%
Richlandtown Borough	437	0	0%
Riegelsville Borough	453	0	0%
Sellersville Borough	1,887	0	0%
Silverdale Borough	336	0	0%
Solebury Township	4,297	0	0%
Springfield Township	2,696	0	0%
Telford Borough	676	0	0%
Tinicum Township	2,345	31	1%
Trumbauersville Borough	374	0	0%
Tullytown Borough	794	6	1%
Upper Makefield Township	3,748	0	0%
Upper Southampton Township	6149	0	0%
Warminster Township	11572	0	0%
Warrington Township	9,037	0	0%
Warwick Township	6,167	0	0%
West Rockhill Township	2,353	98	4%
Wrightstown Township	1,474	0	0%

Table 4.3.12-5 Estimated Manufactured Homes Per Municipality (Bucks County GIS, 2021).

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES IN MANUFACTURED HOME PARCELS	PERCENT MANUFACTURED HOMES
Yardley Borough	1349	0	0%
TOTAL	243,350	4,272	2%

Environmental impacts from tornadoes can include debris in streams, wetlands, and other sensitive environmental features. Tree damage is commonly seen after high wind events. Hazardous material facilities should meet design requirements for the wind zones identified in Figure 4.3.6-1 in order to prevent release of hazardous materials into the environment.

4.3.13. Wildfire

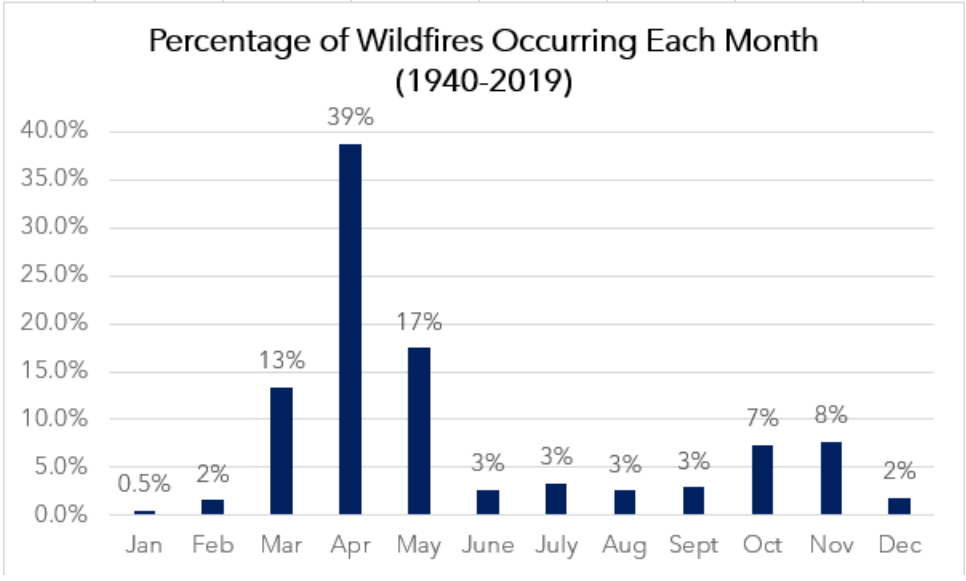
4.3.13.1. *Location and Extent*

A wildfire is an uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures. A wildland fire is a wildfire in an area in which development is essentially nonexistent, except for roads, railroads, power lines, and similar facilities. An urban-wildland interface fire is a wildfire in a geographical area where structures and other human development meet or intermingle with wildland or vegetative fuels.

Wildfires can occur at any time of the year but are most likely to occur in the County during a drought. Wildland fires in Pennsylvania can occur in fields, grass, and brush as well as in the forest itself. Under dry conditions or drought, wildfires have the potential to burn forests as well as croplands. 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 between 1940 and 2019 is shown in Figure 4.3.13-1. This pattern is consistent with wildfires in Bucks County.

Any small fire in a wooded area, if not quickly detected and suppressed, can get out of control. Most wildland fires are caused by human carelessness, negligence, and ignorance. In 2017, debris burning accounted for the largest number of wildfires, while incendiary causes accounted for the largest number of acres burned in Pennsylvania (DCNR, 2017). However, some are precipitated by lightning strikes and in rare instances, spontaneous combustion.

Figure 4.3.13-1 Percentage of Wildfires Occurring Each Month (DCNR, 2019).



Bucks County is generally urban in nature, consisting of large tracts of residential areas with commercial and industrial sprinkled throughout the County. However, a wildfire could develop in any portion of the County. The most high-risk areas of the County are at the forest-urban interface, where the potential for wildfire to spread to structures is greatest.

4.3.13.2. *Range of Magnitude*

Wildfire events can range from small fires that can be managed by local firefighters to large fires impacting many acres of land. Large events may require evacuation from one or more communities and necessitate regional or national firefighting support. The impact of a severe wildfire can be devastating. A wildfire has the potential to kill people, livestock, fish, and wildlife. They often destroy property, valuable timber, and forage, recreational, and scenic values.

Vegetation loss is often an environmental concern with wildfires, but it typically is not a serious impact in that they burn dead trees, leaves, and grasses to allow more open space 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 pinecones and other seed pods. The most significant negative impact the potential for severe erosion, silting of stream beds and reservoirs, and flooding due to ground-cover loss following a fire event.

In addition to the risk wildfires pose to the general public and property owners, the safety of firefighters is also a concern. Although loss of life among firefighters does not occur often in Pennsylvania, it is always a risk. More common firefighting injuries include falls, sprains, abrasions, or heat-related injuries such as dehydration. Response to wildfires also exposes emergency responders to the risk of motor vehicle accidents and can place them in remote acres away from the communities that they are chartered to protect.

4.3.13.3. *Past Occurrence*

Sixty-one wildfire events were reported to the Pennsylvania Department of Conservation and Natural Resources Bureau of Forestry between 2002 and 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. However, it is the most comprehensive list of wildfire occurrences available for this time period in Bucks County. Table 4.3.13-1 list the number of wildfire events and acres burned by municipality from 2002-2013. Appendix H lists each wildfire event that occurred in this time period.

Table 4.3.13-1 Number of wildfire events and acres burned in Bucks County from 2002-2013 (DCNR, 2014).

MUNICIPALITY	NUMBER OF FIRES	ACRES BURNED
Bedminster Township	1	1.2
Bridgeton Township	1	1.2
Bristol Township	2	16.1
Buckingham Township	1	1
Durham Township	1	0.3
East Rockhill Township	5	0.81

Table 4.3.13-1 Number of wildfire events and acres burned in Bucks County from 2002-2013 (DCNR, 2014).

MUNICIPALITY	NUMBER OF FIRES	ACRES BURNED
Haycock Township	6	6.1
Hilltown Township	1	0.75
Milford Township	4	10.66
Nockamixon Township	4	11.75
Plumstead Township	3	40
Quakertown Borough	1	0.01
Richland Township	8	5.8
Solebury Township	1	1.3
Springfield Township	21	20.86
West Rockhill Township	1	0.35
TOTAL	61	118.19

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 more than 20 acres while the smallest only consumed 0.01 acres.

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.

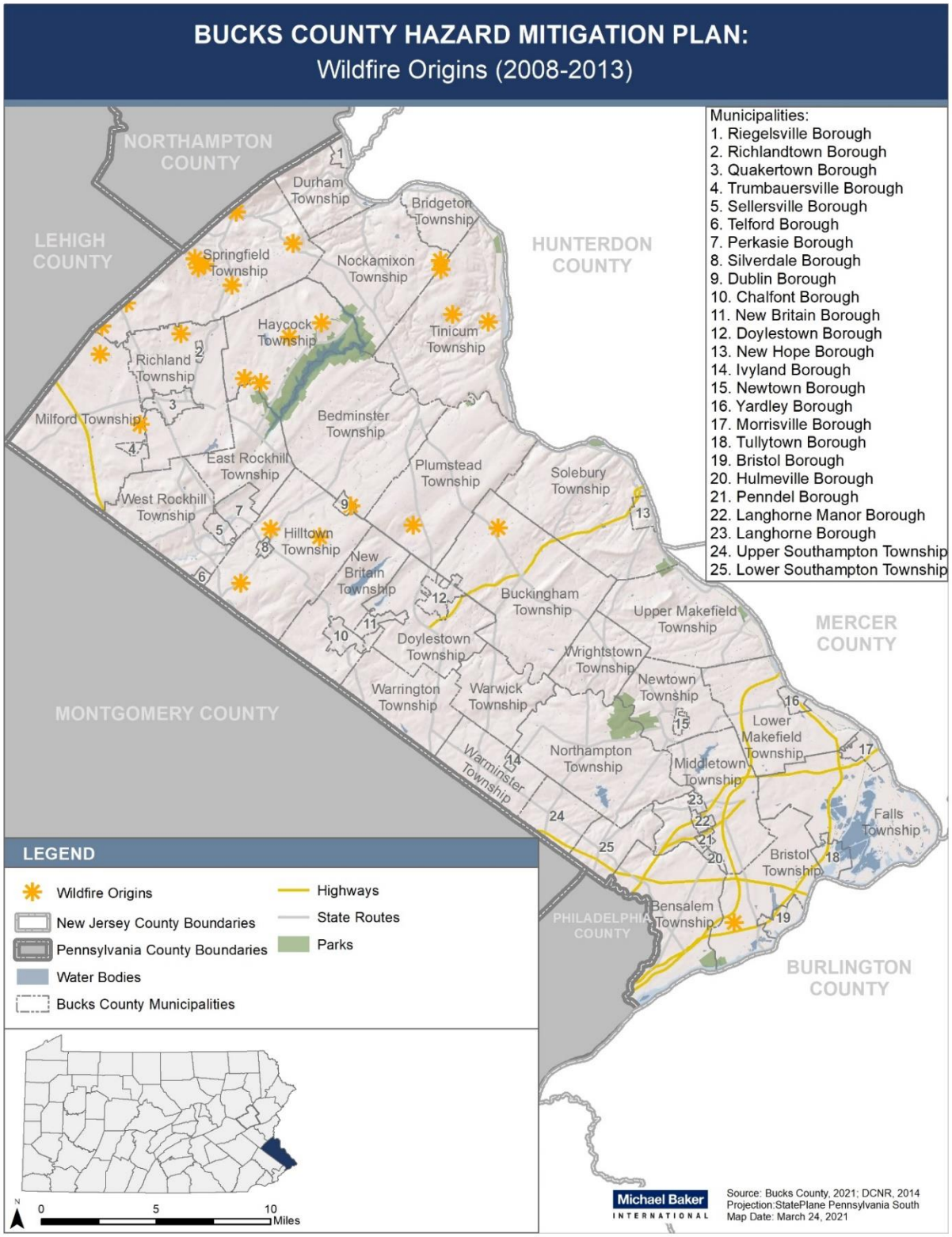
The DCNR Bureau of Forestry (BOF) no longer publicly reports wildfire incidents at the county or municipal level. Open data is available for State Forest Districts; Bucks County lies in State Forest District 17 (William Penn). District 17 consists of nine counties: Berks, Bucks, Chester, Delaware, Lancaster, Lehigh, Montgomery, Northampton, and Philadelphia. From 2014-2020, there were 526 wildfire events in District 17. This number does not include wildfires that were not reported to DCNR or that were controlled solely by the volunteer fire departments in the County, but it is the most current and comprehensive list of wildfire occurrences available for the region surrounding Bucks County. Table 4.3.13-2 lists number of wildfire events and total area burned as reported to DCNR.

Table 4.3.13-2 List of Wildfire Events Reported in PA State Forest District 17 from 2014 to 2020 (DCNR-BOF, 2020).

YEAR	TOTAL # OF FIRES	TOTAL AREA (ACRES)	% TOTAL FIRES	% TOTAL AREA (ACRES)
2014	71	123.5	8.2%	2.7%
2015	75	153.1	9.2%	3.7%
2016	49	133.3	5.7%	1.1%
2017	101	78.0	18.9%	4.7%
2018	66	45.1	9.6%	2.4%
2019	59	43.3	11.0%	6.2%
2020	105	89.4	7.0%	2.9%
Notes: % Total Fires and % Total area represent percentages of the entire state of Pennsylvania.				

Figure 4.3.13-2 maps the origins of the wildfire events which were reported to the DCNR. This is the most recent spatial data available from DCNR-BOF. It is important to note that this is not an inclusive map of all wildfires, just those with known locations. The map shows that previous occurrences of wildfires have occurred throughout the entire County between 2008 and 2013.

Figure 4.3.13-2 Wildfire Origins in Bucks County Between 2008 and 2013



4.3.13.4. *Future Occurrence*

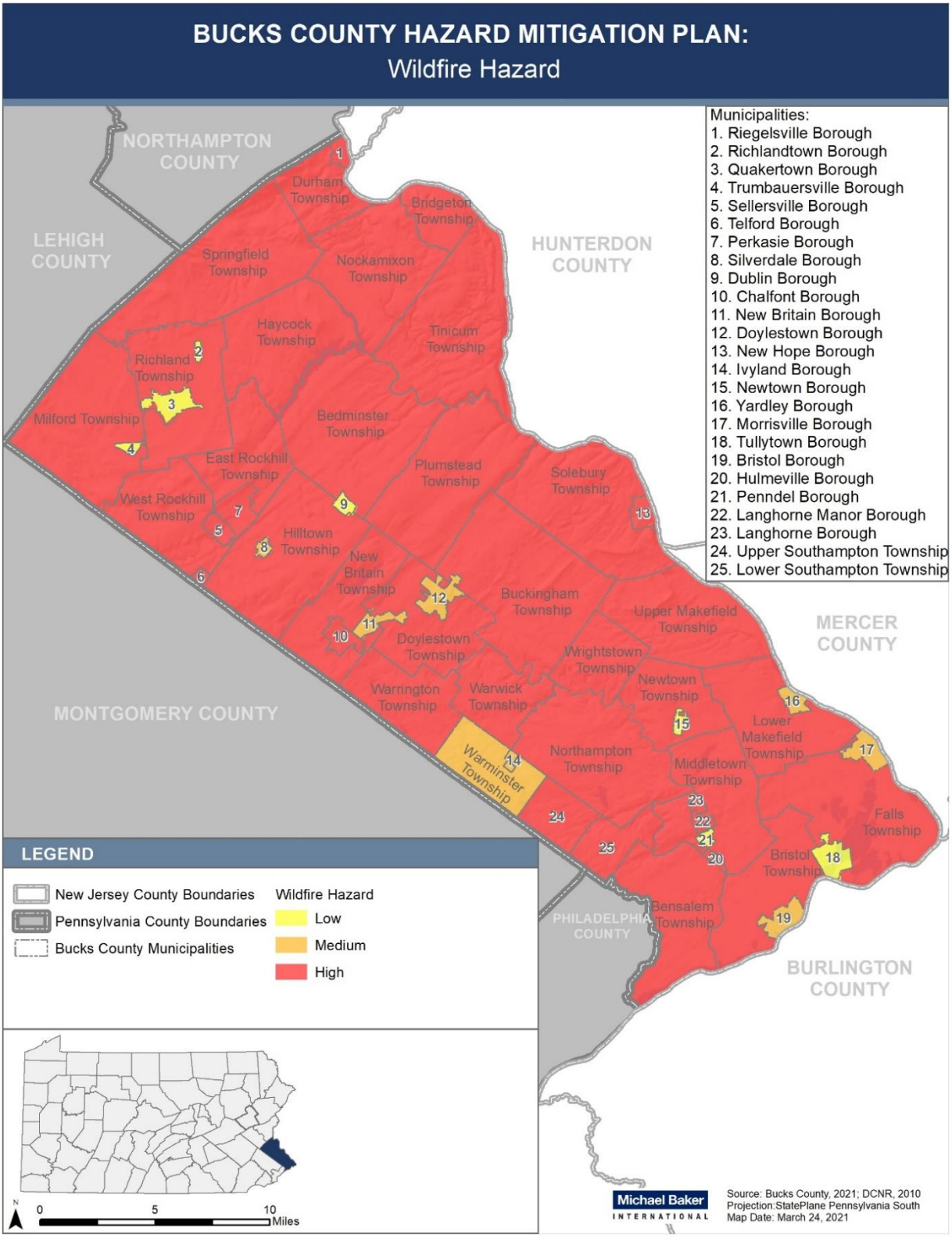
There have been over 500 wildfire events reported to the DCNR over the past six years. Previous events indicate that wildfires will continue to occur yearly in Bucks County. Therefore, the probability of a wildfire is estimated to be more than ninety percent in any given year and can be considered *likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4.1-1). The likelihood of a fire attaining significant size and intensity is unpredictable and highly dependent on environmental conditions and firefighting response.

4.3.13.5. *Vulnerability Assessment*

The DCNR-BOF has conducted an independent wildfire hazard risk assessment for the various municipalities across Bucks County. Results of that assessment are shown in Figure 4.3.13-3. *Wildfire hazard* is defined based on conditions that affect wildfire ignition and/or behavior such as fuel, topography and local weather. Based on this assessment, thirty-nine jurisdictions have a *high* wildfire rating. Eight municipalities within Bucks County have a *medium* wildfire hazard potential. Seven jurisdictions, generally denser suburban or urbanized areas, are considered to have *low* wildfire hazard potential.

Additionally, PEMA estimates that Bucks County as a whole has the second highest vulnerable population within the Commonwealth to wildfires at 29,628 people. Bucks County has the third highest amount of vulnerable buildings to wildfires with 10,462 buildings at $3,766,542 of value, 4.6% of the County's total building value.

Figure 4.3.13-3 Wildfire Hazard Potential per Municipality in Bucks County



Wildfires have the potential to destroy huge areas of vegetation with no regard to the man-made structures within those areas. The rural areas in which these fires occur generally have little firefighting infrastructure such as hydrants, and the fire departments servicing those areas may take extended times to reach and ultimately extinguish the fire.

Using this DCNR assessment, the parcels and critical facilities most vulnerable to wildfire hazards are those located within the thirty-nine high-rated jurisdictions. Table 4.3.13-3 lists the total structures and critical facilities located in each community and how they are vulnerable to wildfires. Please note that 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. Buckingham Township and Solebury Township have the largest number of structures within wooded areas (1,480 and 1,434 structures. Solebury Township, Tinicum Township, New Britain Township, and Upper Makefield Township, Warwick Township, and Springfield Township all have over 10% of their critical facilities located in wooded areas. These municipalities have the highest vulnerability to damages in a wildfire event.

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.

Table 4.3.13-4 lists the number of structures in each municipality located in areas susceptible to wildfire by land use type. The land use type displaying the greatest vulnerability to wildfire hazards is residential.

Table 4.3.13-3 Structures and Critical Facilities Vulnerable to Wildfires in Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES IN WOODED AREAS	PERCENT STRUCTURES IN WOODED AREAS	TOTAL CRITICAL FACILITIES	CRITICAL FACILIITES IN WOODED AREAS	PERCENT CRITICAL FACILITIES IN WOODED AREAS
Bedminster Township	3,229	615	19%	14	1	7%
Bensalem Township	19,450	801	4%	52	0	0%
Bridgeton Township	782	421	54%	2	0	0%
Bristol Borough	3,893	3	0%	15	0	0%
Bristol Township	19,543	235	1%	52	1	2%

Table 4.3.13-3 Structures and Critical Facilities Vulnerable to Wildfires in Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES IN WOODED AREAS	PERCENT STRUCTURES IN WOODED AREAS	TOTAL CRITICAL FACILITIES	CRITICAL FACILIITES IN WOODED AREAS	PERCENT CRITICAL FACILITIES IN WOODED AREAS
Buckingham Township	8,315	1,480	18%	21	0	0%
Chalfont Borough	1,674	43	3%	8	0	0%
Doylestown Borough	3,236	95	3%	20	0	0%
Doylestown Township	6,441	909	14%	27	1	4%
Dublin Borough	595	18	3%	4	0	0%
Durham Township	653	294	45%	1	0	0%
East Rockhill Township	2,429	877	36%	9	0	0%
Falls Township	11,540	171	1%	29	0	0%
Haycock Township	1,227	866	71%	2	0	0%
Hilltown Township	6,265	851	14%	14	1	7%
Hulmeville Borough	392	17	4%	4	0	0%
Ivyland Borough	371	12	3%	4	0	0%
Langhorne Borough	544	27	5%	5	0	0%
Langhorne Manor Borough	345	15	4%	5	0	0%
Lower Makefield Township	13,037	1,363	10%	22	1	5%
Lower Southampton Township	7,706	482	6%	21	1	5%
Middletown Township	15,585	666	4%	40	1	3%
Milford Township	4,370	1,049	24%	16	1	6%
Morrisville Borough	3,134	22	1%	11	0	0%
New Britain Borough	1,145	73	6%	5	0	0%
New Britain Township	4,755	592	12%	18	2	11%

Table 4.3.13-3 Structures and Critical Facilities Vulnerable to Wildfires in Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES IN WOODED AREAS	PERCENT STRUCTURES IN WOODED AREAS	TOTAL CRITICAL FACILITIES	CRITICAL FACILIITES IN WOODED AREAS	PERCENT CRITICAL FACILITIES IN WOODED AREAS
New Hope Borough	1,385	133	10%	6	0	0%
Newtown Borough	1,026	10	1%	6	0	0%
Newtown Township	8,258	328	4%	28	0	0%
Nockamixon Township	1,812	910	50%	10	0	0%
Northampton Township	14,767	774	5%	29	1	3%
Penndel Borough	719	5	1%	5	0	0%
Perkasie Borough	3,381	54	2%	10	0	0%
Plumstead Township	5,789	1,044	18%	18	1	6%
Quakertown Borough	3,163	34	1%	17	0	0%
Richland Township	6,250	930	15%	10	1	10%
Richlandtown Borough	437	0	0%	3	0	0%
Riegelsville Borough	453	15	3%	3	0	0%
Sellersville Borough	1,887	112	6%	7	0	0%
Silverdale Borough	336	3	1%	3	0	0%
Solebury Township	4,297	1,434	33%	13	4	31%
Springfield Township	2,696	1,247	46%	9	1	11%
Telford Borough	676	2	0%	2	0	0%
Tinicum Township	2,345	1,069	46%	11	2	16%
Trumbauersville Borough	374	2	1%	4	0	0%
Tullytown Borough	794	4	1%	7	0	0%
Upper Makefield Township	3,748	764	20%	7	1	14%

Table 4.3.13-3 Structures and Critical Facilities Vulnerable to Wildfires in Bucks County (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES IN WOODED AREAS	PERCENT STRUCTURES IN WOODED AREAS	TOTAL CRITICAL FACILITIES	CRITICAL FACILIITES IN WOODED AREAS	PERCENT CRITICAL FACILITIES IN WOODED AREAS
Upper Southampton Township	6,149	274	4%	18	0	0%
Warminster Township	11,572	197	2%	31	0	0%
Warrington Township	9,037	624	7%	25	0	0%
Warwick Township	6,167	363	6%	16	2	13%
West Rockhill Township	2,353	750	32%	10	0	0%
Wrightstown Township	1,474	516	35%	7	0	0%
Yardley Borough	1,349	89	7%	7	0	0%
TOTAL	243,350	23,684	10%	743	23	3%

Table 4.3.13-4 Structures Vulnerable to Wildfires by Generalized Land Use Type (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Bedminster Township	3,229	1	1	1	2	469	1	2	138	615
Bensalem Township	19,450	4	75	0	9	501	0	2	209	801
Bridgeton Township	782	5	17	0	1	322	0	0	76	421
Bristol Borough	3,893	0	3	0	0	0	0	0	0	3
Bristol Township	19,543	1	66	1	1	67	0	2	88	235
Buckingham Township	8,315	4	22	2	23	1257	1	7	164	1480
Chalfont Borough	1,674	0	12	0	0	28	0	0	3	43
Doylestown Borough	3,236	0	11	0	2	76	0	0	6	95
Doylestown Township	6,441	1	27	1	8	801	0	0	70	909
Dublin Borough	595	0	0	0	0	14	0	0	4	18
Durham Township	653	0	3	0	3	225	0	1	62	294
East Rockhill Township	2,429	9	35	0	7	637	0	0	189	877
Falls Township	11,540	7	37	3	5	67	0	1	51	171
Haycock Township	1,227	1	57	0	14	639	0	0	154	866
Hilltown Township	6,265	5	18	0	3	658	0	7	160	851
Hulmeville Borough	392	0	5	0	0	5	0	1	6	17
Ivyland Borough	371	0	2	0	0	8	0	0	2	12
Langhorne Borough	544	0	4	1	0	19	0	0	3	27
Langhorne Manor Borough	345	1	3	0	4	6	0	0	1	15
Lower Makefield Township	13,037	3	98	0	5	1076	0	2	179	1363
Lower Southampton Township	7,706	4	20	1	1	381	0	0	75	482
Middletown Township	15,585	9	50	0	6	447	0	3	151	666

Table 4.3.13-4 Structures Vulnerable to Wildfires by Generalized Land Use Type (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Milford Township	4,370	10	61	2	18	764	0	1	193	1049
Morrisville Borough	3,134	0	5	0	0	12	0	0	5	22
New Britain Borough	1,145	0	5	1	0	58	0	0	9	73
New Britain Township	4,755	7	25	2	7	461	0	0	90	592
New Hope Borough	1,385	1	4	0	4	101	0	1	22	133
Newtown Borough	1,026	0	0	0	1	7	0	0	2	10
Newtown Township	8,258	3	10	0	3	249	0	3	60	328
Nockamixon Township	1,812	6	40	0	6	659	0	1	198	910
Northampton Township	14,767	2	34	1	19	650	1	1	66	774
Penndel Borough	719	0	2	0	0	1	0	0	2	5
Perkasie Borough	3,381	1	10	0	2	27	0	0	14	54
Plumstead Township	5,789	2	28	0	15	792	0	1	206	1044
Quakertown Borough	3,163	2	5	0	0	22	0	0	5	34
Richland Township	6,250	54	45	0	6	471	0	1	353	930
Richlandtown Borough	437	0	0	0	0	0	0	0	0	0
Riegelsville Borough	453	0	1	0	0	5	0	0	9	15
Sellersville Borough	1,887	0	10	0	1	51	5	0	45	112
Silverdale Borough	336	0	0	0	0	3	0	0	0	3
Solebury Township	4,297	9	31	0	10	1185	1	7	191	1434
Springfield Township	2,696	7	13	0	10	892	1	1	323	1247
Telford Borough	676	0	1	0	1	0	0	0	0	2
Tinicum Township	2,345	4	30	1	14	781	0	0	239	1069

Table 4.3.13-4 Structures Vulnerable to Wildfires by Generalized Land Use Type (Bucks County GIS, 2021)

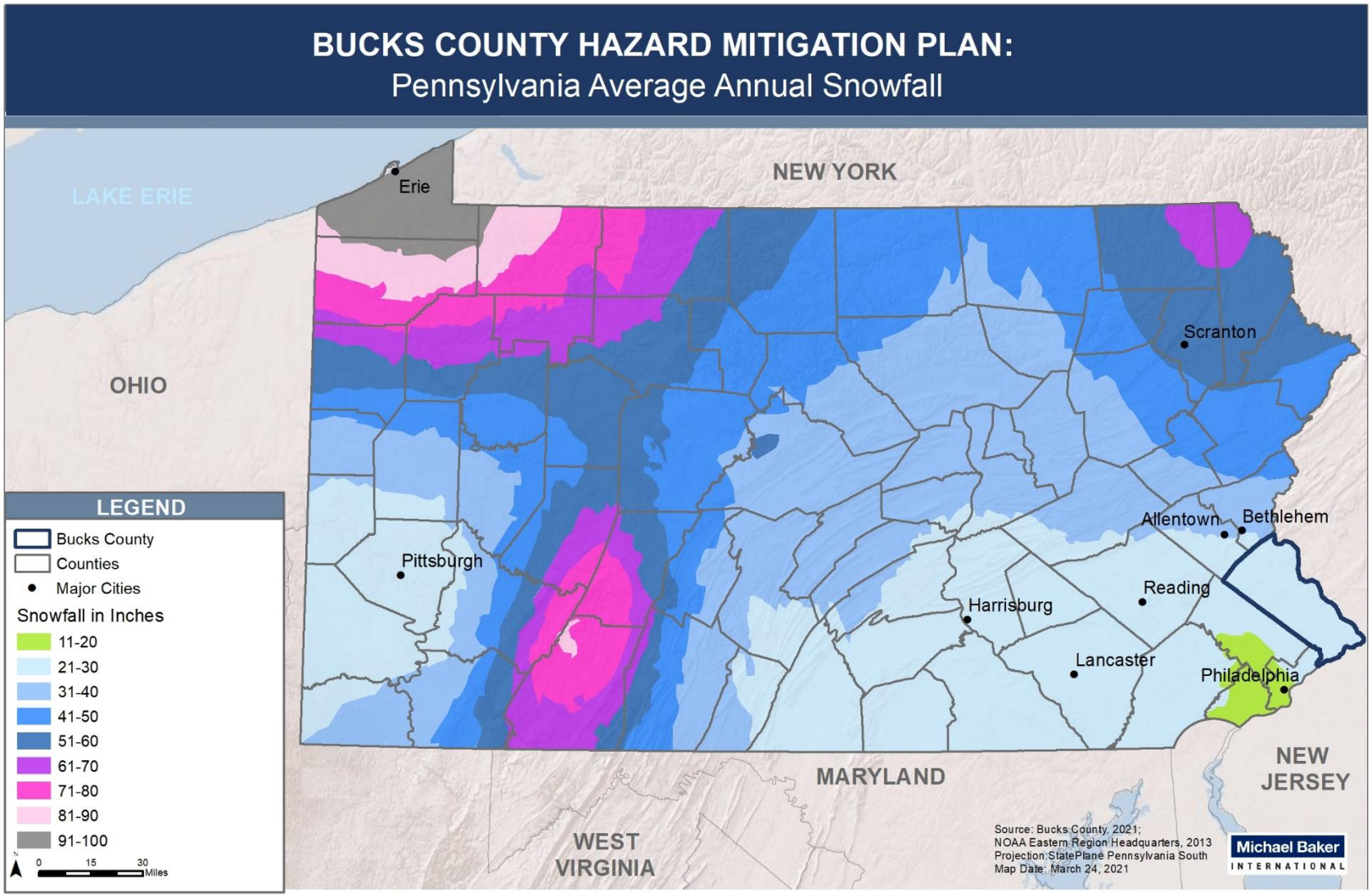
MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Trumbauersville Borough	374	0	2	0	0	0	0	0	0	2
Tullytown Borough	794	0	1	0	0	0	0	0	3	4
Upper Makefield Township	3,748	1	15	0	4	623	1	1	119	764
Upper Southampton Township	6,149	3	17	0	2	212	0	0	40	274
Warminster Township	11,572	2	11	1	3	133	21	0	26	197
Warrington Township	9,037	4	41	0	1	508	0	1	67	624
Warwick Township	6,167	6	47	1	5	250	0	4	50	363
West Rockhill Township	2,353	8	24	1	5	529	1	1	181	750
Wrightstown Township	1,474	4	13	0	4	347	0	12	136	516
Yardley Borough	1,349	0	0	0	0	80	0	0	9	89
TOTAL	243,350	191	1,097	20	235	17,576	33	64	4,454	23,684

4.3.14. Winter Storm

4.3.14.1. *Location and Extent*

Heavy snow or ice occurs throughout the Commonwealth of Pennsylvania. Every municipality in Bucks County is affected by these storms. Bucks County experiences all levels of winter storms from ice storms and freezing rain to heavy snow and blizzards. Generally, the average annual snowfall is consistent throughout the County, with the area receiving between 21 and 30 inches of snow annually (see Figure 4.3.14-1 below). This was the most current data available at the time of this HMP Update.

Figure 4.3.14-1 Average Annual Snowfall for Pennsylvania and Bucks County



4.3.14.2. *Range of Magnitude*

Winter storms consist of cold temperatures, heavy snow or ice and sometimes strong winds. Because winter storms are a regular occurrence in Bucks County, they are considered hazards only when they result in damage to specific structures and/or overwhelm local capabilities to handle disruptions to traffic, communications, and electric power. The cost of removing snow, repairing damages, especially from ice storms, and the loss to businesses can have a negative economic impact for communities. Winter storms can generate other hazards such as infrastructure disruption (blocked roads, severely damaged roads and power outages), human-caused hazards (traffic accidents and trapped vehicles), and technological problems (communication system outages and overload). Winter storms can adversely affect roadways, utilities, business activities, and can cause loss of life, frostbite, or freezing.

Winter 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 12-hour period.
- Sleet Storm: Sleet is formed when snow falling to the earth partially melts as it passes through a layer of warm air. The precipitation then passes through a cold layer of air and refreezes into solid pellets. Sleet causes surfaces to become slippery, posing hazards to pedestrians and motorists.
- Ice Storm: An ice storm occurs when rain freezes upon impact with the ground or other objects such as trees and power lines. Heavy accumulations of ice can bring down trees and topple utility poles, disrupting power and communication for days while crews make the necessary repairs. The icy conditions are also dangerous for pedestrians and vehicular traffic.
- Blizzard: According to the National Weather Service, a blizzard is a severe snowstorm that occurs when winds reach 35 mph or more. The blowing snow reduces visibility to less the one-quarter of a mile for at least three hours. Storms that meet these criteria are not frequent in Bucks County; however, storms that produce blizzard-like conditions are a common occurrence.
- Severe Blizzard: Wind velocity of 45 mph, 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.

