4.1 METHODOLOGY AND TOOLS

This section describes the methodology and tools used to support the risk assessment process.

4.1.1 Methodology

The risk assessment process used for this HMP update is consistent with the process and steps presented in the Federal Emergency Management Agency (FEMA) 386-2, State and Local Mitigation Planning How-to-Guide, Understanding Your Risks – Identifying Hazards and Estimating Losses (FEMA 2001). This process identifies and profiles the hazards of concern and assesses the vulnerability of assets (population, structures, critical facilities, and the economy) at risk in the community. A risk assessment provides the foundation for the community's decision makers to evaluate mitigation measures that can help reduce the impacts of a hazard when one occurs (mitigation measures are described in Section 6). The risk assessment process consists of the following steps:

Step 1: The first step of the risk assessment process is to identify the hazards of concern. FEMA's current regulations only require an evaluation of natural hazards. Natural hazards are natural events that threaten lives, property, and other assets. Natural hazards often can be predicted to reoccur the same geographical locations because they are related to weather patterns or physical characteristics of an area.

Step 2: The next step of the risk assessment is to prepare a profile for each hazard of concern. These profiles assist communities in evaluating and comparing the hazards that can impact their area. Each type of hazard has unique characteristics that vary from event to event. That is, the impacts associated with a specific hazard can vary depending on the magnitude and location of each event (a hazard event is a specific, uninterrupted occurrence of a particular type of hazard). Further, the probability of occurrence of a hazard in a given location impacts the priority assigned to that hazard. Finally, each hazard will impact different communities in different ways based on geography, local development, population distribution, age of buildings, and mitigation measures already implemented.

Steps 3 and 4: To understand risk, a community must evaluate its assets (Step 3) and determine which assets are exposed or vulnerable to the identified hazards of concern (Step 4). Hazard profile information—combined with data regarding population, demographics, general building stock, and critical facilities at risk—prepares the community to develop risk scenarios and estimate potential damages and losses for each hazard. Critical facilities in Pike County are presented in Section 2.6 of this HMP.

4.1.2 Tools

To address the DMA 2000 requirements and better understand potential vulnerability and losses associated with hazards of concern, Pike County used standardized tools combined with local, state, and federal data and expertise to conduct the risk assessment. Tools used by Pike County to support the risk assessment are described in the sections below.

Hazards U.S. – Multi-Hazard (HAZUS-MH)

In 1997, FEMA developed a standardized model for estimating losses caused by earthquakes known as Hazards U.S. (HAZUS). HAZUS was developed in response to the need for more effective national-, state-, and community-level planning and the need to identify areas that face the highest risk and potential for loss. HAZUS was expanded into a multi-hazard methodology (HAZUS-MH) with new models for estimating potential losses from wind (hurricanes) and flood (riverine and coastal) hazards. HAZUS-MH is a geographic information system (GIS)-based software tool that applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide defensible damage and loss estimates. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

HAZUS-MH uses GIS technology to produce detailed maps and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems, and utilities. To generate this information, HAZUS-MH has default data for inventory, vulnerability, and hazards. These default data can be supplemented with local data to provide a more refined analysis. Damage reports can include induced damage (such as inundation, fire, and threats posed by hazardous materials and debris) and direct economic and social losses (such as casualties, shelter requirements, and economic impact) depending on the hazard and available local data. HAZUS-MH's open data architecture can be used to manage community GIS data in a central location. The use of this software also promotes consistency of current and future data output, and standardization of data collection and storage. The guidance "Using HAZUS-MH for Risk Assessment: How-to Guide" (FEMA 433) was relied upon to support the application of HAZUS-MH for this risk assessment and plan (FEMA 2015). More information on HAZUS-MH is available at https://www.fema.gov/hazus .

In general, probabilistic analyses were performed to develop estimates of long-term average losses (annualized losses) for the earthquake and hurricane/tropical storm/Nor'Easter hazards, as well as an expected or estimated distribution of losses (mean return period losses) for the earthquake; flood, flash flood, and ice jam; and hurricane/tropical storm/Nor'Easter hazards. The probabilistic hazard analyses generate estimates of damage and loss for specified return periods. For annualized losses, HAZUS-MH 3.1 calculates the maximum potential annual dollar loss resulting from various return periods averaged on a per-year basis. The analysis consists of the summation of all HAZUS-supplied return periods (e.g., 10, 50, 100, 200, 500) multiplied by the return period probability (as a weighted calculation). In summary, the estimated cost of a hazard (earthquake, flood, and wind hazards) each year is calculated.

