

Table 4.3.9-4 Estimated jurisdictional losses due to landslides.		
COUNTY	NUMBER OF IMPACTED BUILDINGS	DOLLAR VALUE OF EXPOSURE, BUILDING AND CONTENTS (THOUSANDS \$)
Somerset	76,466	\$15,327,784
Susquehanna	2,188	\$432,042
Union	52,167	\$11,273,059
Washington	143,661	\$34,783,249
Wayne	16,325	\$3,447,079
Westmoreland	265,845	\$61,884,497
York	5,998	\$1,344,791
TOTAL	3,291,555	\$746,357,246

4.3.9.9. State Facility Loss Estimation

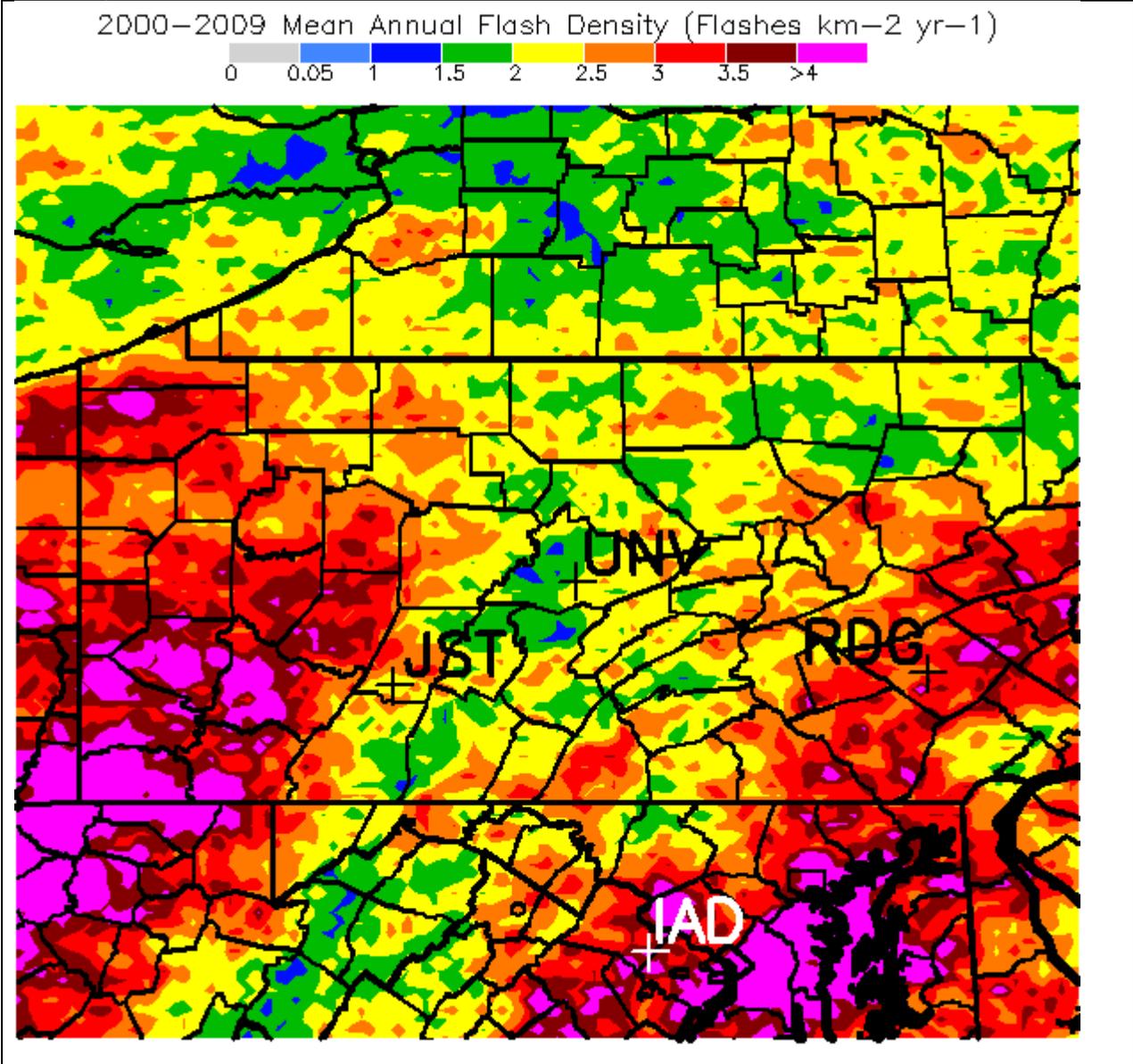
The specific state facility losses will depend on the slope and soil type a given facility is constructed on. For example, facilities located on steep slopes or built on loose soils are more likely to experience landslides of the land beneath them. Additionally, facilities located in valleys are more likely to be buried as a result of debris flow from higher slopes. In total, though, the estimated replacement cost of all State Critical Facilities located in landslide combo-high hazard zones with available replacement values is \$24,789,223,523.