A notable recent winter storm event occurred in January 2016 when a blizzard hit Bucks County. While the Philadelphia International Airport reported 22.4 inches of snow, suburbs around the city, including Bucks County, reported upwards of 30 inches of snow. Strong winds accompanied the heavy snowfall, closing businesses, shopping malls, and SEPTA Regional Rail for the weekend in late January (NOAA NCEI, 2021).

Another recent storm event occurred in 2021 when Winter Storm Oriena hit. Upper Bucks saw a range of 18-31 inches of snow from this event. Springtown Township saw the most snow accumulation with 31.2 inches reported. A winter warning was issued during this event and wind speeds as high as 40 miles per hour were reported (Bucks Local News, 2021).

4.3.14.3. *Past Occurrence*

The Commonwealth of Pennsylvania has a long history of winter storms. Bucks County experienced major winter storms in 1958, 1966, 1972, 1977, 1978, 1981, 1983, 1993, 1994, 1996, 2003, 2007, 2010, and 2014. Winter storms generally occur more than once each year in the County. The NCEI data on past occurrences for winter storm lists events since 1996, causing no estimated property or crop damages and also not causing any injuries or deaths as a result of the events. Table 4.3.14-1 lists the number of winter storm events each year between 2006 and 2021. All winter storm events reported in the NCEI database are listed in Appendix H.

Table 4.3.14-1 Number of winter storm events impacting Bucks County from 2006 to 2020 (NOAA NCEI, 2021).

YEAR	NUMBER OF EVENTS
2006	4
2007	10
2008	11
2009	9
2010	7
2011	8
2012	3
2013	20
2014	20
2015	15
2016	4
2017	5
2018	7
2019	10
2020	2
2021	9
TOTAL	134

4.3.14.4. *Future Occurrence*

Data from NCDC shows that winter storms are a regular occurrence in Bucks County. So, the probability of the occurrence of a winter storm or winter weather event in Bucks County in any given year is 100 percent. The future occurrence of winter storms hazard can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (see Table 4.4.1-1).

4.3.14.5. *Vulnerability Assessment*

Vulnerability to the effects of winter storms on buildings is somewhat dependent on the age of a building because as building codes become more stringent, buildings can support heavier loads and as buildings age, various factors may deteriorate their structural integrity. Vulnerability also depends upon the type of construction and the degree to which a structure has been maintained.

The most vulnerable structures are those that were poorly built or are dilapidated. The weight of heavy snow or ice may lead to structural collapse or to minor damage. Some shed roofs that protect township and borough road maintenance or firefighting equipment have large span roofs that may collapse under the weight of especially heavy snow or ice although none have collapsed due to recent heavy snow or ice storms.

In Bucks County, accumulations of snow and/or ice during winter months are expected and normal. The most common detrimental effects of snow and/or ice are not collapsed structures but traffic accidents and interruptions in power supply and communications services.

All structures and infrastructure in Bucks County are exposed to heavy snow and ice. For this analysis, structures built prior to 1940 are identified as being potentially at risk of being somewhat weakened and more susceptible to damage due to heavy snow or ice. Table 4.3.14-2 lists the number of housing units in Bucks County built prior to 1940 according to the US Census Bureau's estimates. Bristol Borough has the most structures of any municipality in the county built prior to 1940 (over 2,000), as well as the largest proportion of housing units built prior to 1940 (57.7%). While the U.S. Census provides estimates for residential structures, the age of non-residential structures is not available. All structures and infrastructure in Bucks County will be exposed to heavy snow and ice. Because all of Bucks County has adopted the Pennsylvania Uniform Construction Code, new construction will be able to withstand the weight of heavy snow or ice.

Table 4.3.14-2 Age of Housing Units in Bucks County (US Census, 2019)

MUNICIPALITY	NUMBER OF HOUSING UNITS BUILT PRIOR TO 1940	PERCENT OF TOTAL HOUSING UNITS	MUNICIPALITY	NUMBER OF HOUSING UNITS BUILT PRIOR TO 1940	PERCENT OF TOTAL HOUSING UNITS
Bedminster Township	369	13.0%	Newtown Borough	509	51.0%
Bensalem Township	1,059	4.2%	Newtown Township	132	1.6%
Bridgeton Township	256	42.2%	Nockamixon Township	378	23.4%
Bristol Borough	2,416	57.7%	Northampton Township	336	2.3%
Bristol Township	1,556	7.4%	Penndel Borough	106	9.0%
Buckingham Township	687	9.0%	Perkasie Borough	1,172	34.5%
Chalfont Borough	175	9.9%	Plumstead Township	576	10.8%
Doylestown Borough	1,179	28.7%	Quakertown Borough	1,374	38.3%
Doylestown Township	289	4.6%	Richland Township	479	9.0%
Dublin Borough	182	19.5%	Richlandtown Borough	214	43.7%
Durham Township	128	26.6%	Riegelsville Borough	239	58.4%
East Rockhill Township	327	15.9%	Sellersville Borough	598	33.9%
Falls Township	429	3.2%	Silverdale Borough	51	20.5%
Haycock Township	120	13.4%	Solebury Township	763	19.3%
Hilltown Township	724	12.7%	Springfield Township	671	31.4%
Hulmeville Borough	151	41.6%	Telford Borough	133	12.8%
Ivyland Borough	80	24.9%	Tinicum Township	764	35.3%
Langhorne Borough	311	46.3%	Trumbauersville Borough	214	51.9%
Langhorne Manor Borough	133	42.5%	Tullytown Borough	83	9.0%
Lower Makefield Township	539	4.3%	Upper Makefield Township	443	13.7%
Lower Southampton Township	362	5.0%	Upper Southampton Township	296	4.7%
Middletown Township	612	3.5%	Warminster Township	600	4.4%
Milford Township	646	17.0%	Warrington Township	316	3.5%
Morrisville Borough	1,407	35.7%	Warwick Township	317	5.7%
New Britain Borough	118	11.7%	West Rockhill Township	344	14.9%
New Britain Township	288	6.6%	Wrightstown Township	341	29.1%
New Hope Borough	434	29.0%	Yardley Borough	357	28.8%

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.

Adherence to modern building codes can lower a building's risk to collapse. Building codes – developed by the International Code Council in partnership with FEMA and other federal, state, local, and private authorities – specify the minimum legal design and construction requirements for structural integrity, construction materials, and fire protection (FEMA, 2014). Most buildings constructed after 1961 in Bucks County were built under modern building codes as adopted in the Pennsylvania Uniform Construction Code. Table 4.3.14-2 lists the number and percentage of housing units in each municipality built before 1940.

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.

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 (PennDOT, 2018).

As of March 2021, 103 of the 661 bridges on state roads and 50 of the 175 bridges on locally-owned roads were classified as poor in Bucks County. A poor rating was previously referred to as "structurally deficient." This rating does not indicate that a bridge is unsafe, only that there is deterioration to one or more of the major components. Should a bridge be determined to be unsafe, it would be closed. Two bridges on state roads and two bridges on locally-owned roads are closed due to structural integrity (PennDOT, 2021a). Table 4.3.15-2 lists the breakdown of bridges by owner and rating.

The worst-case scenario for a bridge structure collapse is for a high traffic bridge to collapse during rush hour causing injuries and 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. Most often, weather events such as flooding, high winds, and winter storms lead to structure and bridge collapse. The NOAA NCEI Storm Events Database includes incidents of structure collapse in event narrative sections. Six incidents have led to structure or bridge collapse in Bucks County (NOAA NCEI, 2021).

> In June 1996, heavy rain and flash flooding caused the roof of a gym to collapse in Middletown Township. Luckily, the building was evacuated just prior to the incident saving 90 people from possible injury. Seven bridges were washed out in Bristol, Langhorne, Morrisville, Penndel, and Yardley due to this incident.
>
> In September 1999, Hurricane Floyd damaged dozens of bridges in Bucks County. Specifically, bridges were damaged or washed out in Buckingham, Durham, Solebury, Upper Makefield, and Wrightstown Townships. Three bridges were destroyed and not expected to be reopened until 2001. These include River Road over the Jericho Creek in Upper Makefield Township, New Hope Road over Mill Creek in Buckingham Township, and Swamp Road over Mill Creek in Wrightstown Township.
>
> In July 2000, flash flooding damaged and closed several bridges over Mill Creek. SR 532 between Old Bristol Road and Chinquapin Road in Lower Southampton Township and Northampton Township was closed when flood waters washed away the bridge supports. The approaches to bridges in Upper Southampton Township and Northampton Township were washed out leading to road closures.
>
> In June 2001, Tropical Storm Allison led to flash flooding in Buck County. Several bridges were damages or washed out, including a couple on SEPTA Regional Rail lines. Damage to roads and bridges in the region cost around $5 million.

In August 2003, thunderstorms and heavy downpours led to rapid floodwaters. Heavy waters in the Perkiomen Creek beat against the walls of a small bridge on County Line Road in West Rockhill Township. This caused the bridge to collapse.

In February 2017, heavy wind and thunderstorms blew across eastern Pennsylvania. Wind speeds were measured at 47 mph in Northeast Philadelphia. A townhouse in Bucks County collapsed because of this incident.

The most recent Pennsylvania State Hazard Mitigation Plan identified the Delaware River Turnpike Bridge was closed in January 2017 after a crack was found in the steel support of the bridge. While the bridge did not collapse, the inspectors determined the bridge to be unsafe for travel to prevent a collapse from occurring. The 65-year old bridge supported approximately 42,000 vehicles a day. After two months of $12 million dollar repairs were completed on the bridge, the roadway reopened to traffic (PEMA, 2019).

Infrastructure can also be impacted by human caused hazards such as transportation accidents. A notable past occurrence was when the Geigel Hill Road Bridge in Tinicum Township was hit by a vehicle in 2002. The accident damaged one vertical member and broke another on the bridge. In 2008, the bridge was demolished and replaced in 2011 (Jordan, 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 "poor" or "structurally deficient" (PennDOT, 2021a). Consequently, the entire state will see an increased focus on prevention of structure collapse. With over 18 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 or planning to address a number projects to improve bridges in Bucks County, listed in Table 4.3.15-1.

Table 4.3.15-1 Ongoing and anticipated bridge repair projects in Bucks County (PennDOT, 2021b).

STATUS	BRIDGE	IMPROVEMENT TYPE	COST
Ongoing	D6 Bridge Cleaning	Bridge Preservation Activities	$1,209,672
	Main St over SEPTA	Bridge Replacement	$5,749,470
	Hulmeville Ave over CSX	Bridge Replacement	$5,624,091
	Bridge Group M	Bridge Replacement	$4,621,265
	Bridge Rehab Group W	Bridge Deck Replacement	$4,709,612
Anticipated	Stone Road over Deep Run	Bridge Replacement	$1,644,557
	Headquarters Road over Tinicum Creek	Bridge Rehabilitation	$3,963,600
	Bridge Group V	Bridge Replacement	$4,518,000

The future occurrence of structure collapse can be considered *possible* as defined by the Risk Factor methodology probability criteria (see Table 4.4.1-1). Additionally, other hazard events such as fires, winter storms, and tropical storms could create conditions that would cause structures to collapse. Information on the future occurrences of such events can be found in their respective hazard profiles.

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. PennDOT defines the following bridge terminology for the operational status of bridges (PennDOT, 2018):

- Open – bridge is open to traveling public
- Closed – bridge is closed to vehicular traffic (barriers and signs put in place); pedestrian traffic may or may not be allowed
- Posted – bridge is open but signs have been placed stating a weight limit that can travel across the bridge
- Temp – bridge has temporary supports and/or restrictions in place
- U/CON – bridge is closed due to construction

Additionally, PennDOT defines a poor rating as an indication of the bridge's overall status in terms of structural soundness and ability to service traveling public. If a bridge is marked as poor or structurally deficient, that indicates that the bridge has deterioration to one or more of its major components (PennDOT, 2018). Through the Rapid Bridge Replacement Project (RBRP) PennDOT will replace 558 structurally deficient bridges throughout the state (PennDOT, 2021c).

Table 4.3.15-2 shows the numbers of closed and structurally deficient bridges owned by the state and the County and local municipalities. Countywide, over 18% of bridges have poor ratings. Bridges with a poor rating are often still safe for vehicles to cross over but will need work in the near future. Four bridges were closed to vehicular traffic due to their structural deficiencies (PennDOT, 2021a).

Table 4.3.15-2 Summary of Bridge Structure Deterioration in Bucks County (PennDOT, 2021a)

OWNER	TOTAL BRIDGES	CLOSED BRIDGES	STRUCTURALLY DEFICIENT BRIDGES	% STRUCTURALLY DEFICIENT
Stated owned	661	2	103	15.6%
County and Locally owned	175	2	50	28.6%
TOTAL	836	4	153	18.3%

Table 4.3.15-3 lists the numbers of structurally deficient bridges owned by the state and by the County or local municipalities, broken down by municipality.

Table 4.3.15-3 Bridge Structure Deterioration in Bucks County by Municipality (PennDOT, 2021a).

MUNICIPALITY	TOTAL BRIDGES	COUNTY AND LOCALLY OWNED	COUNTY AND LOCALLY OWNED STRUCTRUALLY DEFICIENT	STATE OWNED	STATED OWNED STRUCTURALLY DEFICIENT
Bedminster Township	36	7	4	29	2
Bensalem Township	60	3	3	57	8
Bridgeton Township	7	2	0	5	1
Bristol Borough	5	1	0	4	0
Bristol Township	26	5	3	21	0
Buckingham Township	21	9	3	12	3
Chalfont Borough	4	0	0	4	1
Doylestown Borough	5	0	0	5	2
Doylestown Township	50	11	1	39	6
Dublin Borough	1	0	0	1	0
Durham Township	7	1	1	6	2
East Rockhill Township	13	8	2	5	0
Falls Township	49	6	1	43	5
Haycock Township	12	1	1	11	2
Hilltown Township	42	10	3	32	6
Hulmeville Borough	1	0	0	1	0
Ivyland Borough	0	0	0	0	0
Langhorne Borough	0	0	0	0	0
Langhorne Manor Borough	2	0	0	2	0
Lower Makefield Township	22	0	0	22	3
Lower Southampton Township	10	2	1	8	0
Middletown Township	47	3	1	44	5
Milford Township	23	6	3	17	5
Morrisville Borough	7	0	0	7	3
New Britain Borough	1	0	0	1	1
New Britain Township	14	6	1	8	0
New Hope Borough	7	2	1	5	0
Newtown Borough	2	0	0	2	0
Newtown Township	15	2	0	13	0
Nockamixon Township	21	14	3	7	0
Northampton Township	23	5	0	18	2
Penndel Borough	0	0	0	0	0
Perkasie Borough	4	3	1	1	0

Table 4.3.15-3 Bridge Structure Deterioration in Bucks County by Municipality (PennDOT, 2021a).

MUNICIPALITY	TOTAL BRIDGES	COUNTY AND LOCALLY OWNED	COUNTY AND LOCALLY OWNED STRUCTRUALLY DEFICIENT	STATE OWNED	STATED OWNED STRUCTURALLY DEFICIENT
Plumstead Township	35	11	0	24	5
Quakertown Borough	8	4	0	4	1
Richland Township	26	5	2	21	9
Richlandtown Borough	0	0	0	0	0
Riegelsville Borough	1	0	0	1	0
Sellersville Borough	5	1	0	4	1
Silverdale Borough	1	0	0	1	0
Solebury Township	28	5	1	23	6
Springfield Township	22	4	0	18	5
Telford Borough	0	0	0	0	0
Tinicum Township	40	11	5	29	5
Trumbauersville Borough	0	0	0	0	0
Tullytown Borough	5	0	0	5	1
Upper Makefield Township	17	3	1	14	3
Upper Southampton Township	7	2	0	5	0
Warminster Township	8	2	1	6	0
Warrington Township	13	4	0	9	0
Warwick Township	18	9	4	9	2
West Rockhill Township	25	5	2	20	2
Wrightstown Township	12	0	0	12	0
Yardley Borough	8	2	1	6	2
Other	20	0	0	20	4
TOTAL	836	175	50	661	103

4.3.16. Dam Failure

Due to data sensitivity, 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 381 SARA Title III – Tier II reporting facilities in Bucks County as of 2018 (PEMA, 2018). SARA Title III facilities are protected data, and this is the most recent information at this time.

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.

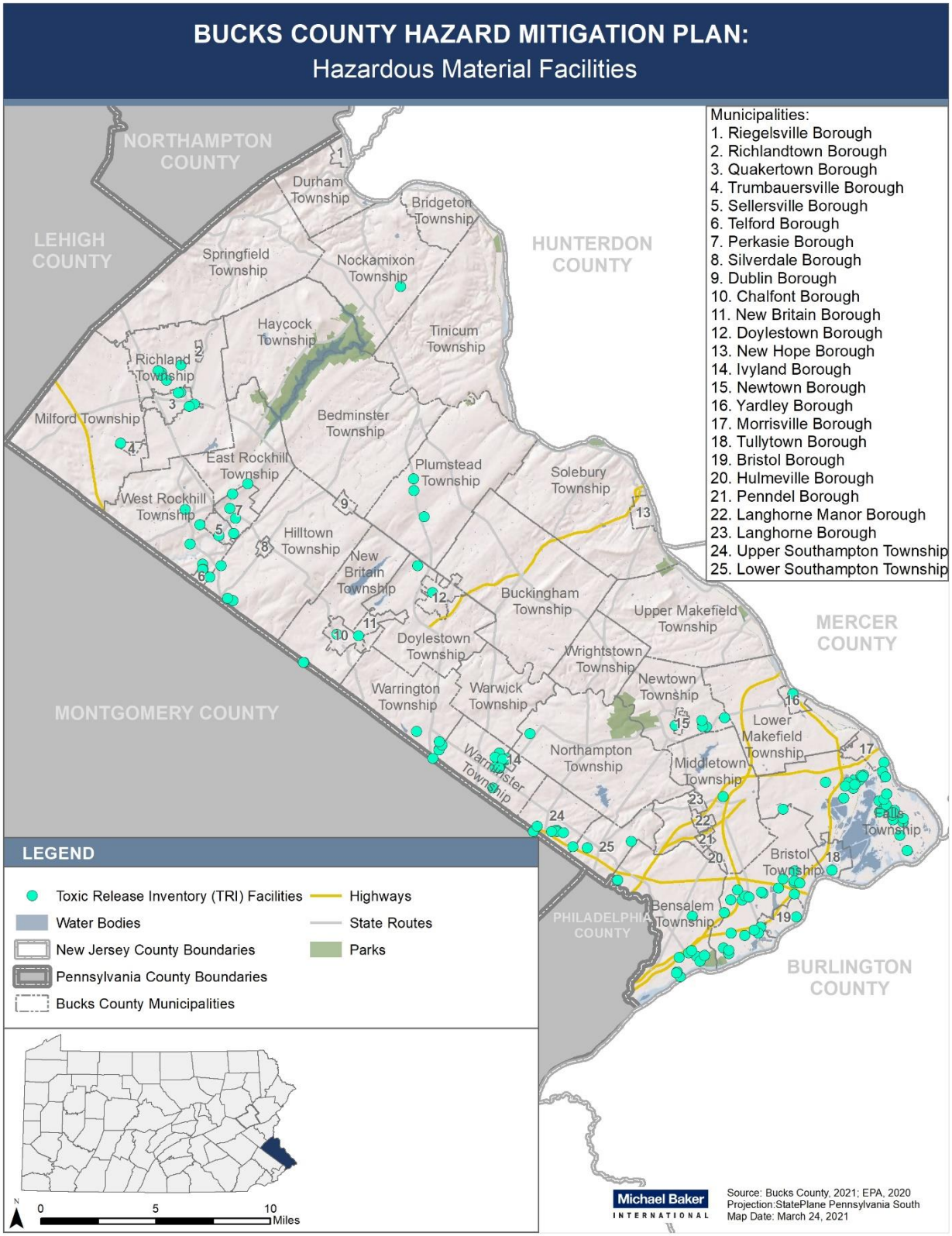
Using this dataset will help to provide a more complete picture of the risk of hazardous materials releases in the County. Bucks County has 76 EPA-identified hazardous materials sites throughout the County, shown in Figure 4.3.17-1. Bristol and Fairless Hills have the most hazardous materials facilities within the County. Other municipalities and places hosting TRI

sites include Richland, Quakertown, Trumbauersville, Nockamixon, West Rockhill, Telford, Sellersvillle, Perkasie, Hilltown, Plumstead, New Britain, Chalfont, Doylestown, Warrington, Warminster, Northampton, Upper Southampton, Lower Southampton, Newton, Bensalem, Middletown, Yardley, Morrisville, Tullytown, and Falls.

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 highway 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. 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 has been a total of 2,859,990 pounds of chemicals released from fixed sites in Bucks County in 2019 (US EPA, 2021). 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 2010-June 1, 2015. Table 4.3.17-3 lists the reported incidents from PHMSA in Bucks County from June 2, 2015- present as of May 2021, with a total of 106 incidents occurring since the previous plan update.

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-June 1, 2015 (PHMSA, 2015).

MATERIAL RELEASED	2010	2011	2012	2013	2014	2015	TOTAL INCIDENTS
COMBUSTIBLE LIQUID	1	0	0	1	0	0	2
CORROSIVE MATERIAL	6	7	6	10	13	2	44
FLAMMABLE - COMBUSTIBLE LIQUID	17	19	7	29	48	6	126
FLAMMABLE GAS	0	0	3	1	1	1	6
MISCELLANEOUS HAZARDOUS MATERIAL	2	4	0	3	4	0	13

Table 4.3.17-2 Previous Hazardous Materials Incidents in Transit in Bucks County Between 2010-June 1, 2015 (PHMSA, 2015).

MATERIAL RELEASED	2010	2011	2012	2013	2014	2015	TOTAL INCIDENTS
NONFLAMMABLE COMPRESSED GAS	0	1	0	0	2	1	4
ORGANIC PEROXIDE	0	1	0	0	0	0	1
OXIDIZER	0	2	2	5	3	0	12
POISONOUS MATERIALS	2	1	1	0	2	0	6
TOTAL	28	35	19	49	73	10	214

Table 4.3.17-3 Previous Hazardous Materials Incidents in Transportation in Bucks County Between June 2, 2015- May 2, 2021 (PHMSA, 2021).

MATERIAL RELEASED	DATE OF INCIDENT	MODE OF TRANSPORTATION
Paint Including Paint, Lacquer, Enamel, Stain, Shellac Solutions, Varnish, Polish, Liquid Filler, And Liquid Lacquer Base	6/22/2015	Highway
Caustic Alkali Liquids, N.O.S.	6/24/2015	Highway
Styrene Monomer, Stabilized	7/23/2015	Highway
Petroleum Distillates, N.O.S. Or Petroleum Products, N.O.S.	7/27/2015	Highway
Petroleum Gases, Liquefied Or Liquefied Petroleum Gas	9/3/2015	Rail
Fuel Oil (No. 1, 2, 4, 5, Or 6)	9/18/2015	Highway
Printing Ink, Flammable Or Printing Ink Related Material (Including Printing Ink Thinning Or Reducing Compound), Flammable	10/5/2015	Highway
Compounds, Cleaning Liquid	10/8/2015	Highway
Styrene Monomer, Stabilized	10/26/2015	Highway
Corrosive Liquid, Acidic, Organic, N.O.S.	10/27/2015	Highway
Extracts, Flavoring, Liquid	10/27/2015	Highway
Sodium Hydroxide, Solid	10/28/2015	Highway
Corrosive Liquid, Acidic, Organic, N.O.S.	11/22/2015	Highway
Corrosive Liquid, Basic, Inorganic, N.O.S.	12/28/2015	Highway
Carbon Disulfide	12/29/2015	Highway
Sodium Hydroxide, Solid	2/8/2016	Highway
Methanol	3/10/2016	Highway
Hydrochloric Acid	4/7/2016	Highway
Paint Including Paint, Lacquer, Enamel, Stain, Shellac Solutions, Varnish, Polish, Liquid Filler And Liquid Lacquer Base	4/25/2016	Highway
Isopropenylbenzene	4/25/2016	Rail
Extracts, Flavoring, Liquid	4/27/2016	Highway

Table 4.3.17-3 Previous Hazardous Materials Incidents in Transportation in Bucks County Between June 2, 2015- May 2, 2021 (PHMSA, 2021).

MATERIAL RELEASED	DATE OF INCIDENT	MODE OF TRANSPORTATION
Nitrocellulose, Solution, Flammable With Not More Than 12.6 Percent Nitrogen, By Mass, And Not More Than 55 Percent Nitrocellulose	6/23/2016	Highway
Corrosive Liquid, Basic, Organic, N.O.S.	6/29/2016	Highway
Paint Including Paint, Lacquer, Enamel, Stain, Shellac Solutions, Varnish, Polish, Liquid Filler And Liquid Lacquer Base	8/10/2016	Highway
Sodium Hydroxide, Solid	8/10/2016	Highway
Corrosive Liquids, Oxidizing, N.O.S.	8/26/2016	Highway
Petroleum Gases, Liquefied Or Liquefied Petroleum Gas	9/3/2016	Rail
Paint Including Paint, Lacquer, Enamel, Stain, Shellac Solutions, Varnish, Polish, Liquid Filler And Liquid Lacquer Base	9/17/2016	Highway
Elevated Temperature Liquid, Flammable, N.O.S., With Flash Point Above 37.8 C, At Or Above Its Flash Point	9/19/2016	Highway
Phenol, Molten	9/21/2016	Rail
Petroleum Distillates, N.O.S. Or Petroleum Products, N.O.S.	10/9/2016	Highway
Paint Related Material Including Paint Thinning, Drying, Removing, Or Reducing Compound	11/3/2016	Highway
Dioxane	12/1/2016	Highway
Sodium Hydroxide, Solid	1/17/2017	Highway
Pine Oil	1/25/2017	Highway
Compounds, Tree Killing, Liquid Or Compounds, Weed Killing, Liquid	2/6/2017	Highway
Sodium Hydroxide, Solid	2/22/2017	Highway
Butyl Acrylates, Stabilized	2/24/2017	Highway
Fuel Oil (No. 1, 2, 4, 5, Or 6)	3/10/2017	Highway
Resin Solution, Flammable	3/28/2017	Highway
Styrene Monomer, Stabilized	4/6/2017	Rail
Fuel Oil (No. 1, 2, 4, 5, Or 6)	4/19/2017	Rail
Ethanol And Gasoline Mixture Or Ethanol And Motor Spirit Mixture Or Ethanol And Petrol Mixture, With More Than 10% Ethanol	5/5/2017	Highway
Corrosive Liquid, Basic, Inorganic, N.O.S.	6/15/2017	Highway
Paint Including Paint, Lacquer, Enamel, Stain, Shellac Solutions, Varnish, Polish, Liquid Filler And Liquid Lacquer Base	7/7/2017	Highway
Corrosive Liquid, Basic, Inorganic, N.O.S.	7/14/2017	Highway
Adhesives, Containing A Flammable Liquid	7/14/2017	Highway
Sodium Hydroxide, Solution	7/17/2017	Highway

Table 4.3.17-3 Previous Hazardous Materials Incidents in Transportation in Bucks County Between June 2, 2015- May 2, 2021 (PHMSA, 2021).

MATERIAL RELEASED	DATE OF INCIDENT	MODE OF TRANSPORTATION
Corrosive Liquid, Basic, Inorganic, N.O.S.	8/7/2017	Highway
Aerosols, Flammable, (Each Not Exceeding 1 L Capacity)	8/14/2017	Highway
Flammable Liquids, Toxic, N.O.S.	8/17/2017	Highway
Printing Ink, Flammable Or Printing Ink Related Material (Including Printing Ink Thinning Or Reducing Compound), Flammable	8/18/2017	Highway
Potassium Chlorate	8/25/2017	Highway
Batteries, Wet, Filled With Acid, Electric Storage	9/18/2017	Highway
Fuel Oil (No. 1, 2, 4, 5, Or 6)	9/25/2017	Highway
Naphtha	10/6/2017	Highway
Aerosols, Flammable, (Each Not Exceeding 1 L Capacity)	10/9/2017	Highway
Sodium Hydroxide, Solution	11/28/2017	Highway
Diacetone Alcohol	1/12/2018	Highway
Petroleum Distillates, N.O.S. Or Petroleum Products, N.O.S.	1/19/2018	Highway
Self-Heating, Solid, Organic, N.O.S.	3/28/2018	Highway
Isopropanol Or Isopropyl Alcohol	4/27/2018	Highway
Isopropanol Or Isopropyl Alcohol	4/30/2018	Highway
Toxic Solids, Organic, N.O.S.	5/3/2018	Highway
Batteries, Wet, Filled With Acid, Electric Storage	5/3/2018	Highway
Hydrofluorosilicic Acid	5/15/2018	Highway
Corrosive Liquids, N.O.S.	6/5/2018	Highway
Sodium Borohydride And Sodium Hydroxide Solution, With Not More Than 12 Percent Sodium Borohydride And Not More Than 40 Percent Sodium Hydroxide By Mass	6/7/2018	Highway
Hydrochloric Acid	6/13/2018	Rail
Sodium Hydroxide, Solution	7/17/2018	Highway
Ethyl Mercaptan	10/26/2018	Highway
Paraformaldehyde	11/1/2018	Highway
Isopropenylbenzene	11/21/2018	Rail
Petroleum Distillates, N.O.S. Or Petroleum Products, N.O.S.	12/4/2018	Highway
Corrosive Liquid, Basic, Organic, N.O.S.	12/6/2018	Highway
Ethanol Or Ethyl Alcohol Or Ethanol Solutions Or Ethyl Alcohol Solutions	12/15/2018	Highway
Isopropenylbenzene	12/19/2018	Rail
Resin Solution, Flammable	1/9/2019	Highway
Adhesives, Containing A Flammable Liquid	1/14/2019	Highway
Potassium Hydroxide, Solid	2/7/2019	Highway
Batteries, Wet, Filled With Acid, Electric Storage	2/15/2019	Highway

Table 4.3.17-3 Previous Hazardous Materials Incidents in Transportation in Bucks County Between June 2, 2015- May 2, 2021 (PHMSA, 2021).

MATERIAL RELEASED	DATE OF INCIDENT	MODE OF TRANSPORTATION
Toxic Solids, Organic, N.O.S.	3/5/2019	Highway
Toxic Solids, Organic, N.O.S.	3/8/2019	Highway
Extracts, Flavoring, Liquid	3/28/2019	Highway
Paint Including Paint, Lacquer, Enamel, Stain, Shellac Solutions, Varnish, Polish, Liquid Filler And Liquid Lacquer Base	5/6/2019	Highway
Methyl Isobutyl Ketone	5/6/2019	Highway
Resin Solution, Flammable	5/30/2019	Highway
Paint Including Paint, Lacquer, Enamel, Stain, Shellac Solutions, Varnish, Polish, Liquid Filler And Liquid Lacquer Base	10/11/2019	Highway
Cyclohexane	10/11/2019	Highway
Isopropanol Or Isopropyl Alcohol	10/21/2019	Highway
Vinyl Acetate, Stabilized	10/28/2019	Highway
Methanol	11/6/2019	Highway
Hydrochloric Acid	11/22/2019	Highway
Flammable Liquids, N.O.S.	2/7/2020	Highway
Flammable Liquids, Toxic, N.O.S.	4/17/2020	Highway
Flammable Liquids, N.O.S.	5/27/2020	Highway
Batteries, Wet, Filled With Acid, Electric Storage	5/27/2020	Highway
Combustible Liquid, N.O.S.	6/19/2020	Highway
Sodium Hydroxide, Solution	8/13/2020	Highway
Sodium Hydroxide, Solution	8/13/2020	Highway
Sodium Persulfate	9/28/2020	Highway
Corrosive Liquids, N.O.S.	10/8/2020	Highway
Sodium Nitrite	10/9/2020	Highway
Ethanol Or Ethyl Alcohol Or Ethanol Solutions Or Ethyl Alcohol Solutions	10/15/2020	Highway
Compressed Gas, N.O.S	11/2/2020	Highway
Styrene Monomer, Stabilized	1/5/2021	Rail

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 4.4.1-1).

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 4.3.17-4 illustrates the structures vulnerable to hazardous material facilities – specifically structures within 1.5 miles of a hazardous material facility – as well as critical facilities located within 1.5 miles of a hazardous material facility. 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. Bristol Township has the highest number of addressable structures within 1.5 miles with 19,257 and the highest number of critical facilities vulnerable to fixed hazardous materials incidents with 52. Bensalem and Warminster Townships each have 30 or more critical facilities each that are vulnerable to fixed hazardous materials releases. Other municipalities that are home to a high number of critical facilities with 20 or more each vulnerable to fixed hazardous materials incidents include Doylestown Borough, Falls Township, Lower Southampton Township, Middletown Township, and Newtown Township.