The following custom methodologies in HAZUS-MH 3.1 (HAZUS-MH) were used to assess potential exposure and losses associated with hazards of concern for Pike County:

- Inventory: The default demographic data in HAZUS-MH 3.1, based on the 2010 U.S. Census, were used for the potential loss analysis (such as for sheltering and injuries) for each hazard model.

  The default building inventory in HAZUS-MH 3.1 was used for Pike County. The occupancy classes available in HAZUS-MH 3.1 were condensed into categories (residential, commercial, industrial, agricultural, religious, government, and educational) to facilitate the analysis and the presentation of results. Residential loss estimates address both multi-family and single-family dwellings. Building replacement cost values are based upon 2015 RS Means Company, Inc. (RS Means) valuations. Both layers were merged and used to calculate the exposure for each hazard.

  An updated critical facility inventory was also developed and incorporated into HAZUS-MH, replacing the default essential facility (police, fire, schools, etc.), transportation facility, and utility inventories for the earthquake, flood, and wind hazard models. This comprehensive inventory was developed by gathering input from Pike County Office of Community Planning, participating municipalities, and the Steering Committee.

  The "user-defined facilities" category includes all assets that Pike County deemed critical to include in the inventory and that do not fit within a pre-defined HAZUS-MH facility category. These facilities include County buildings, senior care facilities, and municipality-owned buildings.

  HAZUS-MH 3.1 incorporates two types of census block-based data, homogenous and dasymetric. Homogenous census blocks display the full extent of each block, while the dasymetric census blocks have had homogenous undeveloped areas (bodies of area, forests, etc.) removed. The dasymetric blocks were developed to provide more accurate loss estimates by excluding uninhabited and undeveloped areas of a census block.

- Earthquake: A probabilistic assessment was conducted for Pike County for the 100-, 500- and 2,500-year mean return periods (MRP) in HAZUS-MH 3.1 to analyze the earthquake hazard and provide a range of loss estimates for Pike County. Default demographic and building stock data from HAZUS-MH 3.1 and updated critical facility inventories were used for the analysis. The probabilistic method uses information from historic earthquakes and inferred faults, locations, and magnitudes and computes the probable ground-shaking levels that may be experienced during a recurrence period by Census tract.

  As noted in the HAZUS-MH Earthquake User Manual, "*Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning earthquakes and their effects upon buildings and facilities. They also result from the approximations and simplifications that are necessary for comprehensive analyses. Incomplete or inaccurate inventories of the built environment, demographics and economic parameters add to the uncertainty. These factors can result in a range of uncertainly in loss estimates produced by the HAZUS Earthquake Model, possibly at best a factor of two or more*" (FEMA 2015f). However, HAZUS' potential loss estimates are acceptable for the purposes of this HMP.

  Ground shaking is the primary cause of earthquake damage to manmade structures and soft soils amplify ground shaking. One contributor to the site amplification is the velocity at which the rock or soil transmits shear waves (S-waves). The National Earthquake Hazard Reduction Program (NEHRP) developed five soil classifications that impact the severity of an earthquake, ranging from A to E. Soil classified as A represents hard rock that reduces ground motions from an earthquake, and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses. NEHRP soil classifications were not available for Pike County at the time of this analysis. Soils were estimated as NEHRP soil Type D across Pike County as a conservative approach to this risk assessment. Groundwater was set at a depth of 5 feet (default setting). Damages and losses due to liquefaction, landslide, or surface fault rupture were not included in this analysis.

- Flood, Flash Flood, and Ice Jam: The FEMA Digital Flood Insurance Rate Map (DFIRM) dated October 2000 was used to evaluate exposure for the 1- and 0.2-percent annual chance flood events, and determine potential future losses for the 1-percent annual chance event in Pike County. These flood events are generally considered by planners and evaluated under federal programs such as the National Flood Insurance Program (NFIP). HAZUS-MH 3.1 was used to develop the depth grid for the 1-percent annual chance flood depth grid using the FEMA DFIRM data and the 1/3 Arc Second elevation model from U.S. Geological Survey (USGS). The depth grid was integrated into HAZUS-MH 3.1 and the model was run to estimate potential losses using the dasymetric census blocks.

- Hurricane/Tropical Storm/Nor'Easter: After reviewing historic data, a HAZUS-MH 3.1 probabilistic analysis was performed for the 100- and 500-year MRP events to analyze the wind hazard losses for Pike County. The probabilistic hurricane hazard contains data on historic hurricane events and wind speeds; the model activates a database of thousands of potential storms with tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886, and then identifies those storms with tracks associated with the County. It also includes surface roughness and vegetation (tree coverage) maps for the County. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Default demographic and building stock data (homogenous census block) from HAZUS-MH 3.1 and updated critical facility inventories were used for the analysis.