4.3.10. Lightning Strike

4.3.10.1. 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. Figure 4.3.10-1 below shows the average annual lightning flash density for 2000-2009 from the Cooperative for Applied Meteorological Studies (2013). This image indicates that relatively more lightning flashes occur in southwestern Pennsylvania and in the Lehigh Valley. 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. While the most lightning flashes occur in southwestern Pennsylvania, eastern and southeastern Pennsylvania is at greater risk for death, injury, or damage to lightning than central and north-central sections of the Commonwealth due to higher population density.

Figure 4.3.10-1 Mean annual flash density, 2000-2009 (Cooperative for Applied Meteorological Studies, 2013)



4.3.10.2. *Range of Magnitude*

Each year, lightning is responsible for the deaths of a hundred or so people, injuries to several hundred more, and millions of dollars in property damage, in the United States. Many case histories show heart damage. Inflated lungs and brain damage have also been observed from lightning fatalities. 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.

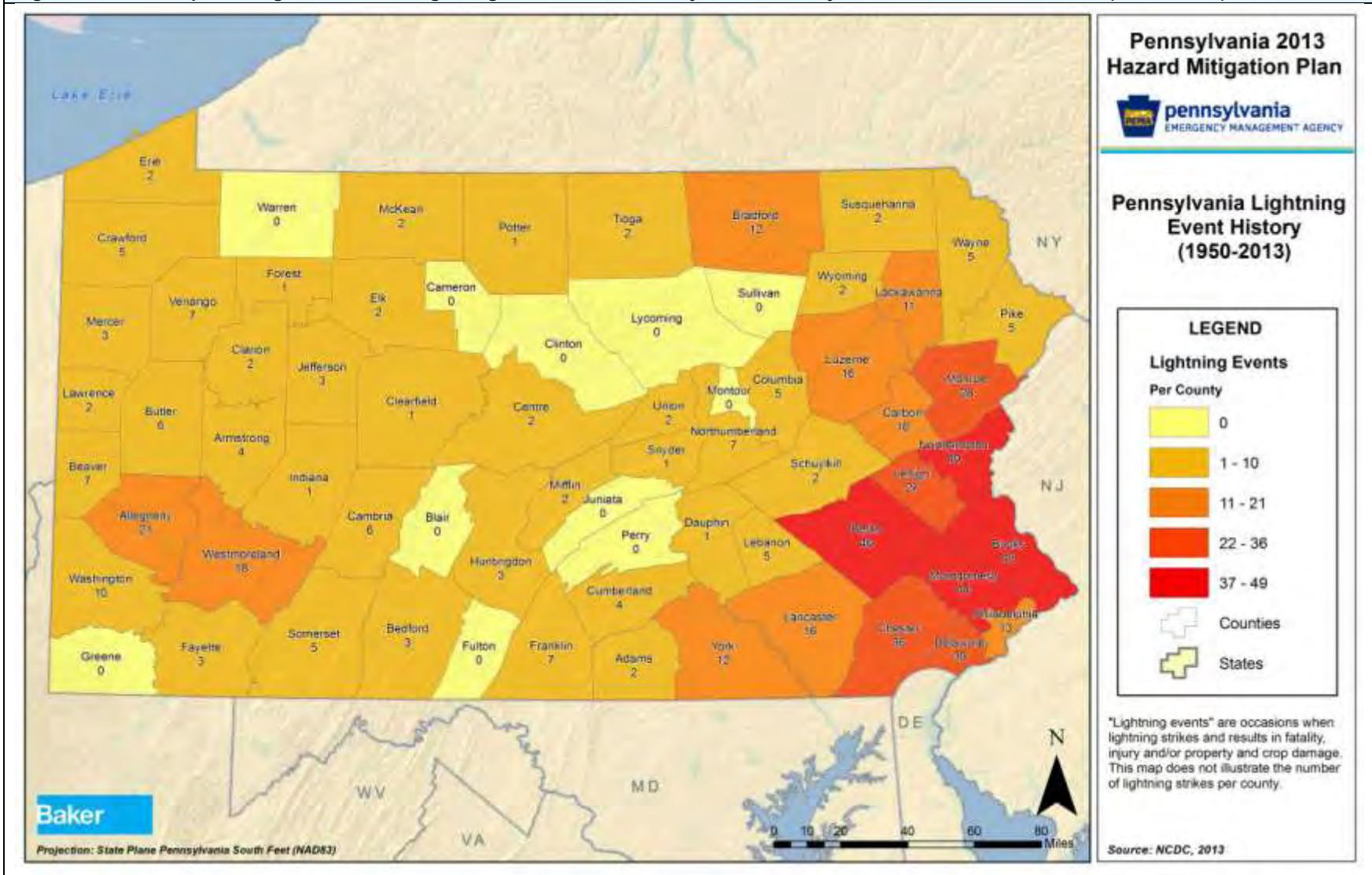
Between 1959 and 1994, Pennsylvania ranked third among all states in the U.S. with 644 casualties (i.e. combination of deaths and injuries). This represents approximately 5% of casualties which occurred throughout the U.S over that 35-year period. Pennsylvania ranked first among all states in the U.S. with 1,441 damage reports. However, it is unclear what the total dollar value is for these damages (NOAA NWS, 1997).