Table 4.3.17-4 Vulnerability of Hazardous Material Sites (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)	PERCENT STRUCTURES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)	PERCENT CRITICAL FACILITIES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)
Bedminster Township	3,229	156	5%	14	0	0%
Bensalem Township	19,450	13,901	71%	52	37	71%
Bridgeton Township	782	0	0%	2	0	0%
Bristol Borough	3,893	3,893	100%	15	15	100%
Bristol Township	19,543	19,257	99%	52	52	100%
Buckingham Township	8,315	282	3%	21	1	5%
Chalfont Borough	1,674	1,674	100%	8	8	100%
Doylestown Borough	3,236	3,236	100%	20	20	100%
Doylestown Township	6,441	3,153	49%	27	10	37%
Dublin Borough	595	0	0%	4	0	0%
Durham Township	653	0	0%	1	0	0%
East Rockhill Township	2,429	1,526	63%	9	7	78%
Falls Township	11,540	10,562	92%	29	29	100%
Haycock Township	1,227	0	0%	2	0	0%
Hilltown Township	6,265	3,017	48%	14	5	36%
Hulmeville Borough	392	136	35%	4	0	0%
Ivyland Borough	371	371	100%	4	4	100%
Langhorne Borough	544	538	99%	5	5	100%
Langhorne Manor Borough	345	229	66%	5	3	60%

Table 4.3.17-4 Vulnerability of Hazardous Material Sites (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)	PERCENT STRUCTURES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)	PERCENT CRITICAL FACILITIES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)
Lower Makefield Township	13,037	4,124	32%	22	10	45%
Lower Southampton Township	7,706	7,557	98%	21	21	100%
Middletown Township	15,585	6,747	43%	40	25	63%
Milford Township	4,370	1,508	35%	16	5	31%
Morrisville Borough	134	2,996	96%	11	11	100%
New Britain Borough	1,145	840	73%	5	5	100%
New Britain Township	4,755	3,645	77%	18	15	83%
New Hope Borough	1,385	0	0%	6	0	0%
Newtown Borough	1,026	1,026	100%	6	6	100%
Newtown Township	8,258	5,404	65%	28	21	75%
Nockamixon Township	1,812	436	24%	10	3	30%
Northampton Township	14,767	2,505	17%	29	3	10%
Penndel Borough	719	4	1%	5	0	0%
Perkasie Borough	3,381	3,381	100%	10	10	100%
Plumstead Township	5,789	4,063	70%	18	15	83%
Quakertown Borough	3,163	3,142	99%	17	17	100%
Richland Township	6,250	4,919	79%	10	9	90%
Richlandtown Borough	437	437	100%	3	3	100%
Riegelsville Borough	453	0	0%	3	0	0%

Table 4.3.17-4 Vulnerability of Hazardous Material Sites (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)	PERCENT STRUCTURES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)	PERCENT CRITICAL FACILITIES VULNERABLE TO HAZARDOUS MATERIAL FACILITIES (WITHIN 1.5 MILES)
Sellersville Borough	1,887	1,887	100%	7	7	100%
Silverdale Borough	336	173	51%	3	2	67%
Solebury Township	4,297	0	0%	13	0	0%
Springfield Township	2,696	0	0%	9	0	0%
Telford Borough	676	676	100%	2	2	100%
Tinicum Township	2,345	96	4%	11	0	0%
Trumbauersville Borough	374	374	100%	4	4	100%
Tullytown Borough	794	733	92%	7	5	71%
Upper Makefield Township	3,748	0	0%	7	0	0%
Upper Southampton Township	6,149	5,058	82%	18	15	83%
Warminster Township	11,572	11,075	96%	31	30	97%
Warrington Township	9,037	4,943	55%	25	14	56%
Warwick Township	6,167	2,124	34%	16	1	6%
West Rockhill Township	2,353	1,670	71%	10	10	100%
Wrightstown Township	1,474	0	0%	7	0	0%
Yardley Borough	1,349	1,349	100%	7	7	100%
TOTAL	243,350	144,823	60%	743	472	64%

4.3.18. Gas and Liquid Pipelines

4.3.18.1. *Location and Extent*

Pipelines are a vital component of the nation's infrastructure that transport two of the materials most essential to daily life – water and energy products. This profile addresses the risks posed by the gas and liquid pipeline systems that move energy products in Pennsylvania and across Bucks County. These pipeline systems cross moderately to densely populated areas as shown in Figure 4.3.18-1. Pipeline systems are defined by federal regulations as all parts of a pipeline facility through which a hazardous liquid or gas moves, including piping, valves, pumps or compressors, metering and delivery stations, and storage and breakout tanks. Although pipelines are typically located underground, they may also be located aboveground when dictated by operational considerations (such as connections to pump and compressor stations) or environmental conditions (such as geological characteristics) (FEMA, 2015).

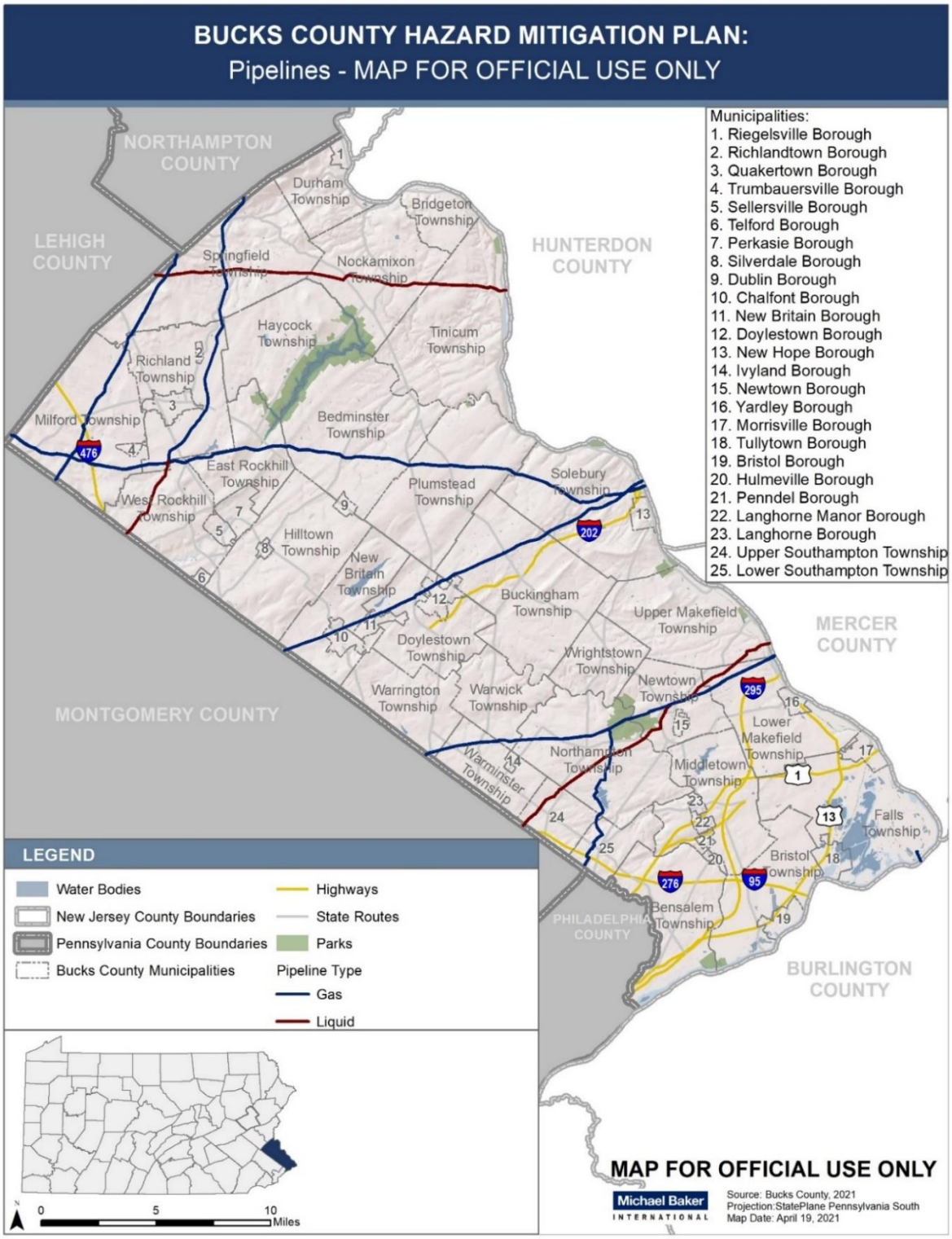
Natural gas pipelines are the most common type of pipeline in the United States and serve to transport natural gas from the point of production to the point of use. Three major types of pipelines move natural gas: gathering lines, transmission lines, and distribution lines. Gathering lines are the pipelines that move natural gas from the production well to a processing facility. Gas transmission lines are the large pipelines (6 to 48 inches in diameter) that move natural gas from the processing facility to local distribution networks. Gas transmission lines are designed to transport natural gas long distances at high pressures (often 200 – 1,500 psi). There are approximately 300,000 miles of gas transmission pipelines in the United States. Gas distribution lines are the smaller gas mains and service lines (1/2 to 2 inches in diameter) that move natural gas from the transmission network directly to homes and businesses. Gas distribution pipelines are designed to transport natural gas shorter distances at relatively low pressures. There are approximately 2.2 million miles of gas distribution lines in the United States (PHMSA, 2018).

Liquid petroleum pipelines are the second most common type of pipeline in the United States, and serve to transport crude oil, refined product, and highly volatile liquids (HVLs) to local distribution networks. For crude oil and its refined products, there are three major types of pipelines that move the product from producing areas to local distribution networks: gathering lines, transmission lines, and refined product lines. Gathering lines are the smaller pipelines (2 to 8 inches in diameter) that gather crude oil from production wells. Crude oil transmission lines are the larger, cross-country pipelines (8 to 48 inches in diameter) that move crude oil from producing areas to refineries. There are approximately 72,000 miles of crude oil transmission pipelines in the United States. Refined product lines are the small to large lines (8 to 42 inches in diameter) that deliver refined petroleum products to storage terminals. There are approximately 63,000 miles of refined products pipelines in the United States (Pipelines 101, 2018). Tanker trucks take the refined petroleum products the last few miles from the storage terminals to gas stations and homes.

Highly volatile liquids (HVLs) are products that are liquid when stored at a certain temperature or pressure, but quickly vaporize when released into the atmosphere. HVLs include natural gas liquids (NGLs), ethylene, propylene, and anhydrous ammonia. There are approximately 69,000 miles of HVL pipelines in the United States. These pipelines are becoming increasingly common as NGL production grows. NGLs are liquids produced at both natural gas processing plants and oil refineries that have many uses spanning nearly all sectors of the economy. As the use of hydraulic fracturing to extract natural gas from shale gas formations expands, the production of NGLs is growing.

Figure 4.3.18-1 shows the gas and liquid pipeline that are located within Bucks County. Gas pipelines are located throughout the county while liquid pipelines can be found in the northern area of Bucks as well as the southern portion of the County. There are 243.3 miles of natural gas transmission pipeline and 47.5 miles of liquid petroleum pipeline within Bucks County, combining for a total of 290.8 miles of pipeline (PEMA, 2019).

Figure 4.3.18-1 Gas and Liquid Pipelines within Bucks County



4.3.18.2. *Range of Magnitude*

Many factors determine the magnitude of the hazard posed by pipeline failures, including the chemicals released, the failure mode of the pipeline, the operating conditions of the pipeline at the time of the incident, and the characteristics of the surrounding area. Impacts to life and property can result from inhalation or ingestion of toxins, exposure to a fire or explosion, or exposure to contaminated soils or drinking water (FEMA, 2015). These impacts may include:

- Serious injuries or fatalities;
- Damage to buildings and infrastructure;
- Disruptions and closures to critical infrastructure and services, including transportation routes and emergency medical services;
- Residential, commercial, and industrial energy supply losses;
- Disruption of local businesses and regional economies; and
- Displacement of residential communities or businesses.

Understanding pipeline threats and hazards begins with understanding the physical and chemical properties of the products in the pipeline. Natural gas is a clean-burning fuel that consists mostly of methane (94 percent) and ethane (2 percent). Some relevant characteristics of natural gas are summarized below:

- Although natural gas is nontoxic, it can cause asphyxiation if released in an enclosed area.
- Natural gas is combustible and natural gas fires produce large amounts of radiant heat.
- If an ignition source exists, natural gas releases can result in a sudden fire or explosion
- near the point of release. Once the release ends, however, the hazard declines very quickly as the gas disperses.
- If natural gas migrates into a building and accumulates inside, the hazard can persist for longer.

Liquid petroleum pipelines can carry many different crude oil and refined petroleum products with widely varying physical and chemical properties. Many of these products can spread over land and water, flowing into valleys, ravines, and waterways. Relevant characteristics of some liquid petroleum products are summarized below:

- Most crude oils are heavier and less toxic than refined petroleum products, and do not penetrate porous surfaces such as soil and sand. Because these products do not evaporate and tend to adhere to surfaces, however, they remain in the environment longer than refined products. Oil spills may take weeks, months, or even years to clean up.
- Most refined petroleum products are highly fluid, spready quickly over land or water surfaces, and penetrate porous surfaces. These products are usually flammable, and their volatile components can burn the eyes and skin and irritate the nose, eyes, and

mouth. Because these products have a high evaporation rate and generally do not adhere to surfaces, they are easier to clean up. Refined petroleum products also produce vapors that are heavier than air. These vapors will collect in low areas.
- Highly volatile liquids are lighter than air and will form a vapor cloud when released to the atmosphere.
- Anhydrous ammonia is a highly volatile liquid that is particularly toxic and corrosive. It is typically transported under pressure as liquefied gas, and rapidly expands when released.

In some cases, natural hazard events can cause pipeline failures and/or complicate emergency response activities. When a pipeline failure occurs during a natural disaster, access to the pipeline may be restricted, waterlines for fire suppression may be compromised, and response personnel and resources may be limited. In addition, the potential threat of a pipeline failure can be amplified by natural hazard events that are accompanied by winds, thunderstorms, or floods. These conditions can spread contamination more quickly and exacerbate the threat to local water supplies, air quality, soil, and agriculture. Other natural hazard events that can lead to pipeline failure include earthquakes, land subsidence, avalanches, lightning, fires, and severe winter storms (FEMA, 1997).

Several exacerbating or mitigating circumstances can affect the severity of a pipeline failure. Mitigating circumstances include precautionary measures taken in advance to reduce the impact of a release on the surrounding environment. After a release, primary and secondary containment or shielding by sheltering-in-place can help protect people and property. Exacerbating circumstances can include weather conditions, the micro-meteorological effects of buildings and terrain, and lack of code compliance or maintenance. 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 pipelines and surrounding buildings.

4.3.18.3. *Past Occurrence*

Pennsylvania has a long history of oil and gas well drilling and transportation and, though relatively infrequent, many accidents and incidents have occurred related to the extraction and transportation of these natural resources. No comprehensive list of oil and gas related incidents exist at the county level. The hazards associated with each incident vary widely and encompass damages including serious injury, explosion, fire, and water contamination.

Other prior year incident information for Pennsylvania can be found on the Pennsylvania Emergency Management Association website. The Pennsylvania Hazardous Material Emergency Planning and Response Act 1990-165 2018 Annual Report states there were 5 “Natural Gas Release” incidents and no pipeline breaks in 2018 in Bucks County. However, within the Commonwealth, there have been 654 Natural Gas Releases and 18 pipeline breaks in 2018 (PEMA, 2018). However, the definition of “Natural Gas Release” is not clearly defined,

and pipeline break data was only reported starting in the 2018 report. Natural gas release information was also only specified from "hazardous materials" incidents in the reports in 2018.

There have been no reported pipeline failures within Bucks County to date.

4.3.18.4. *Future Occurrence*

While many pipeline break incidents have occurred in Pennsylvania in the past, they are generally considered difficult to predict, especially within the boundaries of a county. An occurrence is largely dependent upon the accidental or intentional actions of a person or group. It is difficult to predict when and where environmental hazards related to gas pipelines will arise as they are often related to equipment failure and human error. Adequate monitoring through the DEP will reduce the likelihood of potential impacts to the community and to the environment. Overall, the probability of future environmental hazards events is *likely* as defined by the Risk Factor Methodology (See Section 4.4.1-1).

Pipeline failures are low-probability, potentially high-consequence events. Although gas and liquid pipeline failures are infrequent, the hazardous and inflammable materials released by these events can pose a significant threat to public safety and the built and natural environment. Explosions associated with pipeline failures, for example, can cause severe injury to nearby residents and destroy homes and other property. Corrosion is a major cause of pipeline failure, and is often associated with pipeline age (FEMA, 2015). Besides corrosion, pipeline failures can be caused by external impacts from farm or construction machinery, structural failures, mechanical defects, and natural hazards. Land development tends to increase the likelihood of external impacts and pipeline failure. Gas and liquid pipeline data and information is often difficult to share given the sensitivity and information sharing protections. This limits analysis that can be conducted for proposed and existing developments, community vulnerabilities and impact points. Land development without appropriate planning can also impede access to pipelines for operation and maintenance or emergency response.

4.3.18.5. *Vulnerability Assessment*

Table 4.3.18-1 lists the total structures and critical facilities vulnerable to a liquid or gas pipeline incident. The jurisdictions with the most structures located within 0.25 miles of a liquid or gas are Northampton Township (3,391 structures), Warminster Township (1,635 structures), and Newtown Township (1,562 structures). The communities with the highest percent of total structures within 0.25 miles of a liquid or gas pipeline are Chalfont Borough (40% of total structures), Springfield Township (29% of total structures), and New Britain Borough (29% of total structures). The jurisdictions that have the most critical facilities within 0.25 miles of a liquid or gas pipeline are Springfield Township (7 critical facilities), Northampton Township (4 critical facilities), and Doylestown Borough, Milford Township, New Britain Township, Newtown Township, and Upper Southampton Township all have 3 critical

facilities within 0.25 miles of a liquid or gas pipeline. The jurisdictions with the highest percentage of total critical facilities within 0.25 miles of a liquid or gas pipeline are Springfield Township (78% of total critical facilities), New Britain Borough (40% of total critical facilities), and Chalfont Borough (25% of total critical facilities). Table 4.3.18-2 lists the vulnerability of each municipality to liquid and gas pipelines generalized by land use. There are in total 17,996 total structures located within 0.25 miles of a liquid or gas pipeline; the most vulnerable structure to the hazard is residential with 15,788 structures located near a pipeline. Not considered in the spatial analysis conducted are the Adelphia pipeline and compressor station that are in the process of being installed. The installation of this infrastructure will significantly impact the county, specifically Richland Township and West Rockhill Township. As spatial data becomes available , this new pipeline will be incorporated more thoroughly into the vulnerability analysis.

Table 4.3.18-1 Structures and Critical Facilities Vulnerable Liquid and Gas Pipelines (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES WITHIN .25 MILES OF A LIQUID OR GAS PIPELINE	PERCENT STRUCTURES WITHIN .25 MILES OF A LIQUID OR GAS PIPELINE	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES WITHIN .25 MILES OF A LIQUID OR GAS PIPELINE	PERCENT CRITICAL FACILITIES WITHIN .25 MILES OF A LIQUID OR GAS
Bedminster Township	3,229	199	6%	14	1	7%
Bensalem Township	19,450	0	0%	52	0	0%
Bridgeton Township	782	0	0%	2	0	0%
Bristol Borough	3,893	0	0%	15	0	0%
Bristol Township	19,543	0	0%	52	0	0%
Buckingham Township	8,315	785	9%	21	0	0%
Chalfont Borough	1,674	671	40%	8	2	25%
Doylestown Borough	3,236	588	18%	20	3	15%
Doylestown Township	6,441	770	12%	27	1	4%
Dublin Borough	595	0	0%	4	0	0%
Durham Township	653	0	0%	1	0	0%
East Rockhill Township	2,429	226	9%	9	2	22%
Falls Township	11,540	1	0%	29	0	0%
Haycock Township	1,227	6	0%	2	0	0%
Hilltown Township	6,265	0	0%	14	0	0%
Hulmeville Borough	392	0	0%	4	0	0%
Ivyland Borough	371	0	0%	4	0	0%
Langhorne Borough	544	0	0%	5	0	0%
Langhorne Manor Borough	345	0	0%	5	0	0%
Lower Makefield Township	13,037	554	4%	22	0	0%

Table 4.3.18-1 Structures and Critical Facilities Vulnerable Liquid and Gas Pipelines (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES WITHIN .25 MILES OF A LIQUID OR GAS PIPELINE	PERCENT STRUCTURES WITHIN .25 MILES OF A LIQUID OR GAS PIPELINE	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES WITHIN .25 MILES OF A LIQUID OR GAS PIPELINE	PERCENT CRITICAL FACILITIES WITHIN .25 MILES OF A LIQUID OR GAS
Lower Southampton Township	7,706	1,046	14%	21	2	10%
Middletown Township	15,585	0	0%	40	0	0%
Milford Township	4,370	568	13%	16	3	19%
Morrisville Borough	3,134	0	0%	11	0	0%
New Britain Borough	1,145	332	29%	5	2	40%
New Britain Township	4,755	508	11%	18	3	17%
New Hope Borough	1,385	0	0%	6	0	0%
Newtown Borough	1,026	0	0%	6	0	0%
Newtown Township	8,258	1,562	19%	28	3	11%
Nockamixon Township	1,812	225	12%	10	2	20%
Northampton Township	14,767	3,391	23%	29	4	14%
Penndel Borough	719	0	0%	5	0	0%
Perkasie Borough	3,381	0	0%	10	0	0%
Plumstead Township	5,789	314	5%	18	0	0%
Quakertown Borough	3,163	51	2%	17	0	0%
Richland Township	6,250	949	15%	10	2	20%
Richlandtown Borough	437	0	0%	3	0	0%
Riegelsville Borough	453	0	0%	3	0	0%
Sellersville Borough	1,887	0	0%	7	0	0%
Silverdale Borough	336	0	0%	3	0	0%
Solebury Township	4,297	404	9%	13	2	15%

Table 4.3.18-1 Structures and Critical Facilities Vulnerable Liquid and Gas Pipelines (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES WITHIN .25 MILES OF A LIQUID OR GAS PIPELINE	PERCENT STRUCTURES WITHIN .25 MILES OF A LIQUID OR GAS PIPELINE	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES WITHIN .25 MILES OF A LIQUID OR GAS PIPELINE	PERCENT CRITICAL FACILITIES WITHIN .25 MILES OF A LIQUID OR GAS
Springfield Township	2,696	779	29%	9	7	78%
Telford Borough	676	0	0%	2	0	0%
Tinicum Township	2,345	102	4%	12	1	8%
Trumbauersville Borough	374	0	0%	4	0	0%
Tullytown Borough	794	0	0%	7	0	0%
Upper Makefield Township	3,748	295	8%	7	0	0%
Upper Southampton Township	6,149	1,297	21%	18	3	17%
Warminster Township	11,572	1,635	14%	31	2	6%
Warrington Township	9,037	202	2%	25	1	4%
Warwick Township	6,167	373	6%	16	0	0%
West Rockhill Township	2,353	163	7%	10	0	0%
Wrightstown Township	1,474	0	0%	7	0	0%
Yardley Borough	1,349	0	0%	7	0	0%
TOTAL	243,350	17,996	7.4%	744	46	6%

Table 4.3.18-2 Structures Vulnerable to Liquid and Gas Pipelines by Generalized Land Use Type (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Bedminster Township	3,229	1	0	23	1	133	0	0	41	199
Bensalem Township	19,450	0	0	0	0	0	0	0	0	0
Bridgeton Township	782	0	0	0	0	0	0	0	0	0
Bristol Borough	3,893	0	0	0	0	0	0	0	0	0
Bristol Township	19,543	0	0	0	0	0	0	0	0	0
Buckingham Township	8,315	8	8	0	2	688	0	1	78	785
Chalfont Borough	1,674	4	6	4	4	643	0	0	10	671
Doylestown Borough	3,236	73	6	1	3	483	0	0	21	588
Doylestown Township	6,441	17	8	1	14	721	0	0	9	770
Dublin Borough	595	0	0	0	0	0	0	0	0	0
Durham Township	653	0	0	0	0	0	0	0	0	0
East Rockhill Township	2,429	4	2	0	2	173	0	0	45	226
Falls Township	11,540	0	0	1	0	0	0	0	0	1
Haycock Township	1,227	0	0	0	0	5	0	0	1	6
Hilltown Township	6,265	0	0	0	0	0	0	0	0	0
Hulmeville Borough	392	0	0	0	0	0	0	0	0	0
Ivyland Borough	371	0	0	0	0	0	0	0	0	0
Langhorne Borough	544	0	0	0	0	0	0	0	0	0
Langhorne Manor Borough	345	0	0	0	0	0	0	0	0	0
Lower Makefield Township	13,037	1	23	1	1	499	0	0	29	554
Lower Southampton Township	7,706	74	9	75	12	841	0	0	34	1046
Middletown Township	15,585	0	0	0	0	0	0	0	0	0

Table 4.3.18-2 Structures Vulnerable to Liquid and Gas Pipelines by Generalized Land Use Type (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Milford Township	4,370	22	16	7	5	434	0	4	80	568
Morrisville Borough	3,134	0	0	0	0	0	0	0	0	0
New Britain Borough	1,145	32	4	0	1	291	0	0	4	332
New Britain Township	4,755	7	13	9	1	436	0	1	41	508
New Hope Borough	1,385	0	0	0	0	0	0	0	0	0
Newtown Borough	1,026	0	0	0	0	0	0	0	0	0
Newtown Township	8,258	30	11	0	12	1,453	0	5	50	1562
Nockamixon Township	1,812	3	10	0	2	175	0	1	34	225
Northampton Township	14,767	7	47	59	14	3,209	1	1	53	3391
Penndel Borough	719	0	0	0	0	0	0	0	0	0
Perkasie Borough	3,381	0	0	0	0	0	0	0	0	0
Plumstead Township	5,789	5	3	13	4	249	0	0	40	314
Quakertown Borough	3,163	0	1	0	0	50	0	0	0	51
Richland Township	6,250	14	10	0	7	843	0	1	73	949
Richlandtown Borough	437	0	0	0	0	0	0	0	0	0
Riegelsville Borough	453	0	0	0	0	0	0	0	0	0
Sellersville Borough	1,887	0	0	0	0	0	0	0	0	0
Silverdale Borough	336	0	0	0	0	0	0	0	0	0
Solebury Township	4,297	9	5	0	11	321	0	2	56	404
Springfield Township	2,696	14	9	0	14	578	0	1	163	779
Telford Borough	676	0	0	0	0	0	0	0	0	0
Tinicum Township	2,345	1	4	0	3	61	0	0	33	102

Table 4.3.18-2 Structures Vulnerable to Liquid and Gas Pipelines by Generalized Land Use Type (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Trumbauersville Borough	374	0	0	0	0	0	0	0	0	0
Tullytown Borough	794	0	0	0	0	0	0	0	0	0
Upper Makefield Township	3,748	0	4	0	3	227	0	0	61	295
Upper Southampton Township	6,149	17	19	1	14	1,227	0	1	18	1297
Warminster Township	11,572	36	18	0	7	1,556	0	0	18	1635
Warrington Township	9,037	28	3	15	2	150	0	0	4	202
Warwick Township	6,167	7	4	112	1	213	0	2	34	373
West Rockhill Township	2,353	2	5	0	1	129	0	1	25	163
Wrightstown Township	1,474	0	0	0	0	0	0	0	0	0
Yardley Borough	1,349	0	0	0	0	0	0	0	0	0
TOTAL	243,350	416	248	322	141	15,788	1	21	1,055	17,996

4.3.19. Terrorism

4.3.19.1. *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. As discussed in the beginning of the Risk Assessment, cyberterrorism was identified as a potential threat, but it was ultimately decided to not include a full profile regarding cyberterrorism. 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.

4.3.19.2. *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.

4.3.19.3. *Past Occurrence*

There has been a high consciousness of terrorist activity in the press with 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 have been no reported terrorist incidents in Bucks County in the past.

Nationally, terrorism continues to be an issue of significant importance. The following narratives do not include all national terroristic attacks that have occurred in the United States.

May 2003: A series of over 24 sniper attacks concentrated along the Cap-City Beltway I-270 in the Columbus Metropolitan Area caused widespread fear across Ohio and leaving one dead.

May 1, 2012: Five self-described anarchists were arrested in an alleged plot to blow up a bridge in Cuyahoga Valley National Park in Brecksville, Ohio. The group was being monitored as part of an FBI undercover operation and had considered other plots previously. One of the suspects expressed a desire to cause financial damage to companies while avoiding casualties.

July 20, 2012: In Aurora, Colorado, during the midnight screening of The Dark Knight Rises, a gunman dressed in tactical clothing, set off tear gas grenades and shot into the audience with multiple firearms. Twelve people were killed, and seventy others were injured.

December 2, 2015: In San Bernardino, CA a planned shooting occurred at the Inland Regional Center which resulted in 16 deaths and 23 casualties. A shootout occurred between the suspects, ultimately leading to their deaths.

June 12, 2016: A 29-year old man armed with an automatic assault rifle, walked into a gay nightclub in Orlando, Florida, killing 49 people and injuring 53 more. The man swore allegiance to the leader of the Islamic State of Iraq and the Levant. It has been marked as the deadliest terror attack since the 9/11 attacks in 2001 in the United States.

Multiple dates, 2018: A chemical company employee and his girlfriend (both 32) detonated explosives throughout Upper Bucks County, worrying local residents. After searching for the individuals for months, local law enforcement, aided by the FBI apprehended the two.

August 4, 2019: A gunman entered a bar in the Oregon Historic District in Dayton, Ohio. At around 1 AM, he opened fire on the bar, killing 10 and injuring 27 others. The gunman was shot dead by responding police. The incident was then investigated by the FBI as Domestic Terrorism.

4.3.19.4. *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 *unlikely,* as defined by the Risk Factor Methodology (see Table 4.4.1-1).

4.3.19.5. *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?
- 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?

The Department of Homeland Security's Cybersecurity and Infrastructure Security Agency has recently been focusing on securing soft targets and crowded places. Places such as sports venues, schools and transportation systems need to be protected because they are publicly accessible spaces that large numbers of people use, and they have limited security making them vulnerable. It is important to think about these types of spaces when trying to address terrorism as a hazard (CISA, 2021).

4.3.20. Transportation Incidents

4.3.20.1. *Location and Extent*

For this analysis a transportation incident is defined as an incident involving highway, air, or rail travel. Incidents as a result of infrastructure failure are considered under Section 4.3.14, while incidents involving hazardous materials are considered under Section 4.3.17 of this report. This analysis includes the location of all public airports, passenger and freight rail lines, and highways where major accidents are likely to occur.

Within Bucks County, there are a total of 3,562 linear miles of roads, including 2,500 miles of local municipal road, 20 miles of turnpike, and approximately 965 miles of state roads. In 2019, PennDOT statistics indicated over 12.9 million daily vehicle miles traveled within Bucks County (PennDOT, 2019a). Figure 4.3.20-1 shows the road network in Bucks County and the average annual daily traffic that can be expected on those roads. The 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. In addition, there are several other important components to the county transportation infrastructure, as shown in Figure 4.3.20-2. These include numerous airports, heliports, and railroad lines.