ESRI ArcGIS

For the following hazards, ArcGIS was used to assess potential exposure for hazards of concern with delineated hazard areas in Pike County. The defined hazard areas were overlaid upon the asset data (population, building stock, critical facilities) to estimate the exposure to each hazard. The limitations of these analyses are recognized, and as such the analyses are only used to provide a general estimate:

- <u>Environmental Hazards:</u> Federal SARA, the Emergency Planning and Community Right to Know Act, and the Commonwealth of Pennsylvania set up requirements for producing, storing, and transporting hazardous materials. These hazardous materials are susceptible to spilling at the facilities or during transit. The Pennsylvania Department of Transportation State Roads layer (2011) was used to define the hazard area around major roadways. The hazard area was defined as a ¼ mile buffer around the Interstate, State, and US roadways. Additionally, SARA II facilities were provided by the County, along with specified vulnerability radii for each facility. These in conjunction with the ¼ roadway buffer were used to estimate the exposure to the asset data.

- <u>Landslide</u>: The Geology — Landslide Incidence and Susceptibility geographic information system (GIS) layer from the National Atlas was used to coarsely define the general landslide susceptible area. Available information and a preliminary assessment are provided below.

  According to Radbruch-Hall and others, the Landslide Incidence and Susceptibility GIS layer from National Atlas:

  > "….was prepared by evaluating formations or groups of formations shown on the geologic map of the United States (King and Beikman 1974) and classifying them as having high, medium, or low landslide incidence (number of landslides) and being of high, medium, or low susceptibility to landsliding. Thus, those map units or parts of units with more than 15 percent of their area involved in landsliding were classified as having high incidence; those with 1.5 to 15 percent of their area involved in landsliding, as having medium incidence; and those with less than 1.5 percent of their area involved, as having low incidence. This classification scheme was modified where particular lithofacies are known to have variable landslide incidence or susceptibility. In continental glaciated areas, additional data were used to identify surficial deposits that are susceptible to slope movement. Susceptibility to landsliding was defined as the probable degree of response of the areal rocks and soils to natural or artificial cutting or loading of slopes or to anomalously high precipitation. High, medium, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. For example, it was estimated that a rock or soil unit characterized by high landslide susceptibility would respond to widespread artificial cutting by some movement in 15 percent or more of the affected area. We did not evaluate the effect of earthquakes on slope stability, although many catastrophic landslides have been generated by ground shaking during earthquakes. Areas susceptible to ground failure under static conditions would probably also be susceptible to failure during earthquakes" (Radbruch-Hall 1982).

- <u>Nuclear Incident</u>: Populations, building stock, and critical facilities within the Plume Exposure Pathway Emergency Planning Zone (EPZ), which is a 10 mile radius around the facility, or the Ingestion Exposure Pathway EPZ, which is a 50 mile radius around the facility, of a nuclear power plant are susceptible to a nuclear incident. Pike County is located within the Ingestion Exposure Pathway EPZs of the Susquehanna Steam Electric Station located in Luzerne County, PA and the Indian Point Power Plant in Buchanan, NY. The 50 mile EPZs were used to define the hazard area for a nuclear incident.

- Wildfire: The wildfire urban interface, known as WUI, obtained through the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison was used to define the wildfire hazard areas. The University of Wisconsin-Madison wildland fire hazard areas are based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database. For the purposes of this risk assessment, the high-, medium- and low-density interface areas were combined and used as the 'interface' hazard area and the high-, medium- and low-density intermix areas were combined and used as the 'intermix' hazard areas. The defined hazard area was overlaid upon the asset data (population, building stock, critical facilities) to estimate the exposure to each hazard.

For many of the hazards evaluated in this risk assessment, historic data are not adequate to model future losses at this time. For these hazards of concern, areas and inventory susceptible to specific hazards were mapped and exposure was evaluated to help guide mitigation efforts (mitigation efforts are discussed further in Section 6). Where GIS data are not available for some hazards, a qualitative analysis was conducted using the best available data and professional judgment.

For this risk assessment, the loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

1) Approximations and simplifications necessary to conduct such a study
2) Incomplete or dated inventory, demographic, or economic parameter data
3) The unique nature, geographic extent, and severity of each hazard
4) Mitigation measures already employed by the participating municipalities and the amount of advance notice residents have to prepare for a specific hazard event

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of 2 or more. Therefore, potential exposure and loss estimates are approximate. These results do not predict precise results and should be used to understand relative risk. Over the long term, Pike County will collect additional data to assist in developing refined estimates of vulnerabilities to natural and non-natural hazards.