Figure 4.3.20-1 Average Annual Daily Traffic in Bucks County

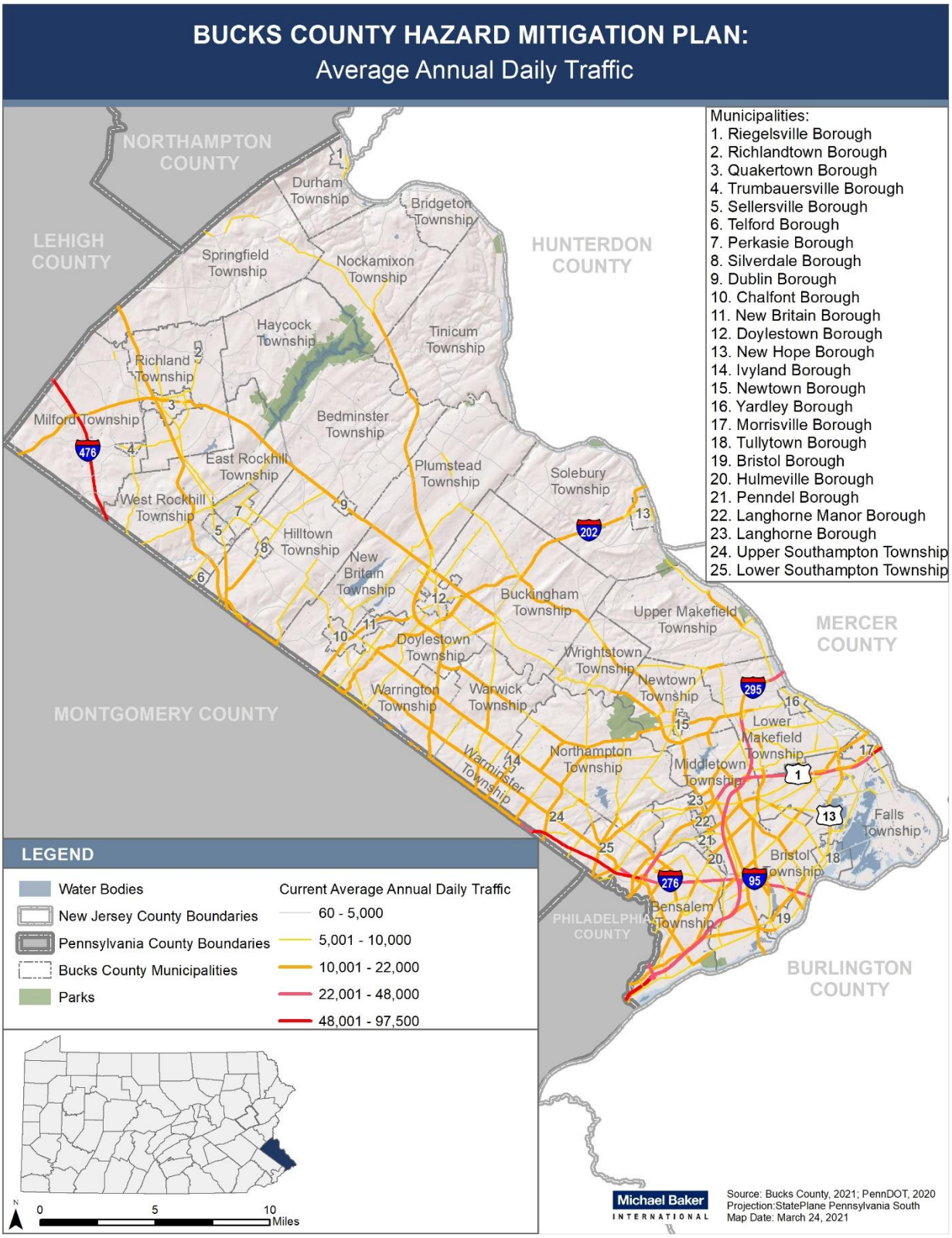
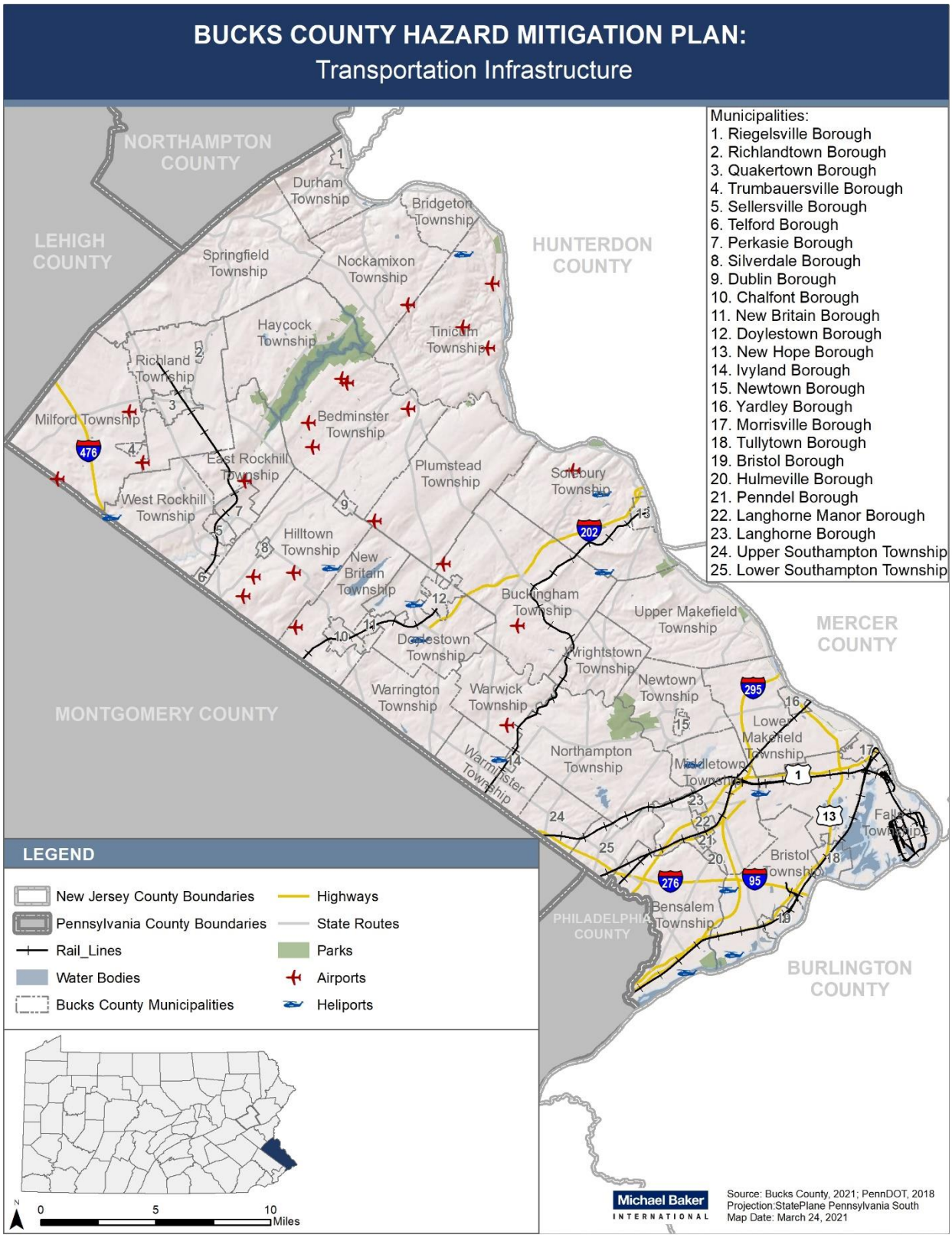


Figure 4.3.20-2 Transportation Infrastructure in Bucks County



Major transportation corridors are more vulnerable to transportation incidents, 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.

Also, airport and heliport data includes both public and private facilities. When thinking about risk it is important to consider that private facility data does not have the same oversight that public facility data does and therefore may not be the most up to date information.

4.3.20.2. *Range of Magnitude*

At a minimum, transportation incidents can result in damage to the vehicles and minor injuries to passengers and drivers. At worst, significant transportation incidents 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 incidents are amplified by the fact that there is often little warning of incidents.

The worst-case scenario for a transportation incident impacting Bucks County would be a road accident which results in a hazardous material spill in a densely populated area, such as near university campuses. Such an event would constitute an immediate health hazard to the university population and requiring an evacuation of campus.

4.3.20.3. *Past Occurrence*

The most common transportation incidents in the County are highway incidents 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 incidents; 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.

Table 4.3.20-1 summarizes the overall vehicular crash data from 2010-2019 for Bucks County. Total crashes have remained largely the same throughout this period. There do not appear to be comparable records available of rail or air traffic incidents that have affected Bucks County.

Table 4.3.20-1 Total Number of Crashes, Traffic Deaths, and Pedestrian Deaths in Bucks County from 2010-2019 (PennDOT, 2019b).

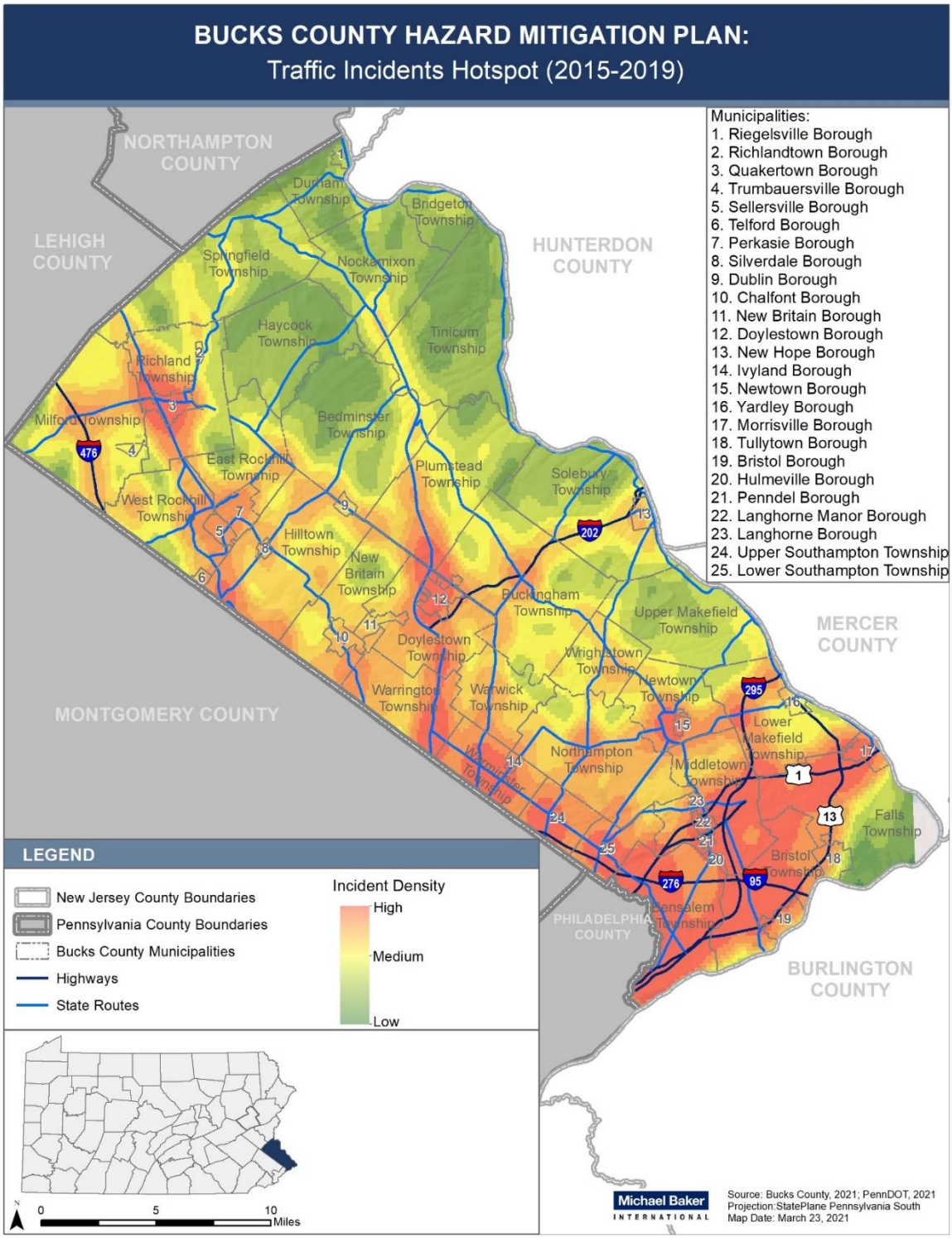
YEAR	TOTAL CRASHES	TRAFFIC DEATHS	PEDESTRIAN DEATHS
2010	6,094	45	8
2011	6,174	61	10
2012	5,900	65	10
2013	5,891	44	6
2014	5,779	44	8

Table 4.3.20-1 Total Number of Crashes, Traffic Deaths, and Pedestrian Deaths in Bucks County from 2010-2019 (PennDOT, 2019b).

YEAR	TOTAL CRASHES	TRAFFIC DEATHS	PEDESTRIAN DEATHS
2015	5,932	55	8
2016	6,159	52	8
2017	6,175	50	11
2018	6,193	54	12
2019	6,103	48	12

Figure 4.3.20-3 shows the density of transportation crashes throughout Bucks County. Red and yellow areas show roadways where the most crashes occurred between 2015 and 2019. In Bucks County, most incidents occur along I-95, I-295, I-276, SR-1, and SR-13. Crashes are also densely concentrated around the more populated communities in the southern portion of the County.

Figure 4.3.20-3 Traffic Incidents Hotspots in Bucks County from 2015 to 2019



4.3.20.4. *Future Occurrence*

Bucks County, as a whole, has experienced up to 0.5% population growth over the past decade according to the US Census Bureau QuickFacts, 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 incident-related congestion. The continued or elevated numbers of tractor-trailers on the County's road system could also contribute to incidences of transportation incidents. While air and rail-related transportation incidents are not as likely to impact the County because of their lower frequency, it is possible that highway incidents may increase slightly without proper mitigation strategies in place.

Overall, the probability of future transportation incidents in Bucks County can be considered *likely* according to the Risk Factor Methodology (see Table 4.4.1-1).

4.3.20.5. *Vulnerability Assessment*

A transportation-related incident can occur on any stretch of road in Bucks County. However, severe incidents 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 incidents occurring. Incidents may also occur on any rail line or air flight path.

Because of the widespread transportation network in Bucks County, a large number of structures are exposed to the threat of transportation incidents. Table 4.3.20-2 lists the critical facilities vulnerable to a major highway, rail, or airport incident in Bucks County. Table 4.3.20-3 lists the total structures vulnerable to a major highway, rail, or airport incident; Table 4.3.20-4 lists the total structures in the roadway incident zone by land use type; Table 4.3.20-5 lists the total structures in the rail incident zone by land use; and Table 4.3.20-6 lists the total structures in the airport incident zone by land use.

The communities with the highest number of total structures 0.5 miles away from a major highway are Bensalem Township (14,862) Middletown Township (11,310), and Bristol Township (10,071). The communities with the highest number of total structures within 0.5 miles of an active rail line are Bensalem Township (5,955), Middletown Township (5,481), and Bristol Township (5,800). The communities with the highest number of total structures within 5 miles of an airport are Doylestown Township (1,003), Warwick Township (730), and Richland Township (570). In Bucks County as a whole, there are 149,891 total structures within 0.5 miles of a major highway, or 62% of the total structure inventory. There are 59,166 total structures within 0.5 miles of an active rail line, or 24% of the total structure inventory, and there are 8,110 total structures within 5 miles of an airport, or 3% of the total structure inventory. 69% of all the County's critical facilities, or 512 facilities, are located within 0.5 miles of a major highway. 16%, or 121, of the County's critical facilities are located within 0.5 miles of an active rail line, and 713, or 96%, of the County's critical facilities are within 5 miles of an airport. For all three transportation routes – roadway, rail, and air – residential structures are the most

vulnerable to transportation accidents with 124,859, 47,255, and 6,364 residential structures to the roadway, rail, and air incident zones.

In addition to the airports and heliports shown in Figure 4.3.20-2 and included in the analysis in Table 4.3.20-5, 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 incidents from these facilities.

Table 4.3.20-2 Critical Facilities Vulnerable to Transportation Incidents (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES WITHIN .5 MI OF A MAJOR HIGHWAY	PERCENT CRITICAL FACILITIES WITHIN .5 MI OF A MAJOR HIGHWAY	CRITICAL FACILITIES WITHIN .5 MI OF AN ACTIVE RAIL LINE	PERCENT CRITICAL FACILITIES WITHIN .5 MI OF AN ACTIVE RAIL LINE	CRITICAL FACILITIES WITHIN .5 MI OF AN AIRPORT	PERCENT CRITICAL FACILITIES WITHIN .5 MI OF AN AIRPORT
Bedminster Township	14	6	43%	0	0%	14	100%
Bensalem Township	52	45	87%	17	33%	52	100%
Bridgeton Township	2	1	50%	0	0%	2	100%
Bristol Borough	15	9	60%	13	87%	15	100%
Bristol Township	52	27	52%	15	29%	52	100%
Buckingham Township	21	15	71%	0	0%	21	100%
Chalfont Borough	8	8	100%	8	100%	8	100%
Doylestown Borough	20	12	60%	7	35%	20	100%
Doylestown Township	27	17	63%	6	22%	27	100%
Dublin Borough	4	4	100%	0	0%	4	100%
Durham Township	1	1	100%	0	0%	0	0%
East Rockhill Township	9	6	67%	0	0%	9	100%
Falls Township	29	11	38%	0	0%	29	100%
Haycock Township	2	0	0%	0	0%	2	100%
Hilltown Township	14	9	64%	0	0%	14	100%
Hulmeville Borough	4	4	100%	0	0%	4	100%
Ivyland Borough	4	4	100%	0	0%	4	100%
Langhorne Borough	5	5	100%	0	0%	5	100%
Langhorne Manor Borough	5	5	100%	4	80%	5	100%
Lower Makefield Township	22	9	41%	6	27%	22	100%
Lower Southampton Township	21	16	76%	3	14%	10	48%
Middletown Township	40	28	70%	12	30%	40	100%
Milford Township	16	10	63%	0	0%	16	100%
Morrisville Borough	11	10	91%	5	45%	4	36%

Table 4.3.20-2 Critical Facilities Vulnerable to Transportation Incidents (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES WITHIN .5 MI OF A MAJOR HIGHWAY	PERCENT CRITICAL FACILITIES WITHIN .5 MI OF A MAJOR HIGHWAY	CRITICAL FACILITIES WITHIN .5 MI OF AN ACTIVE RAIL LINE	PERCENT CRITICAL FACILITIES WITHIN .5 MI OF AN ACTIVE RAIL LINE	CRITICAL FACILITIES WITHIN .5 MI OF AN AIRPORT	PERCENT CRITICAL FACILITIES WITHIN .5 MI OF AN AIRPORT
New Britain Borough	5	0	0%	5	100%	5	100%
New Britain Township	18	3	17%	3	17%	18	100%
New Hope Borough	6	6	100%	0	0%	6	100%
Newtown Borough	6	3	50%	0	0%	6	100%
Newtown Township	28	23	82%	0	0%	28	100%
Nockamixon Township	10	8	80%	0	0%	10	100%
Northampton Township	29	18	62%	0	0%	29	100%
Penndel Borough	5	5	100%	5	100%	5	100%
Perkasie Borough	10	9	90%	0	0%	10	100%
Plumstead Township	18	13	72%	0	0%	18	100%
Quakertown Borough	17	17	100%	0	0%	17	100%
Richland Township	10	7	70%	0	0%	10	100%
Richlandtown Borough	3	3	100%	0	0%	3	100%
Riegelsville Borough	3	3	100%	0	0%	0	0%
Sellersville Borough	7	7	100%	0	0%	7	100%
Silverdale Borough	3	3	100%	0	0%	3	100%
Solebury Township	13	7	54%	0	0%	13	100%
Springfield Township	9	8	89%	0	0%	1	11%
Telford Borough	2	0	0%	0	0%	2	100%
Tinicum Township	11	4	33%	0	0%	12	100%
Trumbauersville Borough	4	0	0%	0	0%	4	100%
Tullytown Borough	7	7	100%	5	71%	7	100%
Upper Makefield Township	7	1	14%	0	0%	4	57%
Upper Southampton Township	18	16	89%	0	0%	18	100%

Table 4.3.20-2 Critical Facilities Vulnerable to Transportation Incidents (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES WITHIN .5 MI OF A MAJOR HIGHWAY	PERCENT CRITICAL FACILITIES WITHIN .5 MI OF A MAJOR HIGHWAY	CRITICAL FACILITIES WITHIN .5 MI OF AN ACTIVE RAIL LINE	PERCENT CRITICAL FACILITIES WITHIN .5 MI OF AN ACTIVE RAIL LINE	CRITICAL FACILITIES WITHIN .5 MI OF AN AIRPORT	PERCENT CRITICAL FACILITIES WITHIN .5 MI OF AN AIRPORT
Warminster Township	31	28	90%	3	10%	31	100%
Warrington Township	25	16	64%	0	0%	25	100%
Warwick Township	16	13	81%	0	0%	16	100%
West Rockhill Township	10	10	100%	0	0%	10	100%
Wrightstown Township	7	5	71%	0	0%	7	100%
Yardley Borough	7	7	100%	4	57%	7	100%
TOTAL	743	512	69%	121	16%	711	96%

Table 4.3.20-3 Structures Vulnerable to Transportation Incidents (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES WITHIN .5 MI OF A MAJOR HIGHWAY	PERCENT STRUCTURES WITHIN .5 MI OF A MAJOR HIGHWAY	STRUCTURES WITHIN .5 MI OF AN ACTIVE RAIL LINE	PERCENT STRUCTURES WITHIN .5 MI OF AN ACTIVE RAIL LINE	STRUCTURES WITHIN .5 MI OF AN AIRPORT	PERCENT STRUCTURES WITHIN .5 MI OF AN AIRPORT
Bedminster Township	3,229	1,600	50%	0	0%	259	8%
Bensalem Township	19,450	14,862	76%	5,955	31%	212	1%
Bridgeton Township	782	395	51%	0	0%	0	0%
Bristol Borough	3,893	1,958	50%	3,864	99%	0	0%
Bristol Township	19,543	10,071	52%	5,800	30%	975	5%
Buckingham Township	8,315	4,861	58%	1,021	12%	262	3%
Chalfont Borough	1,674	1,466	88%	1,255	75%	0	0%
Doylestown Borough	3,236	1,724	53%	1,502	46%	24	1%
Doylestown Township	6,441	3,939	61%	1,045	16%	1,003	16%

Table 4.3.20-3 Structures Vulnerable to Transportation Incidents (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES WITHIN .5 MI OF A MAJOR HIGHWAY	PERCENT STRUCTURES WITHIN .5 MI OF A MAJOR HIGHWAY	STRUCTURES WITHIN .5 MI OF AN ACTIVE RAIL LINE	PERCENT STRUCTURES WITHIN .5 MI OF AN ACTIVE RAIL LINE	STRUCTURES WITHIN .5 MI OF AN AIRPORT	PERCENT STRUCTURES WITHIN .5 MI OF AN AIRPORT
Dublin Borough	595	593	100%	0	0%	0	0%
Durham Township	653	315	48%	0	0%	0	0%
East Rockhill Township	2,429	1,054	43%	482	20%	79	3%
Falls Township	11,540	3,828	33%	3,543	31%	717	6%
Haycock Township	1,227	261	21%	0	0%	0	0%
Hilltown Township	6,265	3,739	60%	349	6%	701	11%
Hulmeville Borough	392	384	98%	0	0%	0	0%
Ivyland Borough	371	371	100%	371	100%	153	41%
Langhorne Borough	544	544	100%	220	40%	0	0%
Langhorne Manor Borough	345	345	100%	219	63%	0	0%
Lower Makefield Township	13,037	8,221	63%	3,663	28%	0	0%
Lower Southampton Township	7,706	5,552	72%	3,351	43%	0	0%
Middletown Township	15,585	11,310	73%	5,481	35%	171	1%
Milford Township	4,370	1,807	41%	1	0%	296	7%
Morrisville Borough	3,134	2,650	85%	1,751	56%	0	0%
New Britain Borough	1,145	87	8%	1,098	96%	0	0%
New Britain Township	4,755	1,226	26%	705	15%	117	2%
New Hope Borough	1,385	1,368	99%	1,198	86%	0	0%
Newtown Borough	1,026	493	48%	0	0%	0	0%
Newtown Township	8,258	5,659	69%	0	0%	0	0%
Nockamixon Township	1,812	1,003	55%	0	0%	42	2%
Northampton Township	14,767	9,285	63%	1,716	12%	39	0%
Penndel Borough	719	719	100%	556	77%	0	0%
Perkasie Borough	3,381	2,989	88%	1,890	56%	128	4%

Table 4.3.20-3 Structures Vulnerable to Transportation Incidents (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	STRUCTURES WITHIN .5 MI OF A MAJOR HIGHWAY	PERCENT STRUCTURES WITHIN .5 MI OF A MAJOR HIGHWAY	STRUCTURES WITHIN .5 MI OF AN ACTIVE RAIL LINE	PERCENT STRUCTURES WITHIN .5 MI OF AN ACTIVE RAIL LINE	STRUCTURES WITHIN .5 MI OF AN AIRPORT	PERCENT STRUCTURES WITHIN .5 MI OF AN AIRPORT
Plumstead Township	5,789	3,510	61%	0	0%	225	4%
Quakertown Borough	3,163	3,144	99%	1,558	49%	312	10%
Richland Township	6,250	3,951	63%	1,680	27%	570	9%
Richlandtown Borough	437	437	100%	0	0%	0	0%
Riegelsville Borough	453	453	100%	0	0%	0	0%
Sellersville Borough	1,887	1,421	75%	1,552	82%	0	0%
Silverdale Borough	336	336	100%	0	0%	0	0%
Solebury Township	4,297	2,958	69%	900	21%	157	4%
Springfield Township	2,696	1,168	43%	0	0%	0	0%
Telford Borough	676	138	20%	609	90%	0	0%
Tinicum Township	2,345	1,019	43%	0	0%	286	12%
Trumbauersville Borough	374	0	0%	0	0%	1	0%
Tullytown Borough	794	711	90%	538	68%	0	0%
Upper Makefield Township	3,748	1,876	50%	0	0%	0	0%
Upper Southampton Township	6,149	4,739	77%	1,854	30%	0	0%
Warminster Township	11,572	8,229	71%	1,700	15%	424	4%
Warrington Township	9,037	3,986	44%	1	0%	0	0%
Warwick Township	6,167	3,373	55%	257	4%	730	12%
West Rockhill Township	2,353	1,505	64%	568	24%	181	8%
Wrightstown Township	1,474	909	62%	278	19%	46	3%
Yardley Borough	1,349	1,349	100%	635	47%	0	0%
TOTAL	243,350	149,891	62%	59,166	24%	8,110	3%

Table 4.3.20-4 Structures in Road Crash Zones by Type per Municipality (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL STRUCTURES IN ROAD CRASH ZONES PER MUNICIPALITY
Bedminster Township	3,229	41	8	27	16	1,352	1	2	153	1,600
Bensalem Township	19,450	1,552	288	172	171	11,667	-	18	988	14,862
Bridgeton Township	782	9	22	-	1	259	-	-	103	395
Bristol Borough	3,893	189	134	21	23	1,491	-	5	91	1,958
Bristol Township	19,543	495	329	194	158	8,168	-	8	690	10,071
Buckingham Township	8,315	225	42	13	25	4,280	-	9	264	4,861
Chalfont Borough	1,674	53	36	6	10	1,337	-	-	24	1,466
Doylestown Borough	3,236	127	30	1	16	1,503	-	2	43	1,724
Doylestown Township	6,441	179	63	6	46	3,509	-	5	119	3,939
Dublin Borough	595	43	15	6	6	499	-	-	24	593
Durham Township	653	9	7	3	2	220	-	-	73	315
East Rockhill Township	2,429	41	42	3	9	818	-	2	139	1,054
Falls Township	11,540	304	78	43	34	3,233	-	4	131	3,828
Haycock Township	1,227	1	58	-	1	176	-	-	24	261
Hilltown Township	6,265	245	39	34	44	3,066	-	5	306	3,739
Hulmeville Borough	392	12	12	3	7	321	-	2	27	384
Ivyland Borough	371	9	14	10	5	320	-	4	9	371
Langhorne Borough	544	52	12	1	24	437	-	-	17	544
Langhorne Manor Borough	345	3	12	-	16	295	-	-	18	345
Lower Makefield Township	13,037	466	141	-	31	7,143	1	4	435	8,221
Lower Southampton Township	7,706	388	60	133	38	4,774	-	1	154	5,552

Table 4.3.20-4 Structures in Road Crash Zones by Type per Municipality (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL STRUCTURES IN ROAD CRASH ZONES PER MUNICIPALITY
Middletown Township	15,585	599	191	38	114	9,639	-	7	715	11,310
Milford Township	4,370	60	90	36	26	1,448	-	2	143	1,807
Morrisville Borough	3,134	154	71	6	39	2,289	-	3	87	2,650
New Britain Borough	1,145	3	-	-	-	84	-	-	-	87
New Britain Township	4,755	29	11	3	9	1,095	-	-	79	1,226
New Hope Borough	1,385	166	34	1	15	1,033	-	15	103	1,368
Newtown Borough	1,026	54	13	-	11	401	-	2	12	493
Newtown Township	8,258	231	26	51	46	5,073	-	13	212	5,659
Nockamixon Township	1,812	44	40	5	9	689	-	3	209	1,003
Northampton Township	14,767	225	96	90	51	8,595	1	2	223	9,285
Penndel Borough	719	105	10	15	10	539	-	1	39	719
Perkasie Borough	3,381	159	63	22	44	2,564	-	2	133	2,989
Plumstead Township	5,789	276	34	38	20	2,916	-	2	224	3,510
Quakertown Borough	3,163	268	53	30	47	2,622	1	1	122	3,144
Richland Township	6,250	500	84	11	33	2,751	3	1	567	3,951
Richlandtown Borough	437	12	11	-	13	392	-	-	9	437
Riegelsville Borough	453	21	10	-	16	333	-	1	71	453
Sellersville Borough	1,887	54	52	10	18	1,168	9	2	107	1,421
Silverdale Borough	336	9	3	2	8	298	-	-	16	336
Solebury Township	4,297	132	65	2	18	2,403	1	8	325	2,958
Springfield Township	2,696	42	13	3	19	881	-	2	208	1,168
Telford Borough	676	1	2	-	-	134	-	-	1	138
Tinicum Township	2,345	34	30	7	25	672	-	1	246	1,019

Table 4.3.20-4 Structures in Road Crash Zones by Type per Municipality (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL STRUCTURES IN ROAD CRASH ZONES PER MUNICIPALITY
Trumbauersville Borough	374	-	-	-	-	-	-	-	-	-
Tullytown Borough	794	60	36	10	11	529	-	8	57	711
Upper Makefield Township	3,748	36	53	-	12	1,550	2	1	219	1,876
Upper Southampton Township	6,149	328	56	67	44	4,132	-	3	107	4,739
Warminster Township	11,572	1,140	75	139	95	6,487	117	1	175	8,229
Warrington Township	9,037	245	53	32	24	3,461	-	6	163	3,986
Warwick Township	6,167	98	88	11	20	2,937	2	3	196	3,373
West Rockhill Township	2,353	101	29	33	32	1,073	1	2	234	1,505
Wrightstown Township	1,474	48	15	2	12	710	-	5	117	909
Yardley Borough	1,349	93	16	3	21	1,093	-	4	118	1,349
TOTAL	243,350	9,770	2,865	1,343	1,545	124,859	139	172	9,069	149,891

Table 4.3.20-5 Structures in Rail Crash Zones by Type per Municipality (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL STRUCTURES IN RAIL ACCIDENT ZONES PER MUNICIPALITY
Bedminster Township	3,229	-	-	-	-	-	-	-	-	-
Bensalem Township	19,450	520	125	158	89	4,476	-	15	569	5,955
Bridgeton Township	782	-	-	-	-	-	-	-	-	-
Bristol Borough	3,893	360	197	23	70	3,018	-	8	184	3,864
Bristol Township	19,543	269	224	106	97	4,655	-	3	436	5,800
Buckingham Township	8,315	10	14	-	14	882	-	12	89	1,021
Chalfont Borough	1,674	54	32	7	10	1,119	-	-	33	1,255
Doylestown Borough	3,236	294	28	2	25	1,105	-	2	45	1,502
Doylestown Township	6,441	31	16	-	26	921	-	4	32	1,045
Dublin Borough	595	-	-	-	-	-	-	-	-	-
Durham Township	653	-	-	-	-	-	-	-	-	-
East Rockhill Township	2,429	9	15	-	5	424	-	-	29	482
Falls Township	11,540	240	55	111	29	2,873	-	10	225	3,543
Haycock Township	1,227	-	-	-	-	-	-	-	-	-
Hilltown Township	6,265	1	1	5	-	334	-	-	8	349
Hulmeville Borough	392	-	-	-	-	-	-	-	-	-
Ivyland Borough	371	9	14	10	5	320	-	4	9	371
Langhorne Borough	544	10	6	1	4	189	-	-	10	220
Langhorne Manor Borough	345	3	8	-	16	182	-	-	9	219
Lower Makefield Township	13,037	281	63	-	15	3,137	1	5	160	3,663
Lower Southampton Township	7,706	161	31	50	18	2,931	-	-	157	3,351

Table 4.3.20-5 Structures in Rail Crash Zones by Type per Municipality (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL STRUCTURES IN RAIL ACCIDENT ZONES PER MUNICIPALITY
Middletown Township	15,585	347	131	35	50	4,477	-	5	434	5,481
Milford Township	4,370	-	-	-	-	1	-	-	-	1
Morrisville Borough	3,134	126	58	7	28	1,457	-	3	71	1,751
New Britain Borough	1,145	114	16	22	24	887	-	-	33	1,098
New Britain Township	4,755	10	25	14	2	629	-	-	25	705
New Hope Borough	1,385	160	27	1	15	890	-	14	90	1,198
Newtown Borough	1,026	-	-	-	-	-	-	-	-	-
Newtown Township	8,258	-	-	-	-	-	-	-	-	-
Nockamixon Township	1,812	-	-	-	-	-	-	-	-	-
Northampton Township	14,767	79	25	119	21	1,412	-	3	57	1,716
Penndel Borough	719	104	4	14	10	390	-	1	33	556
Perkasie Borough	3,381	109	41	22	34	1,586	-	2	94	1,890
Plumstead Township	5,789	-	-	-	-	-	-	-	-	-
Quakertown Borough	3,163	132	29	28	26	1,277	-	1	65	1,558
Richland Township	6,250	229	49	34	16	1,242	-	-	110	1,680
Richlandtown Borough	437	-	-	-	-	-	-	-	-	-
Riegelsville Borough	453	-	-	-	-	-	-	-	-	-
Sellersville Borough	1,887	57	51	10	27	1,285	9	2	110	1,552
Silverdale Borough	336	-	-	-	-	-	-	-	-	-
Solebury Township	4,297	95	10	-	6	658	-	8	121	900
Springfield Township	2,696	-	-	-	-	-	-	-	-	-

Table 4.3.20-5 Structures in Rail Crash Zones by Type per Municipality (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL STRUCTURES IN RAIL ACCIDENT ZONES PER MUNICIPALITY
Telford Borough	676	16	8	10	12	534	-	3	26	609
Tinicum Township	2,345	-	-	-	-	-	-	-	-	-
Trumbauersville Borough	374	-	-	-	-	-	-	-	-	-
Tullytown Borough	794	59	36	10	11	357	-	8	57	538
Upper Makefield Township	3,748	-	-	-	-	-	-	-	-	-
Upper Southampton Township	6,149	157	24	58	14	1,552	-	1	47	1,854
Warminster Township	11,572	589	24	180	29	820	-	1	57	1,700
Warrington Township	9,037	1	-	-	-	-	-	-	-	1
Warwick Township	6,167	7	6	166	5	39	-	2	32	257
West Rockhill Township	2,353	20	10	19	11	446	1	2	59	568
Wrightstown Township	1,474	4	10	2	3	199	-	12	48	278
Yardley Borough	1,349	30	9	1	9	551	-	1	34	635
TOTAL	243,350	4,697	1,422	1,225	776	47,255	11	132	3,598	59,166

Table 4.3.20-6 Structures in Air Crash Zones by Type per Municipality (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL STRUCTURES IN AIR CRASH ZONES PER MUNICIPALITY
Bedminster Township	3,229	2	1	2	2	206	0	1	45	259
Bensalem Township	19,450	22	24	28	1	80	0	0	57	212
Bridgeton Township	782	0	0	0	0	0	0	0	0	0
Bristol Borough	3,893	0	0	0	0	0	0	0	0	0
Bristol Township	19,543	13	36	71	13	660	0	0	182	975
Buckingham Township	8,315	25	5	35	3	162	0	0	32	262
Chalfont Borough	1,674	0	0	0	0	0	0	0	0	0
Doylestown Borough	3,236	2	3	0	1	15	0	0	3	24
Doylestown Township	6,441	15	14	1	17	924	0	0	17	1003
Dublin Borough	595	0	0	0	0	0	0	0	0	0
Durham Township	653	0	0	0	0	0	0	0	0	0
East Rockhill Township	2,429	23	3	0	0	49	0	0	4	79
Falls Township	11,540	114	7	1	3	535	0	0	57	717
Haycock Township	1,227	0	0	0	0	0	0	0	0	0
Hilltown Township	6,265	53	1	9	11	558	0	3	66	701
Hulmeville Borough	392	0	0	0	0	0	0	0	0	0
Ivyland Borough	371	5	7	9	2	121	0	3	6	153
Langhorne Borough	544	0	0	0	0	0	0	0	0	0
Langhorne Manor Borough	345	0	0	0	0	0	0	0	0	0
Lower Makefield Township	13,037	0	0	0	0	0	0	0	0	0
Lower Southampton Township	7,706	0	0	0	0	0	0	0	0	0
Middletown Township	15,585	28	1	0	6	129	0	0	7	171
Milford Township	4,370	5	10	20	0	221	0	0	40	296

Table 4.3.20-6 Structures in Air Crash Zones by Type per Municipality (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL STRUCTURES IN AIR CRASH ZONES PER MUNICIPALITY
Morrisville Borough	3,134	0	0	0	0	0	0	0	0	0
New Britain Borough	1,145	0	0	0	0	0	0	0	0	0
New Britain Township	4,755	0	0	0	2	101	0	0	14	117
New Hope Borough	1,385	0	0	0	0	0	0	0	0	0
Newtown Borough	1,026	0	0	0	0	0	0	0	0	0
Newtown Township	8,258	0	0	0	0	0	0	0	0	0
Nockamixon Township	1,812	0	0	0	1	38	0	0	3	42
Northampton Township	14,767	0	2	0	0	36	0	0	1	39
Penndel Borough	719	0	0	0	0	0	0	0	0	0
Perkasie Borough	3,381	0	0	0	0	117	0	0	11	128
Plumstead Township	5,789	57	1	15	2	129	0	0	21	225
Quakertown Borough	3,163	0	3	0	2	306	0	0	1	312
Richland Township	6,250	3	1	0	1	538	0	0	27	570
Richlandtown Borough	437	0	0	0	0	0	0	0	0	0
Riegelsville Borough	453	0	0	0	0	0	0	0	0	0
Sellersville Borough	1,887	0	0	0	0	0	0	0	0	0
Silverdale Borough	336	0	0	0	0	0	0	0	0	0
Solebury Township	4,297	2	5	0	6	134	1	0	9	157
Springfield Township	2,696	0	0	0	0	0	0	0	0	0
Telford Borough	676	0	0	0	0	0	0	0	0	0
Tinicum Township	2,345	1	9	0	4	228	0	0	44	286
Trumbauersville Borough	374	0	0	0	0	0	0	0	1	1
Tullytown Borough	794	0	0	0	0	0	0	0	0	0

Table 4.3.20-6 Structures in Air Crash Zones by Type per Municipality (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL STRUCTURES IN AIR CRASH ZONES PER MUNICIPALITY
Upper Makefield Township	3,748	0	0	0	0	0	0	0	0	0
Upper Southampton Township	6,149	0	0	0	0	0	0	0	0	0
Warminster Township	11,572	9	5	103	3	289	0	1	13	424
Warrington Township	9,037	0	0	0	0	0	0	0	0	0
Warwick Township	6,167	3	2	78	1	625	0	0	20	730
West Rockhill Township	2,353	0	12	0	0	139	0	0	30	181
Wrightstown Township	1,474	0	2	0	0	24	0	0	20	46
Yardley Borough	1,349	0	0	0	0	0	0	0	0	0
TOTAL	243,350	382	154	372	81	6,364	1	8	731	8,110

4.3.21. Urban Fire and Explosion

4.3.21.1. *Location and Extent*

Urban fires and explosions involve a structure or property fire 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, 2019). Urban fires can more easily spread from building to building in these denser areas.

Urban fires and explosions can be triggered or exacerbated by other disaster events such as floods, storms, drought, transportation accidents, hazardous materials releases, criminal activity such as arson, and terrorism. Urban fires have the potential to cause extensive damage to residential, commercial, or public property. Damage ranges from minor smoke and/or water damage to the destruction of buildings. People are often displaced for several months to years depending on the magnitude of the event. Urban fires and explosions can also cause injuries and death; in Pennsylvania, the fire mortality rate is approximately 13.9 deaths per million residents, or about 180 fire-related deaths per year. This is the 21st highest fire mortality rate in the national and is higher than the national average of 13.3 deaths per million residents (US Fire Administration, 2019).

4.3.21.2. *Range of Magnitude*

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). The impacts of urban fire and explosion events vary based on the size of the incident and the population and structure where it occurs. Although most fires are small structural fires, the cumulative effect of these small incidents can be great in terms of property damage and lives lost. Many small incidents have the potential for a fire disaster if early warning and fire department services are not available. The secondary effects of urban fire events relate to the ability of public, private, and non-profit entities to provide post-incident relief.

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. Human services agencies (community support programs, health and medical services, public assistance programs, and social services) can be affected 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 events 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 (NFPA, 1982). 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 as 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 (Marcovitz, 2005).

4.3.21.3. *Past Occurrence*

Table 4.3.21-1 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 4.3.21-1 shows the incidence of fire events averaged from 2001-2014 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 4.3.21-1 Annual Fire Incident Counts for Bucks County by Municipality from 2001-2014 (Bucks County 911 Center, 2015)

MUNICIPALITY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL INCIDENTS	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	2,013	201.3
Bristol Township	931	915	1,038	830	883	951	890	836	754	757	1,396	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

Table 4.3.21-1 Annual Fire Incident Counts for Bucks County by Municipality from 2001-2014 (Bucks County 911 Center, 2015)

MUNICIPALITY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL INCIDENTS	AVERAGE
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

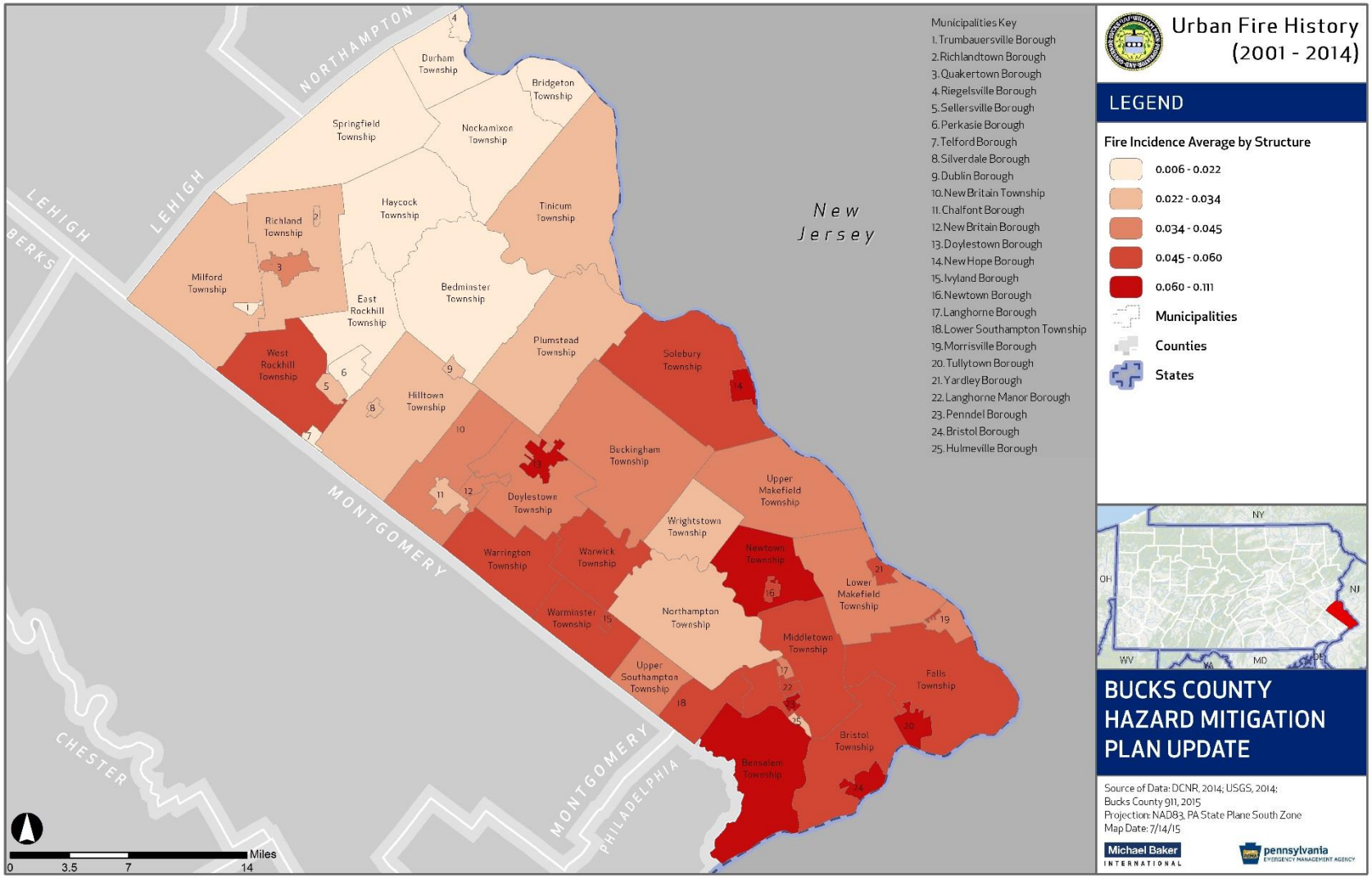
Table 4.3.21-1 Annual Fire Incident Counts for Bucks County by Municipality from 2001-2014 (Bucks County 911 Center, 2015)

MUNICIPALITY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL INCIDENTS	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

Table 4.3.21-1 Annual Fire Incident Counts for Bucks County by Municipality from 2001-2014 (Bucks County 911 Center, 2015)

MUNICIPALITY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL INCIDENTS	AVERAGE
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	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 4.3.21-1 Urban fire events in Bucks County (Bucks County 911 Center, 2015).


Municipalities Key
1. Trumbauersville Borough
2. Richlandtown Borough
3. Quakertown Borough
4. Riegelsville Borough
5. Sellersville Borough
6. Perkasie Borough
7. Telford Borough
8. Silverdale Borough
9. Dublin Borough
10. New Britain Township
11. Chalfont Borough
12. New Britain Borough
13. Doylestown Borough
14. New Hope Borough
15. Ivyland Borough
16. Newtown Borough
17. Langhorne Borough
18. Lower Southampton Township
19. Morrisville Borough
20. Tullytown Borough
21. Yardley Borough
22. Langhorne Manor Borough
23. Penndel Borough
24. Bristol Borough
25. Hulmeville Borough
Urban Fire History (2001 - 2014)
LEGEND
Fire Incidence Average by Structure
0.006 - 0.022
0.022 - 0.034
0.034 - 0.045
0.045 - 0.060
0.060 - 0.111
Municipalities
Counties
States
NORTHAMPTON
LEHIGH
BERKS
MONTGOMERY
CHESTER
PHILADELPHIA
New Jersey
Durham Township
Bridgeton Township
Springfield Township
Nockamixon Township
Haycock Township
Tinicum Township
Richland Township
Milford Township
East Rockhill Township
Bedminster Township
West Rockhill Township
Plumstead Township
Solebury Township
Hilltown Township
Buckingham Township
Upper Makefield Township
Doylestown Township
Wrightstown Township
Warrington Township
Warwick Township
Newtown Township
Lower Makefield Township
Warminster Township
Northampton Township
Middletown Township
Upper Southampton Township
Falls Township
Bristol Township
Bensalem Township
NY
OH
NJ
WV
MD
DE
BUCKS COUNTY HAZARD MITIGATION PLAN UPDATE
Source of Data: DCNR, 2014; USGS, 2014; Bucks County 911, 2015
Projection: NAD83, PA State Plane South Zone
Map Date: 7/14/15
Michael Baker INTERNATIONAL
pennsylvania EMERGENCY MANAGEMENT AGENCY
0 3.5 7 14 Miles

Since the previous plan was developed, there have been approximately 1700 fires a year from 2015-2020. Only county-level data was available for this plan update. Table 4.3.21-2 depicts the different fires that have occurred in the County each year. The most common fire event types over the past five years have been dwelling fires (3,351), brush fires (3,038), and fumes inside the building (2,409). The year with the most fire incidents was 2015 with 2,638 total fire events.

Table 4.3.21-2 Annual Fire Incident Totals Within Bucks County from 2015-2020 (Bucks County 911 Center, 2021).

FIRE EVENT TYPE	2015	2016	2017	2018	2019	2020	TOTAL INCIDENTS
Brush Fire	677	595	467	381	420	498	3,038
Extinguished Fire Inside Any Building	67	84	92	97	84	67	491
Apartment Fire	154	181	148	148	162	136	929
Barn Fire	7	10	6	8	8	4	43
Building Fire (General)	172	212	164	147	170	169	1,034
Chimney Fire	87	87	72	68	79	72	465
Dwelling Fire (Residence)	798	509	502	478	543	521	3,351
Garage Fire	11	9	6	18	11	5	60
Grill Fire (Attached to Home)	18	13	10	21	13	19	94
Hospital Fire	1	2	1	1	4	3	12
Nursing Home Fire	14	16	15	20	18	13	96
Out Building Fire (Shed, Pavilion, etc.)	20	24	10	26	21	27	128
School Fire	9	14	7	12	18	10	70
Store/Storefront Fire	23	40	8	20	17	9	117
Fumes Inside the Building	374	405	365	426	417	422	2,409
Electrical Fire Inside the Building	206	180	239	255	203	173	1,256
TOTAL	2,638	2,381	2,112	2,126	2,188	2,148	13,593

4.3.21.4. *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 4.4.1-1). 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.

4.3.21.5. *Vulnerability Assessment*

Areas where large buildings are located or where 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 and Bristol Boroughs (US Census, 2019). 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.

The Fire Marshal Department advises the County Commissioners in matters regarding fire protection and safety within Bucks County. The Fire Marshal Department operates and maintains a juvenile fire-setter intervention program in order to address the juvenile fire-setting problem and reduce the threat of fire from the youth population. The department operates a number of other urban fire mitigation programs (Bucks County, 2021b):

- Inspects all County Government owned and leased properties for fire safety.
- Inspect provider homes for the Bucks County Area Agency on Aging and Foster Care Homes for the Children and Youth Agency.
- Maintains fire alarms, security alarms, and panic alarms in all Bucks County owned and leased properties.
- Operates a central station to monitor all County owned emergency alarms.
- Maintains thousands of Bucks County portable fire extinguishers.

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.

In Bucks County a Future of Fire Service Report was recently completed that recognizes a shortage of volunteers to help with emergency response to fires. This report is discussed in more detail in Section 5 Capability Assessment.

4.3.22. Utility Interruption

4.3.22.1. *Location and Extent*

Utility interruptions include any impairment of the functioning of telecommunications, gas, electric, water, or waste networks. Interruptions or outages occur because of geomagnetic storms, fuel or resource shortage, electromagnetic pulses, information technology failures, transmission facility or linear utility accident, and major energy, power, or utility failure.

These kinds of interruptions rarely spontaneously occur on their own; this hazard is often secondary to other hazard events, particularly transportation accidents, lightning strikes, floods, windstorms, extreme heat or cold events, coastal storms, and winter storms. For example, severe thunderstorms or winter storms could bring down power lines and cause widespread disruptions in electricity service. Strong heat waves may result in rolling blackouts where power may not be available for an extended period. Local outages may be caused by traffic accidents or wind damage. National and international current events can also impact the supply of fuels to the County.

Utility interruptions and power failures can take place throughout the County. 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. Bucks County is served by three high-powered electric providers; PPL, Inc., PECO Energy, and First Energy. Natural gas service is available in many parts of the county through PPL, Inc., PECO Energy Company, and UGI. Local telephone service is provided by Version and Frontier Communications, and all major long-distance and cellular providers are available in Bucks County (BCEDC, 2021).

According to the 2019 5-year American Community Survey, in Bucks County, 36.6% of housing units use utility gas, followed by 29.5% of home using electric heat and 27.0% of homes using fuel oil/kerosene (US Census, 2019). As a result, an interruption in any three of those utilities could affect a significant number of residents. Utility interruptions have the potential to take place throughout the County in any location where a utility is present, including along any of its 243 miles of natural gas pipeline and 48 miles of liquid petroleum pipeline. In addition, an increasing reliance on internet access and telecommunications could also impact a large number of residents at any given time.

In Bucks County there are over 80 community water suppliers that utilize 239 public wells and 8 water filtration plants. Major community water suppliers primarily include private water companies, municipal water departments, and water supply authorities. Approximately 82% of households in the County rely on public water supply. Public suppliers serve portions of 47 of the 54 municipalities in Bucks County; only Bridgeton, Durham, Haycock, Nockamixon, Tinicum, Upper Makefield, and Wrightstown Townships contain no major community water supply systems (BCPC, 2011a).

4.3.22.2. *Range of Magnitude*

Most severe utility interruptions and power failures are regional events. With the loss of power, electric-powered equipment and systems will not be operational. Examples may include HVAC and ancillary support equipment; communication (i.e. public address systems, telephone, computer servers, and peripherals); ventilation systems; fire and security systems; refrigerators; sterilizers; trash compactors; office equipment; and medical equipment. This can cause food spoilage, loss of heat or air conditioning, basement flooding (sump pump failure), lack of light, loss of water (well pump failure), lack of phone service, or lack of internet service. These issues are more of a nuisance than a hazard but can cause damage or harm depending 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.

The severity of a utility interruption can be compounded with extreme weather events, especially winter weather, extreme wind, or windstorm events. Interruptions can also be more severe for special needs populations that are dependent on electronic medical equipment. Utility interruptions can significantly hamper first responders in their efforts to provide aid in a compound disaster situation, especially with losses of telecommunications and wireless capabilities. Telecommunications interruptions can also hinger first responders' efforts. Additionally, an internet outage could be crippling to the economy, as many companies and government entities process payments and invoices electronically rather than with physical checks.

In a possible worst-case scenario in Bucks County, a winter storm event could cause widespread power outages, leaving citizens without heat during subzero temperatures for several days, stranded as they wait for roads to be plowed. The power outage would also put elderly populations or others at risk of health problems due to the lack of heat and the inability to call for assistance or leave their homes. Power lines may also be difficult to repair because of the magnitude of the storm. A power outage during an extreme heat event would have a similar impact. A lack of air conditioning would put vulnerable populations at risk.

An additional 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.

4.3.22.3. *Past Occurrence*

Energy emergencies may be caused by nationwide shortages or localized supply problems. Bucks County, like most of Pennsylvania, experienced problems in 1972-73 and again in 1976-

77. During the 1972-73 incident, the County was particularly affected by heating oil shortages. Voluntary cutbacks in energy use helped ease the shortage. In 1976-77, the main problem was a gasoline shortage. This time voluntary cutbacks were insufficient, and an odd-even rationing plan was enforced.

Additionally, the County reports yearly occurrences of minor outages, as well as a notable ice storm event in January 2004 which led to widespread power outages.

In October 2012, Hurricane Sandy made landfall near Atlantic City, NJ and tracked through Southeastern Pennsylvania while heading north. In addition to a variety of impacts from flooding and wind damage, 1.8 million Pennsylvania residents experienced power outages. More than 300,000 of these homes were in Bucks and Montgomery Counties. PECO serves 1.6 million customers in the greater Philadelphia region; 850,000 were without power at some point which topped the previous record of 520,000 during a 1994 ice storm. As a result of hurricane sandy many residents were without power for days or weeks, depending on the ability for crews to make repairs in remote areas (Callahan, 2013).

On August 4, 2020 more than 600,000 customers in the Southeastern Pennsylvania region lost power due to complications from Tropical Storm Isaias. Outages were heaviest in Chester and Bucks Counties. About 98,000 Bucks County residents, or 43% of its customers lost power, according to PECO. A spokesperson noted this was one of the worst storms to impact utilities in the region in recent years (Maykuth, 2020).

On May 7, 2021, Colonial Pipeline was shut down after a cyberattack occurred on the pipeline. The eastern coast of the country, specifically Pennsylvania, New Jersey, and Delaware, and Mississippi and Tennessee have seen spikes in gasoline prices as the pipeline shutdown has resulted in a limited amount of gasoline available. Pennsylvania and New Jersey's gas prices have risen eight cents within a week; Delaware's gas prices are up ten cents (Prigeon, 2021).

4.3.22.4. *Future Occurrence*

Utility interruptions will continue to occur annually with minimal impact. Widespread utility interruption events usually occur approximately once every five years, usually as a secondary effect of an extreme weather event. These interruptions should be anticipated, and first responders should be prepared during severe weather events. Research by the National Oceanic and Atmospheric Administration (NOAA) suggests that climate change may cause more extreme storms in Pennsylvania (Frankson et al, 2017). This could increase the occurrence of power outages in the future.

The Philadelphia region is expected to see large increases in precipitation and numbers of very hot and very cold days (Climate Central, 2019). These factors can increase the occurrence of hazards such as flooding, hurricanes and tropical storms, landslides, tornados and windstorms, wildfires, and winter storms. Impacts from any of these hazards can lead to utility

interruption on a range of scales. Overall, the future probability of utility interruptions can be considered *likely* according to the Risk Factor Methodology (see Table 4.4.1-1).

Aging infrastructure also brings risk in the form of potential utility interruptions, particularly for places like Bucks County with aging infrastructure. In many utility systems, significant portions of the equipment and facilities date from the growth periods of the 1950s and 1960s that followed World War II. As this equipment ages, it deteriorates from the constant wear and tear of service. Eventually the equipment reaches a point at which it will either fail on its own or as a result of outside forces (storms, loads it was designed to handle but no longer can, etc.). These failures cause service interruptions and can require expensive emergency repairs. In addition, as repairs have taken place along transmission routes, there is often a mix of new and old equipment along the line; repair, not replacement is generally the choice to resolve an issue.

The wholesale replacement of a system is not a feasible solution for utility companies. This would require the interruption of services while the replacement occurs, as well as accessing the existing system (which may lay under roads, private property, or other inconvenient places). Utility companies face the challenge of managing the issue of the aging infrastructure. They are tasked with reducing the effects of aging equipment while also controlling the deterioration of the existing system as much as possible. This balance will be tenuous as transmission equipment continues to age and break down. These breakdowns will likely lead to more frequent utility disruptions as time goes by.

4.3.22.5. *Vulnerability Assessment*

All jurisdictions are vulnerable on some level to utility interruptions, but because this hazard often occurs in conjunction with other hazards, jurisdictions that have been identified as more vulnerable to winter storms, wind storms, tornado, flooding, and other natural hazard events may be more vulnerable to a utility interruption.

Emergency medical facilities, including retirement homes and senior centers are particularly vulnerable to power outages. While back-up power generators are often used at these facilities, loss of electricity may result in hot or cold temperatures for which elderly populations are particularly vulnerable. Appendix C provides a list of where those facilities are located in Bucks County. Conservation and improved technology have resulted in more efficient use of energy sources. The increasing use of alternative fuel supplies, such as kerosene heaters, wood burning stoves, coal burners, etc., have also decreased our vulnerability to future shortages. However, severe weather extremes, accidents, labor strikes, terrorism, or nationwide shortages could cause significant energy shortage problems

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 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 partner agencies involved in the hazard mitigation planning process. The RF system relies mainly on historical data, local knowledge, and consensus 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 22 hazards profiled in the 2021 HMP Update. 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 4.4.1-1. 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 4.4.1-1 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 4.4.1-1 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 *(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)*	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 *(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)*	2	
	LESS THAN 1 WEEK	SELF-DEFINED	3	
	MORE THAN 1 WEEK	SELF-DEFINED	4	

4.4.2. Ranking Results

Using the methodology described in Section 4.4.1, Table 4.4.2-1 lists the Risk Factor calculated for each of the 22 hazards identified in the 2021 HMP Update. Hazards identified as *high* risk have risk factors of 2.5. or greater. 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 4.4.2-1 Ranking of hazard types based on Risk Factor methodology.

RISK	NATURAL HAZARD	RISK ASSESSMENT CATEGORY					RISK FACTOR
		PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	
HIGH	Flood, Flash Flood, Ice Jam	4	3	3	3	3	3.3
	Winter Storm	4	2	4	2	3	3.1
	Environmental Hazards	4	2	2	4	2	2.8
	Hurricane, Tropical Storm, Nor'easter	2	3	4	1	3	2.7
	Utility Interruption	3	2	3	3	1	2.5
MODERATE	Transportation Accidents	3	2	1	4	2	2.3
	Urban Fire and Explosion	3	2	1	4	2	2.3
	Gas and Liquid Pipelines	3	2	1	4	2	2.3
	Pandemic	2	3	1	1	4	2.2
	Drought	2	1	4	1	4	2.2
	Extreme Temperature	2	2	4	1	1	2.2
	Terrorism	1	4	1	4	1	2.2
	Wildfire	3	2	1	4	1	2.2
	Lightning Strike	4	1	1	3	1	2.1
	Tornado, Windstorm	2	2	2	4	1	2.1
	Landslide	3	1	2	1	3	2
LOW	Structure Collapse (Infrastructure)	2	2	1	3	2	1.9
	Dam Failure	2	2	1	3	2	1.9

Table 4.4.2-1 Ranking of hazard types based on Risk Factor methodology.

RISK	NATURAL HAZARD	RISK ASSESSMENT CATEGORY					RISK FACTOR
		PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	
	Earthquake	1	2	2	2	2	1.7
	Radon	2	1	1	1	4	1.6
	Hailstorm	2	1	1	1	2	1.4
	Subsidence, Sinkhole	2	1	1	1	2	1.4

Based on these results, there are five *high* risk hazards, eleven *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).

A risk assessment result for the entire county does not mean that each municipality the same risk to each hazard. Municipalities completed a *Hazard Risk Assessment Survey* during the planning process to evaluate their jurisdictional risk to each hazard. Results from these surveys were reassessed by the HMPT, and the update risk assessment was used to complete Table 4.4.2-2 which shows 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.

Municipalities completed a *Risk Evaluation Survey* to during the planning process evaluate their jurisdictional risk to each hazard since the previous plan was developed. Results from these surveys were assessed by the HMPT, and the update risk assessment was used to complete Table 4.4.2-2 which shows the different municipalities in Bucks County and whether their risk to each hazard has increased (>), decreased (<), or remained the same (=) since the previous plan was developed. Any changes made in the table from the 2015 rankings are indicated by the cell being highlighted grey.

Table 4.4.2-2 Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk

JURISDICTION	IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR																				
	Flood, Flash Flood, Ice Jam	Winter Storm	Environmental Hazards	Hurricane, Tropical Storm, Nor' easter	Utility Interruption	Transportation Accident	Urban Fire and Explosion	Gas and Liquid Pipelines	Pandemic and Infectious Disease	Drought	Extreme Temperature	Terrorism	Wildfire	Lightning Strike	Tornado, Windstorm	Landslide	Structure Collapse	Dam Failure	Earthquake	Radon Exposure	Hailstorm	Subsidence, Sinkhole
	3.3	3.1	2.8	2.7	2.5	2.3	2.3	2.3	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2	1.9	1.9	1.7	1.6	1.4	1.4
Bucks County	>	<	>	>	>	>	=	=	>	=	>	>	=	>	>	=	=	=	=	=	=	=
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	=	=	>	=	=	>	=	=	>	=	=	=	=	=	=	<	=	=	=	=	=	=

Table 4.4.2-2 Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk

JURISDICTION	IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR																				
	Flood, Flash Flood, Ice Jam	Winter Storm	Environmental Hazards	Hurricane, Tropical Storm, Nor' easter	Utility Interruption	Transportation Accident	Urban Fire and Explosion	Gas and Liquid Pipelines	Pandemic and Infectious Disease	Drought	Extreme Temperature	Terrorism	Wildfire	Lightning Strike	Tornado, Windstorm	Landslide	Structure Collapse	Dam Failure	Earthquake	Radon Exposure	Hailstorm	Subsidence, Sinkhole
	3.3	3.1	2.8	2.7	2.5	2.3	2.3	2.3	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2	1.9	1.9	1.7	1.6	1.4	1.4
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	=	=	<	>	=	>	=	=	=	=	=	=	<	=	=	=	=	=	=	=	=	=

Table 4.4.2-2 Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk

JURISDICTION	IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR																				
	Flood, Flash Flood, Ice Jam	Winter Storm	Environmental Hazards	Hurricane, Tropical Storm, Nor' easter	Utility Interruption	Transportation Accident	Urban Fire and Explosion	Gas and Liquid Pipelines	Pandemic and Infectious Disease	Drought	Extreme Temperature	Terrorism	Wildfire	Lightning Strike	Tornado, Windstorm	Landslide	Structure Collapse	Dam Failure	Earthquake	Radon Exposure	Hailstorm	Subsidence, Sinkhole
	3.3	3.1	2.8	2.7	2.5	2.3	2.3	2.3	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2	1.9	1.9	1.7	1.6	1.4	1.4
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	=	=	=	=	=	=	=	>	>	=	=	>	=	=	>	=	=	=	=	=	=	=

Table 4.4.2-2 Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk

JURISDICTION	IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR																				
	Flood, Flash Flood, Ice Jam	Winter Storm	Environmental Hazards	Hurricane, Tropical Storm, Nor' easter	Utility Interruption	Transportation Accident	Urban Fire and Explosion	Gas and Liquid Pipelines	Pandemic and Infectious Disease	Drought	Extreme Temperature	Terrorism	Wildfire	Lightning Strike	Tornado, Windstorm	Landslide	Structure Collapse	Dam Failure	Earthquake	Radon Exposure	Hailstorm	Subsidence, Sinkhole
	3.3	3.1	2.8	2.7	2.5	2.3	2.3	2.3	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2	1.9	1.9	1.7	1.6	1.4	1.4
Warminster Township	=	=	=	=	>	=	=	>	>	=	=	>	=	=	>	<	=	=	=	=	=	=
Warrington Township	>	>	=	=	>	>	=	=	>	=	=	=	=	>	>	=	=	=	=	=	=	<
Warwick Township	>	>	=	>	=	=	=	=	>	=	>	=	=	=	>	=	=	=	=	=	=	=
West Rockhill Township	=	>	=	>	>	=	=	>	>	=	>	=	=	>	>	=	=	=	=	=	=	=
Wrightstown Township	=	=	=	=	=	=	=	=	>	=	=	=	=	=	=	=	=	=	=	=	=	=
Yardley Borough	=	>	=	>	=	=	=	=	>	=	=	=	=	=	=	=	=	=	=	=	=	=

4.4.3. Potential Loss Estimates

Based on various kinds of available data, potential loss estimates were established for flood, flash flood, and ice jam. Estimates provided in this section are based on Hazus version 4.2, geospatial analysis, and previous events. Estimates are considered *potential* in that they generally represent losses that could occur in a countywide hazard scenario. In events that are localized, losses may be lower, while regional events could 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.

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

- Updated demographic data from the 2010 Census;
- Updated essential facilities data from the County and other sources

Using these datasets in Hazus, total building-related losses from a 1%-annual-chance flood in Bucks County are estimated to equal $1,150.34 million. Residential occupancies make up 32.29% of the total estimated building-related losses. Damages would be most significant along the Delaware River and Neshaminy Creek floodways, where most of the vulnerable buildings are located. Total economic loss, including replacement value, content loss, functional loss and displacement cost, from a countywide 1%-annual-chance flood are estimated to equal $2,061.50 million. In this scenario, an expected 1,724 buildings would be moderately damaged. In addition, an estimated 5,420 households would be displaced, and 500 people would require shelter. Essential facilities would largely remain undamaged in this scenario, but one fire station, one police station, and four schools are estimated to have at least moderate damage. All of these facilities would experience some loss of use, but none would experience substantial damage. For more details on the Hazus methodology used and additional results reports, see Appendix F.

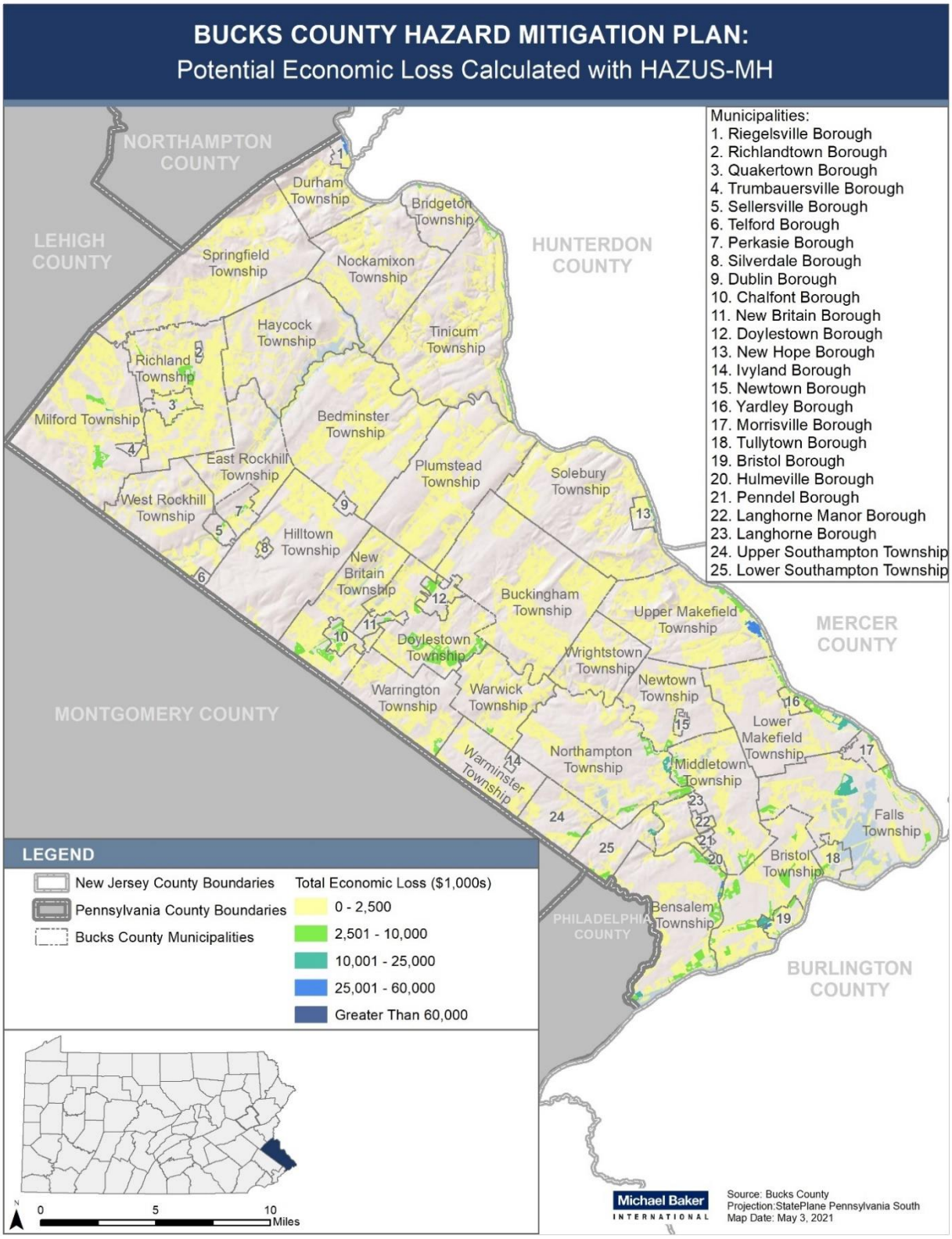
Losses associated with natural hazard events are sometimes reported to the NCEI with the event. The reporting time frame is 1950-October 2020. While these historic losses give a glimpse of potential losses in hazard events, they are not reported for all events and should be considered a broad estimate. Several deaths and millions of dollars' worth of property

damage have been caused by floods, flash floods, or ice jams in Bucks County. Previous flood events listed in Table 4.3.4-2 and Appendix H have caused an estimated $77.91 million worth of property damage throughout the County from 1996-2020 (NOAA NCEI, 2021). It is important to note that loss estimates are not available for many of the previous flood events which have occurred in the County.

Additionally, as discussed in Section 4.3.4, there are 3,454 policies in force in Bucks County under the NFIP. A total of 4,698 NFIP claims for flood damages have been made since 1978 for these structures, as of May 2018. Cumulative NFIP payments for those flood damage claims have exceeded $128 million (FEMA, 2021c).

Below, Figure 4.4.3-1 shows Hazus modeled potential economic losses in Bucks County. This model is consistent with other data found for flood risk in the county. The greatest losses are expected to be found in areas along the Delaware River and Neshaminy Creek, for example Upper Makefield Township, Lower Makefield Township, Bristol Borough, Middletown Township, and Doylestown Township. However, due to the topography of Bucks County, flood losses can be expected in every municipality.

Figure 4.4.3-1 Hazus Modeled Economic Flood Loss in Bucks County



The NCEI database listed losses for hailstorms, lightning, tornados and windstorms, and winter weather events in Bucks County. Hailstorms agricultural losses estimated $400,000. Lightning events accounted for over $3.535 million in property damage. Tornados and windstorms accounted for over $1.323 million in losses. For winter storm events, there were not any reported losses from the previous occurrences; however, it is likely property and/or crop damages from the events were not reported. A high percentage of losses from winter storms are usually in the form of repairs to damaged utility poles, wires, and other infrastructure (NOAA NCEI, 2021).

4.4.4. Future Development and Vulnerability

Risk and vulnerability to natural 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 stay static or even be reduced.

Population change and the age of the housing stock are main indicators of vulnerability change in Bucks County. As discussed in Section 2.3, the total population of Bucks County is estimated to have increased by 0.5 percent from 2010-2019, indicating the overall population of the County has generally stayed the same. Twenty-five municipalities increased in population while twenty-nine decreased in population during this time period. Areas of higher density, in the larger municipalities and growing municipalities, face increased vulnerability and increased exposed structures with most hazard events. Increases in population results in increased vulnerability to hazards such as wildfires, floods, and winter storms as more people will be impacted.

Climate change is also an important topic that could affect Bucks County in the future. The Pennsylvania Department of Environmental Protection (PA DEP) states that climate change in Pennsylvania adds more flooding events, more heat and respiratory deaths, more disease and pests, and harm to agriculture. As climate change intensifies, the warmer and wetter the Commonwealth will become. In the past century, temperatures increased 1.8°F within Pennsylvania. By 2050, Pennsylvania is expected to see temperatures increase by 5.9°F. In terms of precipitation, Pennsylvania is expected to see an 8% increase by 2050. The increase in temperature and precipitation will impact public health, infrastructure, emergency services, agriculture, tourism, and recreation. In 2018 alone, PennDOT had over $125.7 million dollars in repairs to infrastructure from flood and landslides (PADEP, 2021c).

In Bucks County, the temperature has increased by 3.2°F from September 2014 to September 2019, one of the fastest rates within the Commonwealth. The only other county in Pennsylvania to have a higher increase in average temperature was Philadelphia with a 3.4°F increase (Bagenstose, 2019).

Section 2.3 also discusses the projected population change in Bucks County by 2040. Figure 2.3-1 shows the percent population change from 2010-2030 for each municipality while Table 2.3-4 shows the percent population change from 2010-2040. The largest population increases are expected to occur in the Northern to middle portions of the county. This includes Bedminster Township, Hilltown Township, Richland Township, Plumstead Township, and Milford Township. The smallest population increases are expected to be seen in more densely populated areas along the southern edge of the Delaware River, like the Falls Township, Bristol Township, Bristol Borough or the northern border, like Riegelsville Borough, Durham Township, and Springfield Township. The Planning Commission has also started to see a trend towards multi-family developments and apartments for instance in Middletown, Morrisville, Doylestown Borough, Doylestown Township.

Current zoning and development regulations dictate how future development should safely occur within the SFHA. However, there are structures within the SFHA that were constructed prior to the first Flood Insurance Rate Maps were available and floodplain management regulations were in effect. This suggests that there is potential for additional loss due to flooding in the future. SFHA development regulations relate to the base flood elevation, which is the estimated level of flooding that has a 1-percent chance of being equaled or exceeded in any given year. Because the SFHA or floodplain development regulations specify that residential structures must be elevated to or above the base flood elevation and commercial structures must either be elevated or flood-proofed to or above this level, the degree to which future structures are exposed to flood damages should be minimal. However, calculations of base flood elevations are based on models that rely upon data about previous flood events; should future floods be greater than those experienced in the past, the base flood elevation may not provide enough protection.

In addition, remote and sparsely populated municipalities also face higher vulnerability to certain hazards because they may not have as easy access to care facilities or response personnel. For instance, the less populated municipalities such as Riegelsville Borough, Trumbauersville Borough, Hulmeville Borough, and Ivyland Borough face increased vulnerability to winter storms due to isolation, access issues, and longer emergency response times.

Roughly 19% of Bucks County's population is over the age of 65. Older residents pose unique challenges when it comes to evacuation and/or mobility during the rescue and recovery processes that typically occur in the case of a hazard event. Officials may consider partnering with human services organizations to specifically plan for this vulnerable population.

The aging housing stock in Bucks County is another source of current and future vulnerability in many hazard events. As discussed in Section 4.3.14.5, many homes in the County were built before 1940. Bucks County can experience gusts of wind up to 160 miles per hour during windstorms, tornadoes, hurricane, tropical storms, or nor'easters. The structure of these older houses may be more at risk of destruction under these strong wind conditions. These

structures may also be at risk during flooding and winter storm events if the materials are either not strong enough to withstand the pressure or weight of the precipitation or are liable to leak, causing further risk of destruction to the house. 26,783 homes in Bucks County, or 10.7% of the total residential stock within the County, were built in 1939 or earlier (US Census, 2019).

The 2011 Bucks County Comprehensive Plan is the current Comprehensive Plan for Bucks County and is the policy basis for zoning decisions and other land development policies in the County. This plan is described as "a guide for local officials, residents, developers, business owners, and interested agencies… to coordinate development and preservation in appropriate areas of the county." The future land use plan proposes areas targeted as growth areas and preservation areas. Growth should be concentrated in town centers and secondary town centers, while rural resources and natural resources should be left undeveloped. The future land use plan is intended to "reaffirm the county's long-term goals of sustainability and good stewardship." Guiding principles are detailed to prioritize preservation and hazard mitigation when locating new development (BCPC, 2011a). Concentrating growth may help to reduce isolation-based vulnerability of communities with few access routes, no municipal water supply, and low cell phone reception. On the other hand, higher densities mean that more people are likely to be impacted in a hazard event should it strike those more populated areas. The County recently introduced a Model Alternative Energy Ordinance to address future vulnerability.

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 2021 plan update included a process to validate the human, physical, technological, informational, planning, and financial resources identified in the 2016 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 2021 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 2021 HMP update, the HMPT completed a 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.

The Mitigation Strategy, including the goals and actions, is incorporated into relevant planning mechanisms based on their pertinence and relevance to specific plans and ordinances. For example, all structural projects should be included in the Capital Improvements Program. Land use and zoning related projects should be incorporated into the next update of the County's Comprehensive Plan through collaboration with the County and local Planning department. Likewise, information from relevant planning documents was

used to inform and update the Hazard Mitigation Plan. A general list of relevant plans and documents and corresponding areas for incorporation are listed below:

Table 5.1-1 Relevant Departments and Documents

RELEVANT DOCUMENTS	HAZARD MITIGATION PLANNING ELEMENTS
Comprehensive Plan/Land Use Plan, Zoning/Subdivision Regulations, Floodplain Ordinances	Demographic data, land use, development trends, and floodplain management information
Stormwater Management (SWM) Plans	Stormwater management and infrastructure data and projects
Evacuation Plans, Emergency Operations/Response Plans	All-hazards information for evacuation, response and recover
Dam Safety Regulations, Wetland Regulations	Risk and vulnerability data, and storm/floodwater management
Bucks County 2016 Hazard Mitigation Plan Update	Risk and vulnerability data, framework for the current plan
Bucks County Open Space and Greenways Plan, August 2011	Mitigation progress and solutions
Commonwealth of Pennsylvania 2018 State Hazard Mitigation Plan, October 2019 Annual Update	Risk and vulnerability assessment data

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. The County's comprehensive plan update is currently underway. Additionally, all but six municipalities have developed and adopted comprehensive plans (Bucks County, 2021c). Municipalities without comprehensive plans include Hulmeville Borough, Langhorne Manor Borough, Nockamixon Township, Penndel Borough, and Yardley Borough.

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. The UCC was amended most recently in 2017. Act 25 of 2017 and Act 36 of 2017, the amendments to the Pennsylvania Construction Code Act, went into effect October 25, 2017. The UCC was revised in 2018 to include Chapter 11, Appendix E of the International Building Code of 2018 and any other accessibility requirements contained in the 2018 I-codes. These revisions became effective on June 15, 2019. All 54 municipalities in Bucks County are required to adhere to the UCC.

High Hazard Potential Dam Emergency Action Plans

Pennsylvania requires a dam owner of a high hazard potential dam to prepare, update and periodically test and Emergency Action Plan. In order to meet this requirement, Emergency Action Plans have been prepared for high hazard dams located in Bucks County. Each Emergency Action Plan addresses ways to safeguard lives and reduce property damage within the inundation area; procedures for effective dam surveillance; procedures for prompt notification of emergency management officials; warning and evacuation procedures; and emergency response actions that will be taken in the event of potential or imminent failure of the dam (PA DEP, 2021d).

Bucks County and Municipality Capabilities

Tables 5.2-1 and 5.2-2 include 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 Identified Through 2021 HMP Capability Assessment Surveys (BCPC, 2021a)

MUNICIPALITY	COMPREHENSIVE PLAN	BUILDING CODE	FLOODPLAIN ORDINANCE - NFIP PARTICIPANT	SUBDIVISION & LAND DEVELOPMENT ORDINANCE	ZONING ORDINANCE
Bucks County	Yes	Yes	No	No	Yes
Bedminster Township	Yes	Yes	Yes	Yes	Yes

Table 5.2-1 Summary of Planning Tools Adopted by Each Municipality in Bucks County Identified Through 2021 HMP Capability Assessment Surveys (BCPC, 2021a)

MUNICIPALITY	COMPREHENSIVE PLAN	BUILDING CODE	FLOODPLAIN ORDINANCE - NFIP PARTICIPANT	SUBDIVISION & LAND DEVELOPMENT ORDINANCE	ZONING ORDINANCE
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
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	No	Yes	Yes	Yes	Yes
Ivyland Borough	Yes	Yes	No (No SFHA)	Yes	Yes
Langhorne Borough	Yes	Yes	Yes	Yes	Yes
Langhorne Manor Borough	No	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	No	Yes	Yes	Yes	Yes

Table 5.2-1 Summary of Planning Tools Adopted by Each Municipality in Bucks County Identified Through 2021 HMP Capability Assessment Surveys (BCPC, 2021a)

MUNICIPALITY	COMPREHENSIVE PLAN	BUILDING CODE	FLOODPLAIN ORDINANCE - NFIP PARTICIPANT	SUBDIVISION & LAND DEVELOPMENT ORDINANCE	ZONING ORDINANCE
Northampton Township	Yes	Yes	Yes	Yes	Yes
Penndel Borough	No	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	Yes	Yes	Yes	Yes	Yes
Sellersville Borough	Yes	Yes	Yes	Yes	Yes
Silverdale Borough	Yes	Yes	Yes	Yes	Yes
Solebury Township	Yes	Yes	Yes	Yes	Yes
Springfield Township	No	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, sanctioned)	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	No	Yes	Yes	Yes	Yes

Table 5.2-2 Additional Planning Mechanisms and Regulatory Tools Acknowledged by Jurisdiction

MUNICIPALITY	EVACUATION PLAN	CONTINUITY OF OPERATIONS	NATURAL RESOUCRE PROTECTION PLAN	CAPITAL IMPROVEMENT PLAN	FIREWISE COMMUNITY
Bucks County	Yes	Yes	No	Yes	No
Bedminster Township					
Bensalem Township	No	Yes	No	Yes	No
Bridgeton Township					
Bristol Borough	Yes	Yes	Yes	Yes	Yes
Bristol Township	Yes	Yes	No	Yes	No
Buckingham Township	No	No	Yes	Yes	No
Chalfont Borough					
Doylestown Borough	Yes	Yes	Yes	UD*	UD*
Doylestown Township	Yes	UD*	No	Yes	No
Dublin Borough					
Durham Township					
East Rockhill Township	Yes	No	Yes	Yes	No
Falls Township					
Haycock Township	Yes	No	Yes, in Zoning Ordinance	No	No
Hilltown Township	Yes	Yes	Yes	No	No
Hulmeville Borough					
Ivyland Borough	No	Yes	UD*	Yes	No
Langhorne Borough					
Langhorne Manor Borough					
Lower Makefield Township	Yes	Yes	No	No	No
Lower Southampton Township					
Middletown Township	Yes	Yes	Yes	Yes	Yes
Milford Township	UD*	Yes	No	Yes	No
Morrisville Borough					
New Britain Borough					
New Britain Township					
New Hope Borough					
Newtown Borough					
Newtown Township					

Table 5.2-2 Additional Planning Mechanisms and Regulatory Tools Acknowledged by Jurisdiction

MUNICIPALITY	EVACUATION PLAN	CONTINUITY OF OPERATIONS	NATURAL RESOUCRE PROTECTION PLAN	CAPITAL IMPROVEMENT PLAN	FIREWISE COMMUNITY
Nockamixon Township	Yes	Yes	Yes	Yes	Yes
Northampton Township	UD*	Yes	Yes	Yes	UD*
Penndel Borough					
Perkasie Borough					
Plumstead Township	Yes	Yes	Yes, in Zoning Ordinance	Yes	No
Quakertown Borough					
Richland Township					UD*
Richlandtown Borough					
Riegelsville Borough	UD*	UD*	Yes	Yes	No
Sellersville Borough	Yes	UD*	Yes	Yes	UD*
Silverdale Borough					
Solebury Township	Yes	Yes	Yes	Yes	Yes
Springfield Township	No	No	Yes, in Zoning Ordinance	No	No
Telford Borough					
Tinicum Township	UD*	UD*	Yes	No	UD*
Trumbauersville Borough	Yes	UD*	UD*	UD*	Yes
Tullytown Borough	Yes	No	No	No	No
Upper Makefield Township	Yes	Yes	Yes	Yes	Yes
Upper Southampton Township	Yes	No	Yes	Yes	No
Warminster Township	Yes	No	No	Yes	No
Warrington Township	Yes	Yes	No	Yes	No
Warwick Township	Yes	Yes	Yes	Yes	No
West Rockhill Township	Yes	Yes	Yes	Yes	Yes
Wrightstown Township					
Yardley Borough	Yes	Yes	No	No	No

UD* = Under Development

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 5.2-3 for specific stormwater management plans and regulations in place in Bucks County municipalities.

Table 5.2-3 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	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
Bedminster Township	Tohickon Creek and Perkiomen Creek	East Branch Perkiomen SMP 2004 and Tohickon Creek SMP 2002	Stand Alone	Yes	No	

Table 5.2-3 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	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
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	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	Yes – Stand Alone	Yes	Yes	Yes
Bristol Township	Neshaminy Creek and Delaware River South		Yes – SALDO Section 518; Neshaminy Creek SMP & Storm. Mgmt. Ord. 9/2005	Yes	Yes	Yes
Buckingham Township	Neshaminy Creek and Delaware River South		Yes – 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		Yes – SALDO Ordinance amendment No. 2005-4		Yes	
Doylestown Township	Neshaminy Creek	Neshaminy Act 167 Plan (May 3, 2011)	Yes – Code of Ord.'s - Chapter 148	Yes	Yes	Yes
Dublin Borough	Tohickon Creek and E. Branch Perkiomen Creek		Yes. SALDO 1985 Article VII Section 705	Yes	No	

Table 5.2-3 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	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
Durham Township	Delaware River North		Yes--Stormwater Management Ord. 8/2003	Yes	No	
East Rockhill Township	Tohickon Creek and Perkiomen Creek	Tohickon Creek Watershed Plan (2002)	Yes – 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	Tohickon Creek and Delaware River North		Yes – Stormwater Management Ord.#91 10/7/2002	Yes	No	
Hilltown Township	Neshaminy Creek E. Branch Perkiomen Creek and Tohickon Creek		Yes – 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		Yes – 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	

Table 5.2-3 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	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
Lower Makefield Township	Neshaminy Creek and Delaware River South		Yes – 5/18/2011 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	
Middletown Township	Neshaminy Creek and Delaware River South		Yes – Amended Ord. 00-09 8/16/2000 & (Section 406 SALDO)	Yes	Yes	Yes
Milford Township	Perkiomen Creek and Tohickon Creek		Yes – 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	

Table 5.2-3 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	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
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	Yes – Nockamixon Twp. Storm. Mgmt. Ord.106 Sept.18,2002 & SALDO Section 196-516	Yes	No	
Northampton Township	Neshaminy Creek and Little Neshaminy Creek		Yes – Chpt. 113 Ord. #499 Stormwater Mgmt. And Grading (Feb. 11, 2005)	Yes	Yes	
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	Yes – 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

Table 5.2-3 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	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
Quakertown Borough	Perkiomen Creek and Tohickon Creek		Yes--Act 167 ordinance adopted 2002	Yes	Yes	
Richland Township	Perkiomen Creek Tohickon Creek and Delaware River North		Yes – 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		Under Development SALDO - Section 7005l; ZO - Section 1100 (g)	Yes	No	
Sellersville Borough	E. Branch Perkiomen Creek		Yes – 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	Yes – 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	
Telford Borough	E. Branch Perkiomen Creek		(tentative adoption of Act 167 plan)		Yes	

Table 5.2-3 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	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
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 Tohickon Creek		Yes – SALDO - Section 512 & Ord. No. 197-02 (Stormwater Management Ordinance)	Yes	Yes / IP	
Tullytown Borough	Delaware River South	Delaware River South SMP	Yes – Section 700	Yes	Yes	Yes
Upper Makefield Township	Delaware River South and Neshaminy Creek	Delaware River South SMP and Neshaminy Creek SMP 2011	Yes – 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	Yes – SALDO - Section 160-67	Yes	Yes	Yes
Warminster Township	Neshaminy Creek and Little Neshaminy Creek	Neshaminy Creek watershed SMP 2011	Yes – Stand Alone	Yes	Yes	
Warrington Township	Pennypack Creek and Little Neshaminy Creek	Neshaminy Creek SMP 2010	Yes – Stand Alone Chapter 26 Stormwater Management	Yes	Yes	
Warwick Township	Neshaminy Creek and Little Neshaminy Creek		Yes – Storm. Mngt. Ord. 157-14, SALDO. Adopted 6-6-2005 by Ord. No. 2005-2	Yes	Yes	

Table 5.2-3 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	TOTAL MAXIMUM DAILY LOADS (TMDLS) WITHIN THE TOWNSHIP?
West Rockhill Township	Perkiomen Creek E. Branch Perkiomen Creek and Tohickon Creek	Tohickon Creek Watershed Plan (2002)	Yes – Article V -- Section 516 -- SALDO 2010	Yes	Yes / IP	
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	Yes – 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 5.2-4.

Table 5.2-4 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

Table 5.2-4 Regulations in Place for Municipalities with Risk for Subsidence and Sinkholes

MUNICIPALITY	REGULATIONS
	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. Sets requirements for inspections during building and for repair and maintenance if a hazard appears after building. Regulates impervious surface and stormwater.

Bucks County Planning Commission Model Alternative Energy Ordinance

In early 2021, the Bucks County Planning Commission presented the Model Ordinance for Alternative Energy. The model ordinance offers communities within the County draft language of purpose and objective, definitions, applicability, land use and dimensional regulations, provisions for encouraging passive energy conservation, bonus provisions, permit and special exception application requirements, supplemental design, installation, and maintenance requirements, liability and insurance requirements, decommissioning, and public inquiries, inspections, violations, and remedies. Alternative energy allows residents to be less dependent on fossil fuels by opting for energy provided through solar, water, wind, or geothermal sources, thus protecting public health, safety, and welfare. Additionally, alternative energy sources can increase the resiliency of a community by being less reliant on a traditional power grid. Cleaner air quality and reduced greenhouse gasses are a few positive impacts alternative energy can have on the environment. As Bucks County and its jurisdictions continue to see development, incentivizing the inclusion of alternative energy in redevelopment and new development will support a healthier and more resilient community.

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 recommended by the local jurisdiction, to the Governor, for official appointment. 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 30 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 (BCEMA, n.d.).

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.

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 (VOAD, 2021).

5.2.1.3. *Participation in the National Flood Insurance Program*

The Pennsylvania Floodplain Management Act (Act 166 of 1978) requires every municipality with flood hazard areas identified by the 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.

FEMA Region 3 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 with a suggested ordinance document to assist

municipalities in meeting the minimum requirements of the NFIP and the Pennsylvania Flood Plain Management Act (Act 166), based on their 44 CFR 60.3 level of regulations. As new Flood Insurance Rate Maps (FIRMs) are published, the Pennsylvania State NFIP Coordinator at DCED works with communities to ensure the timely and successful adoption of an updated floodplain management ordinance by reviewing and providing feedback on existing and draft ordinances. In addition, DCED provides guidance and technical support through Community Assistance Contacts (CAC) and Community Assistance Visits (CAV).

Throughout the planning process communities were asked to fill out an NFIP survey to help collect information on each community's participation in and continued compliance with the NFIP. It also has each community identify areas for improvement that could be potential mitigation actions. As of May 2021, 27 municipalities have completed this form. Some key findings include that many municipalities including Tinicum Township, Solebury Township, Upper Makefield Township, Bensalem Township, Sellersville Borough, Buckingham Township, Lower Makefield Township and more provide assistance with local floodplain determinations and many of these communities also provide information on their local website. Also, many municipalities including Upper Makefield Township, Lower Makefield Township, Warwick Township, Upper Southampton Township, Tinicum Township and more have local coordinated processes to determine substantial damage and to permit repair and improvement. While this is a brief overview of some of the NFIP form findings, each completed form is included in Appendix C.

As stated in Section 4.3.4, 49 out of 54 municipalities in Bucks County participate in the NFIP and are in good standing. Table 5.2-5 details the municipalities participating in the NFIP, their current policies and coverage, and the number of claims and amount received from those claims since 1978.

Table 5.2-5 Bucks County Municipal National Flood Insurance Program Information (FEMA, 2021d).

MUNICIPALITY	PARTICIPATION STATUS	POLICIES IN FORCE	TOTAL PREMIUM AND COVERAGE	TOTAL CLAIMS SINCE 1978	TOTAL PAID SINCE 1978
Bedminster Township	Participating	16	$4,539,367.00	7	$53,199
Bensalem Township	Participating	135	$39,228,103.00	265	$4,397,410
Bridgeton Township	Participating	75	$16,567,381.00	209	$7,009,292
Bristol Borough	Participating	180	$55,257,760.00	53	$1,891,196
Bristol Township	Participating	478	$117,792,977.00	290	$5,434,568
Buckingham Township	Participating	50	$15,366,438.00	30	$572,281
Chalfont Borough	Participating	38	$12,031,217.00	11	$162,590
Doylestown Borough	Participating	30	$10,580,545.00	14	$233,147
Doylestown Township	Participating	53	$15,921,460.00	36	$199,086
Dublin Borough	Not Participating	-	-	-	-
Durham Township	Participating	23	$5,821,435.00	77	$2,839,014
East Rockhill Township	Participating	9	$4,149,164.00	5	$19,279
Falls Township	Participating	83	$22,510,408.00	108	$951,720

Table 5.2-5 Bucks County Municipal National Flood Insurance Program Information (FEMA, 2021d).

MUNICIPALITY	PARTICIPATION STATUS	POLICIES IN FORCE	TOTAL PREMIUM AND COVERAGE	TOTAL CLAIMS SINCE 1978	TOTAL PAID SINCE 1978
Haycock Township	Participating	11	$3,409,309.00	10	$159,177
Hilltown Township	Participating	18	$4,098,746.00	6	$9,554
Hulmeville Borough	Participating	33	$8,926,323.00	117	$1,834,951
Ivyland Borough	Not Participating	-	-	-	-
Langhorne Manor Borough	Participating	0	0	68	$1,583,686
Langhorne Borough	Participating	2	$700,837.00	13	$136,957
Lower Makefield Township	Participating	295	$90,355,319.00	216	$4,859,080
Lower Southampton Township	Participating	70	$19,858,104.00	156	$2,364,767
Middletown Township	Participating	238	$59,857,741.00	272	$5,341,730
Milford Township	Participating	28	$7,240,367.00	27	$211,490
Morrisville Borough	Participating	45	$8,947,274.00	17	$142,352
New Britain Borough	Participating	3	$962,149.00	0	$0
New Britain Township	Participating	35	$12,593,323.00	10	$199,162
New Hope Borough	Participating	209	$55,742,998.00	377	$15,306,038
Newtown Borough	Participating	6	$1,853,579.00	7	$14,882
Newtown Township	Participating	53	$15,910,675.00	15	$169,656
Nockamixon Township	Participating	11	$3,179,793.00	21	$892,601
Northampton Township	Participating	102	$30,956,743.00	99	$1,414,385
Penndel Borough	Participating	1	350762	0	$0
Perkasie Borough	Participating	25	$8,366,815.00	31	$1,713,840
Plumstead Township	Participating	32	$9,204,183.00	69	$2,404,477
Quakertown Borough	Participating	114	$28,614,217.00	49	$1,684,972
Richland Township	Participating	32	$8,699,003.00	21	$259,551
Richlandtown Borough	Not Participating	-	-	-	-
Riegelsville Borough	Participating	67	$14,059,165.00	123	$2,331,312
Sellersville Borough	Participating	18	$3,969,618.00	72	$1,875,942
Silverdale Borough	Participating	-	-	-	-
Solebury Township	Participating	109	$35,178,289.00	222	$7,670,540
Springfield Township	Participating	10	$3,736,352.00	28	$538,823
Telford Borough	Not Participating	-	-	-	-
Tinicum Township	Participating	98	$27,071,222.00	286	$11,499,762
Trumbauersville Borough	Sanctioned	-	-	-	-
Tullytown Borough	Participating	5	$1,486,214.00	2	$6,887
Upper Makefield Township	Participating	163	$47,820,308.00	340	$13,748,474
Upper Southampton Township	Participating	70	$20,633,905.00	87	$1,739,841
Warminster Township	Participating	70	$19,601,122.00	59	$701,777

Table 5.2-5 Bucks County Municipal National Flood Insurance Program Information (FEMA, 2021d).

MUNICIPALITY	PARTICIPATION STATUS	POLICIES IN FORCE	TOTAL PREMIUM AND COVERAGE	TOTAL CLAIMS SINCE 1978	TOTAL PAID SINCE 1978
Warrington Township	Participating	85	$23,605,708.00	109	$2,119,866
Warwick Township	Participating	52	$15,992,586.00	20	$319,827
West Rockhill Township	Participating	9	$2,571,817.00	9	$56,690
Wrightstown Township	Participating	11	$3,296,842.00	12	$337,420
Yardley Borough	Participating	182	$45,844,771.00	767	$25,013,316
TOTAL		3,482	$964,462,434.00	4,842	$132,426,567

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 1978 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.

CRS Communities

These communities have exceeded minimum floodplain management standards and in turn receive discounts on flood insurance premiums for residents!

Lower Makefield Township
Class 7
15% Discount

Warwick Township
Class 7
15% Discount

Upper Makefield Township
Class 9
5% Discount

Yardley Borough
Class 9
5% Discount

Lower Makefield Township and Warwick Township joined the CRS program in 2016; Upper Makefield Township joined in 2017; Yardley Borough began the process to participate in 2019.

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.

Table 5.2-6 identifies which staff and technical assistance municipalities have available to them. 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 with GIS software experience and grant-writing staff/other fiscal staff with was less likely with among the communities. However, the County may be able to support the jurisdictions with available staff and/or expertise to the communities that lack the administrative and technical capabilities. All municipalities in the County have an identified emergency management coordinator.

Table 5.2-6 Available Staff and Technical Assistance by Municipality

MUNICIPALITY	LAND USE/ DEVELOPMENT PLANNING	ENGINEERING	EMERGENCY MANAGER	FLOODPLAIN MANAGER	STAFF WITH GIS SOFTWARE EXPERIENCE	GRANT-WRTING STAFF/OTHER FISCAL STAFF
Bucks County	X		X		X	X
Bedminster Township			X			
Bensalem Township		X	X		X	X
Bridgeton Township			X			
Bristol Borough	X	X	X	X	X	

Table 5.2-6 Available Staff and Technical Assistance by Municipality

MUNICIPALITY	LAND USE/ DEVELOPMENT PLANNING	ENGINEERING	EMERGENCY MANAGER	FLOODPLAIN MANAGER	STAFF WITH GIS SOFTWARE EXPERIENCE	GRANT-WRTING STAFF/OTHER FISCAL STAFF
Bristol Township	X	X	X	X	X	X
Buckingham Township		X	X	X	X	
Chalfont Borough			X			
Doylestown Borough	X	X	X	X	X	X
Doylestown Township	X	X	X	X	X	X
Dublin Borough			X			
Durham Township			X			
East Rockhill Township	X	X	X	X		
Falls Township			X			
Haycock Township	X	X	X	X	X	
Hilltown Township	X	X	X	X	X	X
Hulmeville Borough			X			
Ivyland Borough	X	X	X	X, Zoning Officer		X
Langhorne Borough			X			
Langhorne Manor Borough			X			
Lower Makefield Township	X	X	X	X		X
Lower Southampton Township			X			
Middletown Township	X	X	X	X	X	X
Milford Township	X	X	X	X	X	X
Morrisville Borough			X			

Table 5.2-6 Available Staff and Technical Assistance by Municipality

MUNICIPALITY	LAND USE/ DEVELOPMENT PLANNING	ENGINEERING	EMERGENCY MANAGER	FLOODPLAIN MANAGER	STAFF WITH GIS SOFTWARE EXPERIENCE	GRANT-WRTING STAFF/OTHER FISCAL STAFF
New Britain Borough			X			
New Britain Township			X			
New Hope Borough			X			
Newtown Borough			X			
Newtown Township			X			
Nockamixon Township	X	X	X	X		X
Northampton Township	X	X	X	X	X	X
Penndel Borough			X			
Perkasie Borough			X			
Plumstead Township	X	X	X	X	X	X
Quakertown Borough			X			
Richland Township	X	X	X	X		
Richlandtown Borough			X			
Riegelsville Borough	X	X	X	X		X
Sellersville Borough	X	X	X	X	X	X
Silverdale Borough			X			
Solebury Township	X	X	X	X	X	X
Springfield Township	X	X	X	X	X	
Telford Borough			X			
Tinicum Township	X	X	X	X	X	X

Table 5.2-6 Available Staff and Technical Assistance by Municipality

MUNICIPALITY	LAND USE/ DEVELOPMENT PLANNING	ENGINEERING	EMERGENCY MANAGER	FLOODPLAIN MANAGER	STAFF WITH GIS SOFTWARE EXPERIENCE	GRANT-WRTING STAFF/OTHER FISCAL STAFF
Trumbauersville Borough	X	X	X			
Tullytown Borough		X	X			
Upper Makefield Township	X	X	X	X	X	X
Upper Southampton Township	X	X	X	X		X
Warminster Township	X	X	X	X	X	
Warrington Township	X	X	X	X	X	
Warwick Township	X	X	X	X	X	X
West Rockhill Township	X	X	X	X		X
Wrightstown Township			X			
Yardley Borough	X	X	X			

Other local organizations that could act as partners include Bucks County Conservation District, Penn State 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.

5.2.2.2. *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 142 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 grant funding, which has resulted in 102 mitigated repetitive loss properties, as of 2017. 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.

Bucks County is actively developing a Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review (SPR). The following capability gaps have been identified for Bucks County (Matthews, 2021):

Hazard Capability Gaps

- Flooding / Hurricane: The capability gap for this event is to be able to provide timely rescue services during flooding events due to limited manpower trained in and equipment for Swift Water Rescue teams.
- Hazardous Materials: The capability gap for this event lies with the ability for the Bucks County Special Operations HazMat Team to solely respond to hazardous material incidents. The current team is made up of primarily volunteer personnel with a limited number of Emergency Services staff providing coordination and response abilities.
- Structure Collapse: The capability gap for this event lies with the ability for the Bucks County Special Operations Technical Rescue Team to solely respond to incidents. The current team is made up of primarily volunteer personnel with a limited number of Emergency Services staff providing coordination and response abilities.
- Terrorism – Cyber: Cybersecurity continues to be a high-risk threat to the County's infrastructure. Currently however, Bucks County does not possess a cyber incident

plan/annex to its Emergency Action Plan nor does it regularly communicate with externally regulated critical infrastructure to ensure its resilience to an attack

Planning Capability Gaps

- Emergency Action Plans: Not all 54 municipalities regularly submit updated Emergency Action Plans and there is a varying amount of experience and abilities across the Municipal Emergency Managers, with a majority of them being volunteer. This presents some difficulty when trying to engage all 54 jurisdictions in hazard identification and prevention efforts.

Administrative and Technical Capability Gaps

- Firefighters: Due to continued dwindling numbers in properly trained and available volunteer firefighters, gaps were identified for the ability to respond effectively to fire events, including multiple occurring at one time. Municipalities would likely need to enact mutual aid.
- Emergency Medical Services (EMS): Gaps were identified for the County's EMS system to effectively respond to a mass casualty incident requiring the transport of 50 people within 1 hour of incident onset. Gaps identified were due to the continued difficulty presented by individual organizations to recruit and retain paramedics and EMTs. Additionally, Bucks County has no immediate mass transportation resources operated by the county for transportation of injured persons. Mutual aid would be heavily utilized.
- Mass Care Services: Gaps exist with the county's ability to solely respond to the need for mass sheltering. This would include the ability to provide shelter and food for approximately 2 weeks. County is currently reliant upon Mutual Aid and partner organizations in addition to requiring additional support from state and federal resources.

Community Capability Gaps

- Community Resiliency: Gaps were identified in ensuring that households are appropriately covered by risk-appropriate insurance for flood, wind, and seismic events.
- Public Information, Warning, Mass Notification: Gaps were identified for the County's ability to provide immediate mass notification or warning to limited English proficiency persons as well as those with functional disabilities.
- Supply Chain Integrity and Security: Gaps exist in regards to the sustainability of private sector supply chains during a disaster. Bucks County currently has limited engagements with the private sector supply chain as it relates to being involved in indent management for restoration. Gaps were identified in the ability to promote

awareness of threats, dependencies, vulnerabilities, and strategies with these private sectors.

An additional report that identifies capability gaps for Bucks County is The Future of Bucks County's Fire Services. An update to the original 1990 Bucks County Community Facilities: Emergency Services Report, the document identifies the rapid decline in active firefighters within the County. Bucks County is estimated to be facing a lack of 770 active firefighters to service the area. While there is plenty of equipment to be used within Bucks, there are not enough firefighters. The report states the solution to the lack of volunteers will be solved through regulatory, operational, and financial changes to entice and encourage additional firefighters to support the communities within Bucks County (BCPC, 2021b).

5.2.3. Financial 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. As mentioned in Section 5.2.2, some communities do not have access to grant writers thus their capacity to pursue and administer grant-funded opportunities is limited. Local programs which may provide financial support for mitigation actions include, but are not limited to:

- Capital improvement programming
- Community Development Block Grants (CDBG)
- Development impact fees
- Gas / electric utility fees
- General obligation, revenue, and/or special tax bonds
- Partnering arrangements or intergovernmental agreements
- Special purpose taxes
- Stormwater utility fees
- Water / sewer fees

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
- Building Resilient Infrastructure and Communities (BRIC)
- 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 (Bucks County, 2021d). 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 partner agencies 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 5.2-7 includes the planning frameworks that were identified in Bucks County.

Table 5.2-7 Planning Framework in Bucks County

PLANNING LEVEL	PLAN
STATE	2018 Commonwealth of Pennsylvania Standard All-Hazard Mitigation Plan: October 2019 Annual Update
	Keystone Principles and Criteria for Growth, Investment, and Resource Conservation, 2005
REGIONAL	Delaware Valley Regional Planning Commission: Connections 2045
	Lehigh Valley Comprehensive Plan
	Montgomery County Comprehensive Plan
	Philadelphia 2035 Comprehensive Plan
COUNTY	Bucks County Waterfront Revitalization Plan, 2005
	Landmark Towns of Bucks County
	Bucks County Open Space and Greenway Plan, 2011
	Bucks County Natural Areas Inventory Update, 2011
	Bucks County Bicycle Plan, 2012
	Bucks County Hazard Mitigation Plan, 2011, 2016, 2021
	Bucks County Hazard Vulnerability Analysis (HVA)
	Bucks County Comprehensive Plan Update, 2011
	Bucks County Flood Recovery and Mitigation Strategy
	Neshaminy Creek Supplemental Watershed Work Plan, 2017
	Bucks County Natural Areas Program, 2013
	Bucks County Emergency Operations Plan
	Bucks County Pedestrian Safety Study, ongoing
	Bucks County Debris Management Plan, 2017
	2018-2028 Municipal Waste Management Plan, 2019
	Bucks County Agricultural Preservation Program, 2019
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 (PGDEC, 2005).

5.2.5.2. *Integration 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 the past 2016 Hazard Mitigation Plan and the current planning in Bucks County and the integration with the 2016 Hazard Mitigation Plan to integrate and strengthen these actions for this 2021 Hazard Mitigation Plan and into 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 5.2-8 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 5.2-9; however, at the

end of the planning process, the county prioritized six of these actions, which are outlined with the guiding principles in Table 5.2-8 below.

Table 5.2-8 Planning Principles and Prioritized Actions Guiding Development in Bucks County (BCPC, 2011a)

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 5.2-9 includes a full list of the mitigation related actions and their associated strategy and guiding principle.

Table 5.2-9 Hazard Mitigation Related Actions in Bucks County (BCPC, 2011a)

STRATEGY	ACTION

Table 5.2-9 Hazard Mitigation Related Actions in Bucks County (BCPC, 2011a)

PRINCIPLE 1: PROTECT NATURAL, HISTORIC, AND SCENIC PROPERTIES	
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 flood prone properties and the return of these areas to a natural state.
PRINCIPLE 4: PROTECT WATER RESOURCES AND REDUCE WASTE	
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 5.2-9 Hazard Mitigation Related Actions in Bucks County (BCPC, 2011a)

	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., flood proofing) 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. Bucks County is currently updating the County Comprehensive Plan. Hazard mitigation principles from the 2021 Hazard Mitigation Plan Update will be integrated into the Bucks 2040 Comprehensive Plan update, which will guide development in Bucks County. The HMSC currently actively monitors high growth and high risk areas for development projects in relation to hazard vulnerability.

Bucks County Watersheds ACT 167 Plans

There are nine 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
- Pennypack Creek
- Perkiomen 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 5.2-10 details the actions from each of the Act 167 plans in Bucks County that are related to hazard mitigation.

Table 5.2-10 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

Table 5.2-10 Act 167 Plan Actions Relevant to Hazard Mitigation

ACTION	LOCATION IN PLAN
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
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

Table 5.2-10 Act 167 Plan Actions Relevant to Hazard Mitigation

ACTION	LOCATION IN PLAN
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 (BCPC, 2011b). The preservation of open space and greenways can be relevant to hazard mitigation goals as the space may be able to manage stormwater, mitigating the effects of flooding. Table 5.2-11 provides detail on the action identified in the Bucks County Open Space and Greenways Plan relevant to hazard mitigation.

Table 5.2-11 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

Emergency Debris Management Plan

In 2017, the County published their Emergency Debris Management Plan, which is focused on helping the county to respond to a natural or manmade debris-generating event (BCEMA, 2017). The plan helps identify agencies and activities that are involved in debris operations in order to help coordinate response in the case of an event. Initiatives in this plan help address debris that may be caused by hazard events, including tornadoes, floods, winter storms, earthquakes and civil disturbance. Elements that were incorporated from the previous hazard mitigation plan into the Debris Management Plan were the different types of disaster events that the County is vulnerable to, the likelihood of each disaster occurring, the different impacts each disaster can have on the County, and post-disaster debris management practices which intertwine with future mitigation projects.

A barrier to plan integration is often the lack of resources to accomplish activities that plan integration requires. Several municipalities noted on the *Capability Assessment Surveys* that they have limited to moderate financial capability resources which may limit the development of some planning tools. The Self-Assessment portion of the survey provided each municipality an opportunity 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 5.2-12 summarizes the results of the self-assessment survey. With available resources being limited and stretched into the foreseeable future, plan integration is extremely relevant and will help leverage existing resources to the maximum extent possible.

Table 5.2-12 Summary of Self-Assessment Capability Responses

CAPABILITY CATEGORY	LIMITED	MODERATE	HIGH
Planning & Regulatory		Bensalem Township Bristol Township Bucks County Haycock Township Hilltown Township Milford Township Northampton Township Plumstead Township Richland Township Riegelsville Borough Springfield Township Tinicum Township	Bristol Borough Buckingham Township Doylestown Borough Doylestown Township East Rockhill Township Lower Makefield Township Middletown Township Nockamixon Township

Table 5.2-12 Summary of Self-Assessment Capability Responses

CAPABILITY CATEGORY	LIMITED	MODERATE	HIGH
		Tullytown Borough Warminster Township Warwick Township	Sellersville Borough Solebury Township Trumbauersville Borough Upper Makefield Township Upper Southampton Township Warrington Township West Rockhill Township Yardley Borough
Administrative & Technical	Tinicum Township	Bensalem Township Bristol Township East Rockhill Township Haycock Township Hilltown Township Milford Township Nockamixon Township Plumstead Township Richland Township Sellersville Borough Springfield Township Tullytown Borough Warminster Township Warwick Township Yardley Borough	Bristol Borough Buckingham Township Bucks County Doylestown Borough Doylestown Township Lower Makefield Township Middletown Township Northampton Township Riegelsville Borough Solebury Township Trumbauersville Borough Upper Makefield Township Upper Southampton Township Warrington Township West Rockhill Township

Table 5.2-12 Summary of Self-Assessment Capability Responses

CAPABILITY CATEGORY	LIMITED	MODERATE	HIGH
Financial	Doylestown Township East Rockhill Township Haycock Township Milford Township Nockamixon Township Northampton Township Riegelsville Borough Springfield Township Tinicum Township Upper Southampton Township	Bensalem Township Bristol Borough Bristol Township Bucks County Hilltown Township Middletown Township Plumstead Township Richland Township Sellersville Borough Solebury Township Trumbauersville Borough Tullytown Borough Warminster Township Warrington Township Warwick Township	Buckingham Township Doylestown Borough Lower Makefield Township Upper Makefield Township West Rockhill Township Yardley Borough

6. Mitigation Strategy

6.1. Update Process Summary

The 2006, 2011, and 2016 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 2016 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 HMSC 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. The result of a collaborative effort by the HMPT are noted in Table 6.1-1. All goals and objectives from the previous plan were confirmed for continuation in to the plan update. Copies of mitigation strategy evaluations and action submissions are located in Appendix C.

Table 6.1-1 Review of Mitigation Strategy from 2016 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: Implement projects that protect properties, critical facilities, and infrastructure from hazards focusing on the 1% annual chance floodplain.	Objectives confirmed and continued.
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.	

Table 6.1-1 Review of Mitigation Strategy from 2016 Bucks County HMP.

EXISTING STRATEGY DESCRIPTION	REVIEW
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	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.	Objectives confirmed and continued.
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.	Goal confirmed and continued.
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.	Objectives confirmed and continued.
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.	Goal confirmed and continued.
Objective 4.A: Implement natural resource planning and projects that assist in hazard mitigation.	Objectives confirmed and continued.

Mitigation actions have been carried over and developed for the County as well as for each participating jurisdiction. While some actions may be more general in nature and could apply to more than one jurisdiction, most actions are specific to individual jurisdictions. The mitigation actions that were developed were based on the following: issues identified in the Hazard Identification and Risk Assessment, gaps identified in the mitigation capability analysis, input from the HMPT, and feedback from the RAMS Workshop held April 8, 2021. These mitigation actions may be implemented through a variety of local tools such as: changes in ordinances and policies, inclusion into capital improvements budgets, and grant funding.

County and Municipal actions in the 2016 Plan were distributed at the RAMS workshop for review and update. Each action has been assigned one of the following categories:

- "Completed" – Actions that were completed since the adoption of the 2016 Plan
- "Cancelled" – Actions that were terminated.
- "Deferred" – Actions that had not been initiated since the adoption of the 2016 Plan
- "On-Going" – Actions that are performed on a regular and continuous basis by the department

The majority of existing mitigation actions have been carried over into the 2021 Plan as they are continuous actions (ongoing) or actions that were not completed (deferred). A list of these actions as well as their status is included in Table 6.1-2.

The left-hand column identifies which communities adopted each action in the 2016 draft of the plan. While most communities chose to defer their actions into this plan update, some did choose to change the status of their actions. Where communities differ, multiple boxes are checked, and a superscript is added to show which communities are in each category. Actions were evaluated by the HMPT and municipal officials with the intent of producing a usable mitigation action plan. Appendix C contains a summary of responses provided by municipalities to the *Mitigation Action Progress Report Form*.

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
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 Township, Upper Southampton Township, Warminster Township[1], Warrington Township, Warwick Township, West Rockhill Township, Wrightstown Township, Yardley Borough	1.A.1	Flood, Hurricane, Tropical Storm, Nor'easter	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).		X[1]	X	

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
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[1], West Rockhill Township	1.A.2	Dam Failure, Flood, Hurricane, Tropical Storm, Nor'easter, Structure Collapse	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.	X[1]		X	
East Rockhill Township, Morrisville Borough, Upper Southampton Township, Yardley Borough	1.A.3	Dam Failure, Flood, Hurricane, Tropical Storm, Nor'easter	Action 1.A.3 Proceed with grant applications for infrastructure that protects community from 1% annual chance floodplain.			X	

All Participating Communities: Bedminster Township[2], 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[2], 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[2], Trumbauersville Borough, Tullytown Borough, Upper Makefield Township, Upper Southampton Township, Warminster Township[1], Warrington Township, Warwick Township, West Rockhill Township[2], Wrightstown Township, Yardley Borough	1.A.4	Flood, Hurricane, Tropical Storm, Nor'easter	Action 1.A.4 Evaluate, implement, and perform mitigation projects identified in this and other planning mechanisms, including acquisition, elevation, foundation and building stabilization, reconstruction, securing access to generator power and other mitigation methods.		X[1]	X	X[2]

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
Bedminster Township[1], 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[1], Trumbauersville Borough[1], Tullytown Borough, Warrington Township, West Rockhill Township	1.B.1	Flood, Hurricane, Tropical Storm, Nor'easter	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.			X	X[1]
Chalfont Borough, Doylestown Township[1], Lower Makefield Township, Newtown Township, Tinicum Township, Yardley Borough	1.B.2	Flood, Hurricane, Tropical Storm, Nor'easter	Action 1.B.2 Evaluate and/or pursue Community Rating System (CRS) participation for insurance premium reduction (and flood damage reduction).			X	X[1]
East Rockhill Township[1], Lower Makefield Township, New Britain Township, Nockamixon Township[1], Plumstead Township, Upper Southampton Township	1.C.1	Flood, Hurricane, Tropical Storm, Nor'easter	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.			X	X[1]

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
Lower Makefield Township, New Britain Township	1.C.2	Flood, Hurricane, Tropical Storm, Nor'easter	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 township administrative procedures, including applications for building permits at township/borough offices.			X	
Sellersville Borough, Solebury Township, Tinicum Township[1], West Rockhill Township	1.D.1	Flood, Hurricane, Tropical Storm, Nor'easter, Environmental Hazards, Urban Fire and Explosion	Action 1.D.1 Identify all storage of hazardous materials in floodplains (including non-addressable structures, such as propane tanks).			X	X[1]

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
West Rockhill Township	1.D.2	Flood, Hurricane, Tropical Storm, Nor'easter, Environmental Hazards, Urban Fire and Explosion	Action 1.D.2 Evaluate alternative methods to minimize risk from existing storage areas.			X	
West Rockhill Township	1.D.3	Flood, Hurricane, Tropical Storm, Nor'easter, Environmental Hazards, Urban Fire and Explosion	Action 1.D.3 Assess means to prevent future storage in floodplain.			X	

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
Doylestown Borough, Tinicum Township[2], West Rockhill Township[1]	1.E.1	Dam Failure Drought, Extreme, Temperature, Flood, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Lightning Strike, Structure Collapse, Tornado, Wind Storm, Utility Interruption, Winter Storm	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).	X[2]		X	X[1]
Doylestown Borough, West Rockhill Township[1]	1.E.2	Dam Failure Drought, Extreme Temperature, Flood, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Lightning Strike, Structure Collapse, Tornado, Wind Storm, Utility Interruption, Winter Storm	Action 1.E.2 Develop action plan for reducing potential damage and loss of function at identified critical facilities and infrastructure.			X	X[1]

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
West Rockhill Township	1.F.1	Dam Failure, Extreme Temperature, Flood, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Lightning Strike, Tornado, Wind Storm, Utility Interruption, Winter Storm	Action 1.F.1 Conduct qualitative evaluation process for managing stranded rural residents and travelers (e.g., temporary shelters).				X
Solebury Township, Trumbauersville Borough, West Rockhill Township	1.F.2	Dam Failure, Extreme Temperature, Flood, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Lightning Strike, Tornado, Wind Storm, Utility Interruption, Winter Storm	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.			X	

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
Tinicum Township	1.G.1	Dam Failure, Earthquake, Environmental Hazards, Extreme Temperature, Flood, Flash Flood, Ice Jam, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Landslide, Lightning Strike, Pandemic, Radon, Structure Collapse, Subsidence, Sinkhole, Terrorism, Tornado, Wind Storm, Urban Fire and Explosion, Utility Interruption, Wildfire, Winter Storm	Action 1.G.1 Utilize available county GIS Resources for municipal hazard related planning and outreach.				X

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
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	1.H.1	Structure Collapse, Transportation Accidents	Action 1.H.1 Review prevalence of transportation accidents and known infrastructure deficiencies and advocate for projects and funding that will increase safety.			X	
Richland Township	1.H.2	Transportation Accidents	Action 1.H.2 Implement signal improvements at intersections that frequently experience traffic accidents.			X	
New Britain Township	2.A.1	All	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.			X	
Doylestown Borough, East Rockhill Township[2], Hilltown Township[1], New Britain Township, Plumstead Township, Silverdale Borough[2]	2.A.2	Winter Storm	Action 2.A.2 Integrate evaluation of snow-removal and emergency access logistics with new development planning.	X[1]		X	X[2]

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
Haycock Township, New Britain Township, Plumstead Township, Silverdale Borough[1], Springfield Township, Upper Southampton Township	2.B.1	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	Action 2.B.1 Evaluate adequacy of township/borough building code implementation.			X	X[1]
Haycock Township, New Britain Township, Silverdale Borough, Upper Southampton Township	2.B.2	Hurricane, Tropical Storm, Nor'easter, Tornado, Wind Storm, Winter Storm	Action 2.B.2 Encourage increasing design wind and/or snow load for future development.			X	

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
Chalfont Borough, Doylestown Borough, East Rockhill Township[1], New Britain Township, Plumstead Township, Silverdale Borough[1], Upper Southampton Township, West Rockhill Township[1]	2.C.1	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	Action 2.C.1 Train the municipal building inspectors to consistently enforce the building code.			X	X[1]

All NFIP Participating Municipalities: Bedminster Township[2], Bensalem Township, Bridgeton Township, Bristol Borough, Bristol Township, Buckingham Township, Chalfont Borough, Doylestown Borough, Doylestown Township[1], Durham Township, East Rockhill Township[2], Falls Township, Haycock Township, Hilltown Township[1], Hulmeville 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[2], Northampton Township, Penndel Borough, Perkasie Borough, Plumstead Township, Quakertown Borough, Richland Township, Riegelsville Borough, Sellersville Borough, Silverdale Borough[2], Solebury Township, Springfield Township, Tinicum Township[2], Tullytown Borough, Upper Makefield Township, Upper Southampton Township, Warminster Township[1], Warrington Township, Warwick Township, West Rockhill Township, Wrightstown Township, Yardley Borough	2.C.2	Flood, Hurricane, Tropical Storm, Nor'easter	Action 2.C.2 Review and consider updates to the floodplain ordinance, on an annual basis.	X[1]		X	X[2]
Bristol Township, Bensalem Township, Buckingham Township, Hulmeville Borough, Middletown Township, Newtown Township,	2.D.1	Flood, Hurricane, Tropical Storm, Nor'easter	Action 2.D.1 Continue to implement measures for mitigation of flood hazard per the December 2001 "Neshaminy Creek Supplemental			X	

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
Lower Southampton Township, Northampton Township, Warwick Township, Wrightstown Township			Watershed Work Plan No. 5." including Flood warning system, Voluntary property acquisition, Voluntary building elevation and flood proofing, and Continuation/ enhancement of floodplain ordinances, flood insurance, and stormwater management.				
Buckingham Township, Doylestown Borough, New Britain Borough, New Britain Township, Warminster Township[1], Warrington Township, Warwick Township	2.D.2	Flood, Hurricane, Tropical Storm, Nor'easter	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.			X	X[1]
Doylestown Township[1], Plumstead Township	2.D.3	All Hazards	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.			X	X[1]

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
Doylestown Borough, Doylestown Township[1], Richlandtown Borough, Tinicum Township[2], Tullytown Borough	2.D.4	Environmental Hazards	Action 2.D.4 Continue coordination and planning to mitigate, prepare, and respond to local hazardous materials facilities.		X[2]	X	X[1]
Delaware Valley College, Holy Family University - Bucks County, Philadelphia Biblical University, Doylestown Township, Langhorne Borough, New Britain Borough, Newtown Township	2.D.5	All	Action 2.D.5 Continue coordination and planning with local colleges and universities to be partners to mitigate, prepare, and respond to hazards.			X	
Bensalem Township, Bristol Borough, Doylestown Township[1], Haycock Township, Richland Township, Solebury Township, Springfield Township, Tinicum Township[2], Upper Makefield Township, and Yardley Borough	2.D.6	All	Action 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.	X[2]		X	X[1]
New Britain Township, Silverdale Borough[1], Warrington Township, West Rockhill Township[1]	3.A.1	All	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.			X	X[1]

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
East Rockhill Township[1], Hulmeville Borough, Langhorne Borough, Lower Southampton Township, New Britain Borough, New Britain Township, New Hope Borough, Plumstead Township, Richlandtown Borough, Sellersville Borough, Silverdale Borough[1], Tinicum Township, Trumbauersville Borough[1], Warrington Township	3.A.2	All	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.			X	X[1]
New Hope Borough, Tinicum Township, Yardley Borough	3.A.3	Flood, Hurricane, Tropical Storm, Nor'easter	Action 3.A.3 Secure flood specific signage that warns travelers that barricades are present to prevent them from traveling into floodwater.			X	
Bedminster Township, Bristol Township, Durham Township, East Rockhill Township, Falls Township, Haycock Township, Hilltown Township[1], Milford Township, Nockamixon Township, Plumstead Township, Richland Township, Solebury Township, Springfield Township, Tinicum Township, West Rockhill Township	3.A.4	Wildfire	Action 3.A.4 Evaluate and consider implementing activities to secure "Firewise" designation.			X	X[1]

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
Solebury Township, Tinicum Township[1], Trumbauersville Borough[1], West Rockhill Township	3.A.5	Dam Failure, Extreme Temperature, Flood, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Lightning Strike, Tornado, Wind Storm, Utility Interruption, Winter Storm	Action 3.A.5 Maintain information and continue outreach to residents with the highest relative vulnerability to the effects of hazards.			X	X[1]
Bensalem Township, Bristol Borough, Doylestown Township, Haycock Township, Richland Township, Solebury Township, Springfield Township, Tinicum Township[1,2], Upper Makefield Township, and Yardley Borough	3.A.6	All	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.	X[2]		X	X[1]
Municipal Representatives, Bucks County Planning Commission, Bucks County Emergency Management Agency	3.B.1	All	Action 3.B.1 Convene regular meetings of a restructured HMSC to discuss issues and progress related to the implementation of the plan.			X	

Table 6.1-2 List and Status of 2016 Mitigation Action Plan

COMMUNITY	ACTION #	HAZARD(S) ADDRESSED	MITIGATION ACTION	STATUS			
				COMPLETE	CANCELED	DEFERRED	ONGOING
Bensalem Township, Bucks County Planning Commission, Bucks County Emergency Management Agency	3.B.2	All	Action 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.			X	
New Britain Township, Silverdale Borough[1], Upper Southampton Township	3.C.1	All	Action 3.C.1 Renew and expand commitments to hazard mitigation planning among partner organizations.			X	X[1]
East Rockhill Township[1], Yardley Borough	4.A.1	Flood, Hurricane, Tropical Storm, Nor'easter	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.			X	X[1]
East Rockhill Township[1], Lower Southampton Riegelsville	4.A.2	Flood, Hurricane, Tropical Storm, Nor'easter	Action 4.A.2 Evaluate and implement projects to manage stormwater effectively.			X	X[1]
Doylestown Borough, Penndel Borough, Tinicum Township[1,2], Warrington Township, Yardley Borough	4.A.3	Flood, Hurricane, Tropical Storm, Nor'easter	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).	X[2]		X	X[1]

Mitigation Success

For the plan update, Bucks County Planning Commission and Emergency Management and individual municipalities provided progress on mitigation actions and success that were accomplished since 2016. This section reflects progress and successes as of May 2021.

Debris management has been a priority to Bucks County since 2016. In 2017, the County published their Emergency Debris Management Plan, which is focused on helping the county to respond to a natural or manmade debris-generating event. The plan helps identify agencies and activities that are involved in debris operations in order to help coordinate response in the case of an event. Initiatives in this plan help address debris that may be caused by hazard events, including tornadoes, floods, winter storms, earthquakes and civil disturbance.

Yardley Borough has taken also action and has worked to mitigate flood by improving their Substantial Improvement/Substantial Damage (SI/SD) procedures. In 2019 they adopted FEMA's model SI/SD administrative procedures to help the Borough implement steps to fulfill SI/SD requirements. To adopt these procedures Yardley Borough worked with FEMA and the State, and they also got CRS points in the process. Since adoption of these SI/SD procedures Yardley Borough has been successful in using them as a tool to help with SI/SD.

Upper Makefield has also taken action to help mitigate flood. In May 2021 the Upper Makefield Board of Supervisors is working to take steps to help residents pay less for flood insurance by working to improve the Township's credit points under CRS. The Bucks County Herald posted an article on this initiative which can be viewed here: https://www.buckscountyherald.com/stories/to-lower-insurance-upper-makefield-township-steps-up-flood-mitigation-efforts,8905.

Upper Southampton Township is another municipality that has worked to mitigate flood over the past five years. During this last HMP cycle Upper Southampton Township has purchased and performed demolition to six properties in the SFHA that has experienced repetitive losses. The township's mitigation efforts to mitigate flood are ongoing. Within the next HMP five year cycle they are planning on purchasing and removing one last and final property as part of this overall initiative.

Due to the COVID-19 Pandemic, Bucks County has recently had to focus a lot of their mitigation resources on pandemic response. As the COVID-19 vaccine became available the County realized the differences between this vaccination distribution effort and previous vaccination distribution efforts and was able to pivot quickly. The county recognized the need to provide two shots to each individual and have them wait in the vaccination facility for a 15-minute observation window. They addressed these differences and were successful in COVID-19 vaccination distribution.

The County has also introduced a Model Alternative Energy Ordinance in January 2021 to assist municipalities with moving towards alternative energy to lessen reliance on traditional

grid power especially for new developments. Currently more than half the municipalities in Bucks County have some type of alternative energy ordinance in place (Stone, 2021).

PEMA has also helped with mitigation efforts in Bucks County. Since 2016 the County has been provided with two 175kw mobile generators. One is located in the north of the County and one is in the south. These generators are on trailers and have ancillary equipment for critical facility needs. Also, State and Federal funds were used to complete a hook up study. Additional, PEMA has been doing several elevation projects in the county and will be doing the first state/local mitigation reconstruction project in the near future.

While these are some examples of mitigation successes, Table 6.1-3 captures progress on all HMA-funded mitigation projects since 2016 to 2018, the most recent data available to the County. Many of the outreach, education, and training actions are considered ongoing.

Table 6.1-3 Mitigated Properties in Bucks County

MUNICIPALITY	ACQUISITION	ELEVATION	TOTAL
HULMEVILLE	0	1	1
LANGHORNE	1	1	2
LOWER MAKEFIELD	0	2	2
LUMBERVILLE	1	0	1
MIDDLETOWN TWP	0	0	0
NEW HOPE	0	1	1
POINT PLEASANT	0	2	2
SOUTHAMPTON	1	1	2
UPPER BLACK EDDY	0	1	1
WASHINGTON CROSSING	3	1	4
YARDLEY	2	7	9
TOTAL	8	17	25

The following projects were completed prior to the 2016 Plan Update thus captured in the 2016 mitigation plan. The importance of highlighting mitigation success within Bucks County, while the projects fall outside of the previous five years, shows the longevity of dedication to furthering hazard mitigation within the planning area.

Figure 6.1-2 Yardley Borough Elevation Project

Bucks County projects were 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, 2021g) (FEMA, 2021h). The images in Figure 6.1-2 show an elevation project in that was 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.

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. Outreach conducted between plan updates 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 Municipalities Use Facebook to Distribute Information on Hazards, Emergencies and Other Community Interests – Sample from East Rockhill

Figure 6.1-4 Buck County ReadyNotify PA Website (bucks.alertpa.org)

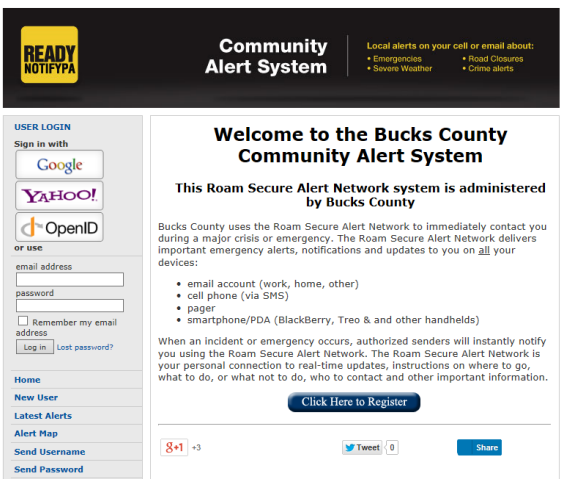
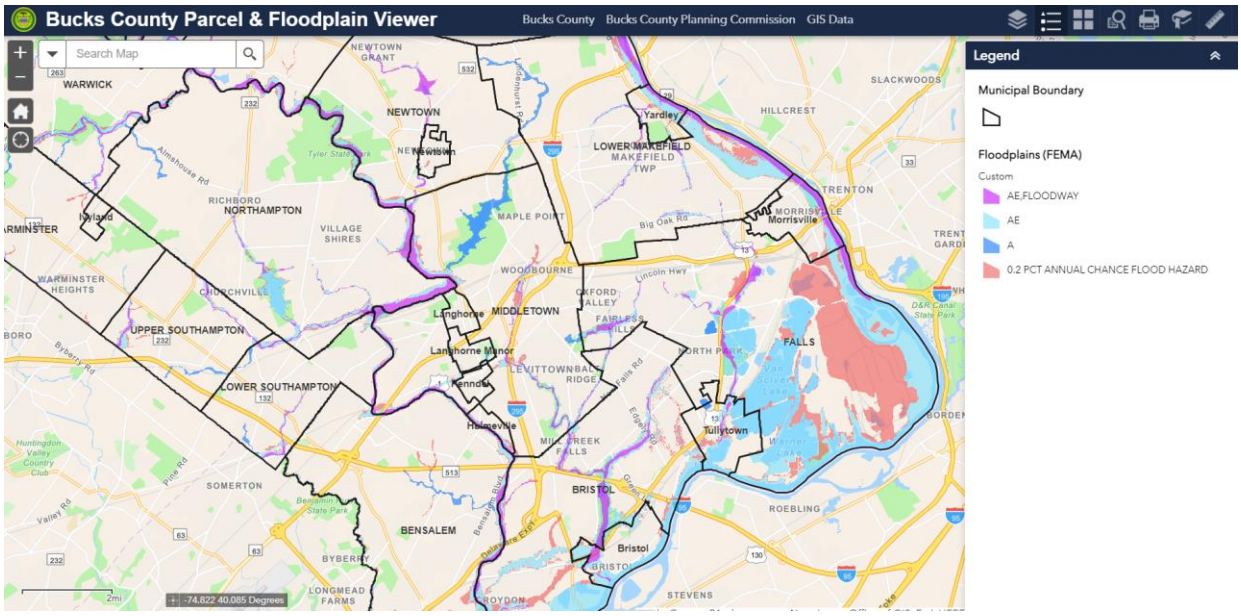


Figure 6.1-5 Snapshot of Bucks County Floodplain Viewer Available at gisweb.co.bucks.pa.us



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 21, 2017. Second, the Comprehensive Plan, which was update in 2011 and is actively being updated in 2021, includes hazard mitigation information and was updated with high levels of municipal participation, and 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 significantly improved items GIS and data capabilities since the 2016 Plan Update. One success directly related to mitigation outreach is hosting a combined Parcel and Floodplain Viewer on the county Maps and Data portal website, still actively in use and available in 2021. Previously these maps were two separate applications requiring users to toggle between two different maps. Combining the two applications provides for greater ease of use and access. 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 was and still 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 a stream restoration plan for a development with an insufficient buffer. These projects represent one way that stormwater management planning and hazard mitigation planning integrate in Bucks County and have the opportunity to meet matching goals.

6.2. Mitigation Goals and Objectives

Based on results of the goals and objectives evaluation exercise and input from the HMSC 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 2021 HMP.

A new objective for the 2021 plan relating to High Hazard Potential Dams was created as Objective 1.I.

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., flood proofing) 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.

Table 6.2-1 List of Mitigation Strategy Goals and Objectives.

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.
Objective 3. D: Consider opportunities to support employers, employees, residents, and visitors increasing remote work capabilities.
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.
GOAL 5 – IMPLEMENT STRUCTURAL PROJECTS TO REDUCE THE IMPACTS OF HAZARDS.
Objective 5.A: Address the risks posed by the potential failure of High Hazard Potential Dams within the county.

6.3. Identification and Analysis of Mitigation Techniques

The mitigation strategy in the updated Hazard Vulnerability Assessment and Mitigation Plan Update 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 2020 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 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, and NFIP outreach.

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		X
Radon Exposure	X			X
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
Gas and Liquid Pipelines	X			

6.4. Mitigation Action Plan

Following the Risk Assessment stage of the HMP update process, the Mitigation Solutions Workshop was held on April 8, 2021 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. Municipalities were informed that they needed to have at least one mitigation action for each municipality. The final list of mitigation actions is made up of actions from the existing 2016 Mitigation Action Plan and the new actions developed at and as follow-up to the RAMS Workshop.

Table 6.4-1 lists all the mitigation actions for the 2021 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 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	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	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 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
	Borough, Nockamixon Township, Northampton Township, Perkasie Borough, Plumstead Township, Richland Township, Riegelsville Borough, Sellersville Borough, Solebury Township, Springfield Township, Tinicum Township, Upper Makefield Township, Upper Southampton Township, Warrington Township, Warwick Township, West Rockhill Township, Wrightstown Township, Yardley Borough						
Action 1.A.2 Continue identifying protection measures to operate critical facilities. Proceed with grant applications to suitably protect and continue operations	Bensalem Township, Bristol Borough, Bristol Township, Doylestown Borough, Lower Makefield Township, Lower Southampton Township, Milford Township, Morrisville Borough, New Britain	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

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
of critical facilities in the 1% annual chance floodplain and at risk to utilities interruption from flooding and other hazards.	Borough, Northampton Township, Quakertown Borough, Riegelsville Borough, Sellersville Borough, Tinicum Township, West Rockhill Township						
Action 1.A.3 Continue identifying protection measures to operate businesses and protect residences. 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
Action 1.A.4 Evaluate, implement, and perform mitigation projects identified in this and other planning mechanisms, including acquisition, elevation, mitigation	All Participating Communities: Bedminster Township, Bensalem Township, Bridgeton Township, Bristol Borough, Bristol Township, Buckingham Township, Chalfont Borough, Doylestown	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 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
reconstruction, foundation and building stabilization, securing access to generator power and other mitigation methods.	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, 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						

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
	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, Warrington Township, Warwick Township, West Rockhill Township, Wrightstown Township, Yardley Borough						
Action 1.A.5 Township will replace 5 existing culverts on Top Rock Trail to mitigate flooding impacts of existing substandard	Haycock Township	Structure and Infrastructure	Flood, Transportation Accidents	Public Works Department	0-1 years	General Township Budget Estimated $10,000	High

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
drainage conditions in this area of the Township. This is part of an on-going effort to improve roadside drainage throughout the Township.							
Action 1.A.6 Clean out all street drains, repair and/or replace culverts and drain grates	Trumbauersville Borough	Natural Systems Protection	Flood	Borough President and Secretary	0-1 years	Borough funds Estimated $15,000	Medium
Action 1.A.7 Install storm sewer along a section of Peppermint Road to address an ongoing flooding issue that impacts neighboring downstream properties.	Springfield Township	Structure and Infrastructure	Flood, Transportation Accidents	Public Works Department	2-3 years	Public Works Budget $Estimated $100,000	Medium
Action 1.A.8 Elevate existing homes in the floodplain to limit damage during future flood events	Upper Makefield Township	Structure and Infrastructure - NFIP Action	Flood	Township Board of Supervisors and Township Staff	2-3 years	FMA grants, BRIC, local match $150,000 per home	High

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
Action 1.A.9 Repair culvert and swales on Lonely Road.	West Rockhill Township	Structure and Infrastructure - NFIP Action	Flood	Township Engineer	0-1 Years	Local, PA Liquid Fuels Estimated $50,000	Medium
Action 1.A.10 Replace culvert on Tabor Road	Nockamixon Township	Structure and Infrastructure - NFIP Action	Flood	Township Manager	0-1 Years	Local Estimated $50,000	Medium
Action 1.A.11 Repair/improve Modla/Park drainage swale.	Trumbauersville Borough	Structure and Infrastructure - NFIP Action	Flood	Borough Engineer	2-3 Years	Local Estimated $50,000	Medium
Action 1.A.12 Improving stormwater management in floodplain by jet cleaning storm drains and installing backflow preventers. Secondly, Yardley Borough will pursue the installation of additional storm drains and pipes to an area without.	Yardley Borough	Structure and Infrastructure - NFIP Action	Flood	Borough Council, Borough Engineer	2-3 Years	American Rescue Plan Act Funds	High

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
Action 1.A.13 Continue elevating flood prone structures.	Yardley Borough	Structure and Infrastructure - NFIP Action	Flood	Borough Council	2-3 Years	FEMA Grants	Medium
Action 1.A.14 Increasing open space cache in floodplain.	Yardley Borough	Structure and Infrastructure - NFIP Action	Flood	Borough Manager	0-1 Years	General Fund	Medium
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	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	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

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
minimizing the cost of flood insurance coverage, and Property acquisition, relocation, elevation, dry floodproofing, and wet floodproofing.	Township, West Rockhill Township						
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
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	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

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
obtained includes: Lowest-floor elevation, Number of stories, Presence of a basement, and Market and/or replacement value.							
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 township	Bedminster Township, Bensalem Township, Bridgeton Township, Bristol Borough, Bristol Township, Buckingham Township, Chalfont Borough, Doylestown Borough, Doylestown Township, Durham Township, East Rockhill Township, Falls Township, Haycock Township, Hilltown Township, Hulmeville Borough, Langhorne Manor Borough, Lower Makefield Township, Lower Southampton Township, Middletown Township, Milford	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 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
administrative procedures, including applications for building permits at township/borough offices.	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, Riegelsville Borough, Sellersville Borough, Solebury Township, Springfield Township, Tinicum Township, Trumbauersville Borough, Tullytown Borough, Upper Makefield Township, Upper Southampton Township, Warminster Township, Warrington Township, Warwick Township, West Rockhill						

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
	Township, Wrightstown Township, Yardley Borough						
Action 1.C.3 Provide a comprehensive update to the database that records floodplain properties and elevation certificates.	Tinicum Township	Local Plans and Regulations/ Structure and Infrastructure	Flood	Township Manager & Adminstrative Services	2-3 years	Local General Tax $1,500 for database upgrades	High
Action 1.C.4 Pre-populating FEMA's Substantial Damage Estimator Tool	Yardley Borough	Local Plans and Regulations/ Structure and Infrastructure - NFIP Action	Flood	EMC	0-1 Years	General Budget	Low
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

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
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 Hazards, Urban Fire and Explosion	Municipalities	Within 3 years	Staff time; DCED Technical Support for Model Ordinance that addresses hazardous materials in floodplain	High
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	Doylestown Borough, West Rockhill Township	Education and Awareness	Dam Failure Drought, Extreme	Municipalities, Bucks County Emergency	Within 3 years	Staff Time; NOAA Storm Ready	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
effects of power outage (i.e., hospitals, nursing homes, fire, police, rescue, and emergency management).			Temperature, Flood, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Lightning Strike, Structure Collapse, Tornado, Wind Storm, Utility Interruption, Winter Storm	Management Agency			
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, Hurricane, Tropical Storm, Nor'easter,	Municipalities, Bucks County Emergency Management Agency	Within 5 years	Staff Time; DHS; NOAA Storm Ready; Private Funding from Critical Facilities and	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
			Lightning Strike, Structure Collapse, Tornado, Wind Storm, Utility Interruption, Winter Storm			Infrastructure	
Action 1.E.3 Add additional water main on North Main Street to provide additional water service for residents and especially for fire fighting activity.	Doylestown Borough	Structure and Infrastructure	Urban Fire and Explosion	Public Works Director/ Deputy Manager	0-1 years	DHS grants, local budget Estimated $400,000	High
Action 1.E.4 Complete interconnection of an existing public water system with facilities owned by North Wales Water Authority to ensure redundancy of supply	Plumstead Township	Structure and Infrastructure	Utility Interruption	Water Department/Township Manager	2-3 years	Water Budget/General Fund Budget Estimated $1.5 Million	High

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
in the Township's water system							
1.E.5 Replace aging sewage pump station to reduce outages and prevent storm damage.	East Rockhill Township	Structure and Infrastructure	Utility Interruption	Township Manager	0-1 Years	Local Estimated $1,000,000	Medium
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	Municipalities, Bucks County Emergency Management Agency	Within 5 years	Staff Time; DHS; NOAA Storm Ready	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
			, Winter Storm				
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	Tinicum Township	Education and Awareness/ Local Plans and Regulations	Dam Failure, Earthquake, Environmen	Municipalities, Bucks County Planning Commission,	Within 5 years	Staff time; HMGP; BRIC	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
related planning and outreach.			tal Hazards, Extreme Temperature, Flood, Flash Flood, Ice Jam, Hailstorm, Hurricane, Tropical Storm, Nor'easter, Landslide, Lightning Strike, Pandemic, Radon, Structure Collapse, Subsidence, Sinkhole, Terrorism, Tornado, Wind Storm, Urban Fire and Explosion, Utility	Bucks County Emergency Management Agency			

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
			Interruption, Wildfire, Winter Storm				
Action 1.G.2 Review and update countywide datasets and coordinate with municipalities during this update. Identify method for distributing updated data.	Bucks County	Education and Awareness/ Local Plans and Regulations	All Hazards	Bucks County Planning Commission and Bucks County GIS	Within 5 years	Staff Time, Local Funding	Medium
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	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 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
	Township, Yardley Borough						
Action 1.H.2 Replace the deck of an existing bridge on Schultz Road that is structurally deficient to ensure that the transportation system of the Township is not adversely impacted if the bridge must be closed to traffic	Hilltown Township	Structure and Infrastructure	Structure Collapse, Transportation Accidents	Township Public Works	0-1 years	Township Public Works Budget Estimated $250,000	Medium
Action 1.H.3 Implement signal improvements at intersections that frequently experience traffic accidents.	Richland Township	Structure and Infrastructure	Transportation Accidents	Municipality	Within 5 years	PennDOT	Low
Action 1.H.4 Bridge replacement project on Rosenberger Rd spanning the	Milford Township	Structure and Infrastructure	Structural Collapse	Public Works Director	0-1 years	Traffic fund and partial grants	High

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
Molasses Creek due to structural failure.						Estimated $500,000	
Action 1.H.5 Traffic calming on Main Street and Barringer Avenue.	Silverdale Borough	Structure and Infrastructure	Transportation Incidents	Borough Engineer	2-3 Years	Local, Grant Estimated $125,000	Medium
Action 1.H.6 Bridge replacement or rehab on Headquarters Rd spanning the Tinicum Creek due to structural failure.	Tinicum Township	Structure and Infrastructure	Transportation Incidents	PennDOT	Within 5 years	PennDOT	High
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	New Britain Township	Education and Awareness/ Local Plans and Regulations	All	Municipalities, Bucks County Planning Commission	Continuously for next 5 years.	Staff Time; HMGP; PDM	High

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
township/borough level.							
Action 2.A.2 Integrate evaluation of snow-removal and emergency access logistics with new development planning.	Doylestown Borough, East Rockhill 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
Action 2.A.3 Update local zoning ordinances.	Buckingham Township	Local Plans and Regulations	All	Township Manager	0-1 years	Operating budget $5,000	Medium
Action 2.A.4 Consider extra permitting requirements for mines and pipelines in areas with carbonate rock.	Springfield Township, Riegelsville Borough	Local Plans and Regulations	Subsidence, Gas and Liquid Pipelines	Local Government	Continuously for next 5 years	Staff Time	Medium
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	Haycock Township, New Britain Township, Plumstead Township, Silverdale Borough,	Local Plans and Regulations	Dam Failure, Earthquake, Environmen	Municipalities	Continuously for next 5 years.	Staff Time	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
building code implementation.	Springfield Township, Upper Southampton Township		tal 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,				

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
			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
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	Municipalities, Bucks County Emergency Management Agency	Continuously for next 5 years.	Staff time; DCED and PEMA Technical Support	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
			Storm, Nor'easter, Landslide, Lightning Strike, Structure Collapse, Subsidence, Sinkhole, Tornado, Wind Storm, Urban Fire and Explosion, Utility Interruption, Wildfire, Winter Storm				
Action 2.C.2 Reach out to municipalities annually to highlight the importance of regularly reviewing floodplain ordinances. Request municipalities share	Bucks County	Local Plans and Regulations	All Hazards	Bucks County	Ongoing	Staff Time	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
updates and changes when applicable.							
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 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, and Continuation/ enhancement of floodplain ordinances, flood	*Involved with Acquisition, Elevation, Ordinances and Stormwater Management:* Bristol Township, Bensalem Township, Buckingham Township, Hulmeville Borough, Middletown Township, Newtown Township, Lower Southampton Township, Northampton Township, Warwick Township, Wrightstown Township *Involved with Ordinances and Stormwater Management:* Buckingham Township, Doylestown Borough,	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 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
insurance, and stormwater management.	New Britain Borough, New Britain Township, Warminster Township, Warrington Township, Warwick Township						
Action 2.D.2 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.3 Continue coordination and planning to mitigate, prepare, and respond to local	Doylestown Borough, Richlandtown Borough, Tullytown Borough	Local Plans and Regulations	Environmental Hazards	Municipalities, Hazardous Materials Facilities	Continuously for next 5 years.	Staff time; DHS	High

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
hazardous materials facilities.							
Action 2.D.4 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.5 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.	Bensalem Township, Bristol Borough, Doylestown Township, Haycock Township, Richland Township, Solebury Township, Springfield Township, Tinicum Township, Upper Makefield Township, and Yardley Borough	Local Plans and Regulations	All	Municipalities	Continuously for next 5 years.	Staff time; PHMC	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
Action 2.D.6 Work with Township Public Works, Police, and local Fire Police to evaluate and develop evacuation plan/routes.	Tinicum Township	Local Plans and Regulations	Dam Failure	Police & Public Works	2-3 years	DHS grants and local funding $5,000 for staff time	Medium
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.	East Rockhill Township, Hulmeville Borough, Langhorne Borough, Lower Southampton Township, New Britain Borough, New Britain	Education and Awareness	All	Municipalities, American Red Cross	Continuously for next 5 years.	Staff time	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
Methods include public outreach and education by website, mailings, workshops, media coverage, newsletter, Twitter and Facebook.	Township, New Hope Borough, Plumstead Township, Richlandtown Borough, Sellersville Borough, Silverdale Borough, Tinicum Township, Trumbauersville Borough, Warrington Township						
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	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

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
	Township, Solebury Township, Springfield Township, Tinicum Township, West Rockhill Township						
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, 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 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
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
Action 3.A.7 Provide staff and public education on radon dangers and mitigation requirements.	Chalfont Borough	Education and Awareness	Radon Exposure	Building Code Official	0-1 Years	General Fund $500	Low
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 HMPT to discuss issues and progress related to	Municipal Representatives, Bucks County Planning Commission, Bucks	Local Plans and Regulations	All	Bucks County Planning Commission, Bucks County Emergency	Continuously for next 5 years.	Staff time	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
the implementation of the plan.	County Emergency Management Agency			Management Agency			
Action 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.	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
Action 3.B.3 Train emergency personnel in a basic understanding of railroads and their dangers.	SEPTA	Education and Awareness/ Local Plans and Regulations	Transportation Accidents	SEPTA Chief Engineer	Continuously for next 5 years.	Staff time, $65 per person	Medium
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	New Britain Township, Silverdale Borough, Upper Southampton Township	Local Plans and Regulations	All	Municipalities, Bucks County Planning Commission,	Continuously for next 5 years.	Staff time	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
planning among partner organizations.				Bucks County Emergency Management Agency			
Action 3.C.2 Evaluate effectiveness of the pandemic protocol implementation and restocking of pandemic response kits.	Hilltown Township	Local Plans and Regulations	Pandemic	Township manager and Emergency Management Coordinator	0-1 years	$5,000	Medium
Objective 3. D: Consider opportunities to support employers, employees, residents, and visitors increasing remote work capabilities.							
Action 3.D.1 Work to provide access to the internet across the County and make sure there are enough cell towers to service the entire County.	Bucks County, All Municipalities	Structure and Infrastructure	All Hazards	Bucks County	Continuously for the next 5 years	TBD	Medium
Action 3.D.2 Create telework plans.	All Municipalities	Plans and Regulations	Pandemic	Bucks County	0-1 years	TBD	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
Action 3.D.3 Implement increased communications and accessibility for residents to the local government.	Bedminster Township	Education and Awareness	Pandemic	Township Manager	4-5 Years	General Fund, Local Government Under $10,000	Low
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	Continuously for next 5 years.	CIP, DEP	Medium

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
				Associations, Private property owners			
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
Action 4.A.4 Restore native plants and wetlands to the watershed to address flooding issues.	Upper Makefield Township	Natural Systems Protection	Flood	Deputy Emergency Management Coordinator	4-5 years	PA Dept. of Natural Resources, BRIC, local funding	Medium
GOAL 5 – IMPLEMENT STRUCTURAL PROJECTS TO REDUCE THE IMPACTS OF HAZARDS.							
Objective 5.A: Address the risks posed by the potential failure of High Hazard Potential Dams within the county.							

Table 6.4-1 List of 2021 Mitigation Actions

ACTION DESCRIPTION	COMMUNITY/ ORGANIZATION	CATEGORY	HAZARD	LEAD AGENCY/ DEPARTMENT	IMPLEMENTATION SCHEDULE	FUNDING SOURCE AND NOTES	PRIORITY
Action 5.A.1 Identify and make any and all repairs to existing class A-1 and B-1 dams in the County.	Bucks County	Structure and Infrastructure	Dam Failure	Public Works Director/ Deputy Manager	Within 5 years	HHPD	High
Action 5.A.2 Provide notice of funding opportunity and supporting documentation from the county HMP to EMCs of municipalities with High Hazard Potential Dams to promote rehabilitation and safety in Bucks County. Examples included on pg. 465.	Bucks County	Structure and Infrastructure	Dam Failure	Emergency Management	Within 5 years	HHPD	High

At least one mitigation action was established for each hazard in Bucks County. More than one action is identified for several hazards. Every participating jurisdiction has at least one mitigation action.

Many of these mitigation actions will require substantial time commitments from staff at the County and local municipalities. While all these activities will be pursued over the next five years, the reality of limited time and resources requires the identification of the feasibility and priority level of mitigation actions. Prioritization allows the individuals and organizations involved to focus their energies and ensure progress on mitigation activities.

Evaluating mitigation actions involves judging each action against certain criteria to determine its feasibility and potential impact. Actions evaluated and prioritized by applying the Multi-Objective Mitigation Action Prioritization criteria. For each action, scores were assigned to each criterion using the following weighted, 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, 2, or 3 were assigned for each multi-objective mitigation action prioritization criterion where 1 is a low score and 3 is a high score. The Efficiency criterion, which considers the cost and effort of each action versus its overall vulnerability reduction benefit, is the most highly weighted criterion as part of the total prioritization score. Actions were prioritized using the cumulative score assigned to each. Each mitigation action was then given a priority ranking (Low, Medium, and High) based on the following:

- Low Priority: 1.0 – 1.8
- Medium Priority: 1.9 – 2.4
- High Priority: 2.5 – 3.0

Table 6.4-2 presents the cumulative results of the prioritization of mitigation actions. 30 actions were ranked High Priority, 47 are ranked Medium Priority, with the remaining 114 ranked as Low Priority.

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	Continue identifying protection measures to operate critical facilities. 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	Continue identifying protection measures to operate businesses and protect residences. Proceed with grant applications for infrastructure that protects community from 1% annual chance floodplain.	3	3	2	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
1.A.4	Evaluate, implement, and perform mitigation projects identified in this and other planning mechanisms, including acquisition, elevation, mitigation reconstruction, foundation and building stabilization, securing access to generator power and other mitigation methods.	3	2	3	3	3	2.7
1.A.5	Township will replace 5 existing culverts on Top Rock Trail to mitigate flooding impacts of existing substandard drainage conditions in this area of the Township. This is part of an on-going effort to improve roadside drainage throughout the Township.	23	22	33	33	13	2.8
1.A.6	Clean out all street drains, repair and/or replace culverts and drain grates.	2	2	3	3	1	2.2
1.A.7	Install storm sewer along a section of Peppermint Road to address an ongoing flooding issue that impacts neighboring downstream properties.	1	2	2	3	3	2.1
1.A.8	Elevate existing homes in the floodplain to limit damage during future flood events	2	3	2	3	3	2.6

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.9	Repair culvert and swales on Lonely Road.	2	2	3	3	3	2.3
1.A.10	Replace culvert on Tabor Road	2	2	3	3	3	2.3
1.A.11	Repair/improve Modla/Park drainage swale.	1	2	2	3	3	2.1
1.A.12	Improving stormwater management in floodplain by jet cleaning storm drains and installing backflow preventers. Secondly, Yardley Borough will pursue the installation of additional storm drains and pipes to an area without.	3	2	2	3	3	2.5
1.A.13	Continue elevating flood prone structures.	1	2	2	3	3	2.1
1.A.14	Increasing open space cache in floodplain.	1	2	2	3	3	2.1
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

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.C.3	Provide a comprehensive update to the database that records floodplain properties and elevation certificates.	3	3	2	3	3	2.8
1.C.4	Pre-populating FEMA's Substantial Damage Estimator Tool.	1	2	1	3	2	1.75
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
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

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.3	Add additional water main on North Main Street to provide additional water service for residents and especially for fire fighting activity.	3	3	3	3	3	3
1.E.4	Complete interconnection of an existing public water system with facilities owned by North Wales Water Authority to ensure redundancy of supply in the Township's water system	3	2	2	3	3	2.5
1.E.5	Replace aging sewage pump station to reduce outages and prevent storm damage.	2	2	1	3	2	1.95
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

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.G.1	Utilize available county GIS Resources for municipal hazard related planning and outreach.	2	2	3	3	2	2.35
1.G.2	Review and update countywide datasets and coordinate with municipalities during this update. Identify method for distributing updated data.	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	Replace the deck of an existing bridge on Schultz Road that is structurally deficient to ensure that the transportation system of the Township is not adversely impacted if the bridge must be closed to traffic.	3	2	1	2	2	2
1.H.3	Implement signal improvements at intersections that frequently experience traffic accidents.	3	2	1	2	1	1.85
1.H.4	Bridge replacement project on Rosenberger Rd spanning the Molasses Creek due to structural failure.	3	3	2	3	2	2.6

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.H.5	Traffic calming on Main Street and Barringer Avenue.	1	3	1	2	3	2.05
1.H.6	Bridge replacement or rehab on Headquarters Rd spanning the Tinicum Creek due to structural failure.	3	3	2	2	3	2.6
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
2.A.2	Integrate evaluation of snow-removal and emergency access logistics with new development planning.	2	3	2	3	3	2.6
2.A.3	Update local zoning ordinances	2	2	3	3	2	2.35
2.A.4	Consider extra permitting requirements for mines and pipelines in areas with carbonate rock.	2	2	2	2	3	2.15
2.B.1	Evaluate adequacy of township/borough building code implementation.	2	2	3	3	1	2.2

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
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	Reach out to municipalities annually and ask them to advise on any changes in their local ordinances.	2	2	3	3	2	2.35
2.D.1	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, and 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.2	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.3	Continue coordination and planning to mitigate, prepare, and respond to local hazardous materials facilities.	3	2	3	3	3	2.7
2.D.4	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.5	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

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.6	*Work with Township Public Works, Police, and local Fire Police to evaluate and develop evacuation plan/routes.*	2	2	1	3	2	2
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
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

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.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.A.7	Provide staff and public education on radon dangers and mitigation requirements.	1	2	1	1	2	1.45
3.B.1	Convene regular meetings of a restructured HMPT 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

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.B.3	Train emergency personnel in a basic understanding of railroads and their dangers.	2	2	3	3	2	2.35
3.C.1	Renew and expand commitments to hazard mitigation planning among partner organizations.	2	2	3	3	2	2.35
3.C.2	Evaluate effectiveness of the pandemic protocol implementation and restocking of pandemic response kits.	3	2	1	2	2	2
3.D.1	Work to provide access to the internet across the County and make sure there are enough cell towers to service the entire County.	2	2	3	3	1	2.2
3.D.2	Create telework plans.	3	3	1	1	2	2.15
3.D.3	Implement increased communications and accessibility for residents to the local government.	2	2	1	2	1	1.65
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
4.A.4	Restore native plants and wetlands to the watershed to address flooding issues.	3	3	2	2	1	2.2
5.A.1	Identify and make any and all repairs to existing class A-1 and B-1 dams, as well as any other dams in the County that may be applicable.	3	3	2	3	2	2.6

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
5.A.2	Provide notice of funding opportunity and supporting documentation from the county HMP to EMCs of municipalities with HHPDs to promote rehabilitation and safety in Bucks County. • Identify mitigation actions to reduce vulnerabilities to/from eligible HHPDs, such as proposing, enacting or delegating authority for local land use regulations, ordinances and/or construction standards to protect life and property from HHPDs. • Work with HHPD owners to integrate EAPs or a dam incident annex into emergency operations plans. • Delegate authority to local governments to adopt and enforce restrictive zoning and land use ordinances in designated inundation areas. • Acquire and/or elevate structures both up and downstream of HHPDs.	3	3	2	3	2	2.6

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. This HMP's plan maintenance also defines the municipalities' role in updating and evaluating the plan. Finally, the 2021 HMP covers how this plan may be integrated into other planning mechanisms in the County. These changes were reviewed at the Final Public Meeting were the HMSC 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 HMSC established for the 2021 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 HMPT in all associated plan maintenance requirements, including annual reviews. The HMSC 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 partner agencies. The HMSC will oversee the progress made on the implementation of action items identified in the 2021 HMP and modify actions, as needed, to reflect changing conditions. The HMSC will meet annually on or around the anniversary of plan adoption to discuss specific coordination efforts that may be needed with other partner agencies. Should a significant disaster occur within the County, the HMSC 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 HMSC to provide updates on applicable mitigation actions and feedback on changing hazard vulnerabilities within their community.

Upon each HMP evaluation, the HMSC 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 HMSC 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 integrate the 2021 HMP into them.

The 2021 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 2021 HMP, the HMSC 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 ((http://www.buckscounty.gov). Also, several municipalities signed up for public outreach related mitigation actions. The HMSC will incorporate all relevant comments during the next update of the HMP.

8. Plan Adoption

This section will be filled out after receiving Approvable Pending Adoption status, provided by FEMA Region 3.

This plan has been reviewed by the Steering Committee, the Planning Team, the general public and the State. Once the plan is approved pending adoption by FEMA each community that participated should adopt the plan. After the first community adopts, FEMA will issue a formal approval.

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 2021 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 2021 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 2021 Hazard Mitigation Plan, and

WHEREAS, the Bucks County 2021 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 2021 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 2021 Hazard Mitigation Plan are hereby directed to implement the recommended activities assigned to them.

ADOPTED, this _____ day of _____, 2021

ATTEST: BUCKS COUNTY COMMISSIONERS

_____ By _____

By _____

By _____

Bucks County 2021 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 2021 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 2021 Hazard Mitigation Plan, and

WHEREAS, the Bucks County 2021 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 2021 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 2021 Hazard Mitigation Plan are hereby directed to implement the recommended activities assigned to them.

ADOPTED, this _____ day of _____, 2021

ATTEST: *<BOROUGH/TOWNSHIP OF MUNICIPALITY NAME>*

_____ By _____

By _____