The worst-case event lightning event would be a strike in a large crowd or gathering of people as might be found at a large sporting event or outdoor concert. This could result in mass deaths or injuries.

4.3.10.3. *Past Occurrence*

Records from the National Climatic Data Center show that there were 579 lightning events in the 67 counties across Pennsylvania between 1950 and 2013. A lightning “event” is defined as a lightning strike which results in fatality, injury, and/or property or crop damage (NCDC, 2010). Forty-three of sixty-seven counties in Pennsylvania have reported five or fewer events, fifteen counties reported six to 20 events, and nine counties have reported more than twenty events over this 63 year period. Northampton and Berks County have both reported the most events with 49 each in the reporting period (see Figure 4.3.10-2). Additionally, according to the National Weather Service Lightning Safety Program, Pennsylvania has averaged one lightning fatality per year from 2006-2012. Evaluation of previous versions of the SSAHMP show that while the absolute number of events have changed for individual counties, the basic pattern of vulnerability across the Commonwealth has remained relatively consistent. The recordation of lightning events is highly subjective and therefore lightning vulnerability is clearly epistemic.

Figure 4.3.10-2 Map showing the number of lightning events in each county across Pennsylvania between 1950 and 2013 (NCDC, 2010).



4.3.10.4. Future Occurrence

Figure 4.3.10-1 showed the frequency of lightning flashes in Pennsylvania between 2000 and 2009. While the map should not be used to predict future lightning activity, it provides a basic estimate of the number of lightning flashes that can be expected per square kilometer per year. In Pennsylvania, these values range from 1.5 to greater than 4 flashes per km² per year.

It is worth noting that while lightning flashes appear to be more frequent in western Pennsylvania, lightning strike *events* as shown in Figure 4.3.10-2 appear to be more common in southeast Pennsylvania and Allegheny and Westmoreland Counties. This is due to denser populations with an increased number of associated properties or structures in these areas.

4.3.10.5. Environmental Impacts

The environmental impacts most often associated with lightning strikes include damage or death to trees and ignition of wildfires.

4.3.10.6. Jurisdictional Vulnerability Assessment

As stated in Section 4.2.2, jurisdictional and state critical facility vulnerability assessments were completed by spatially overlaying hazards with census tracts and state critical facility layers in GIS. When spatial analysis determined that the hazard would impact a census tracts within a county or the location of state critical facilities these locations were deemed vulnerable to the hazard. Loss estimates were prepared based on the value of the facilities impacted by census tract and by state critical facility. Each hazard uses a methodology that is specific to the type of risk it may cause; Table 4.2.2-2 includes a complete methodology description for vulnerability assessments and loss estimates for each hazard.

In the case of lightning strikes, population and building density has a correlation with hazard vulnerability and loss. In particular, the urban and suburban areas around Philadelphia have higher population and structure density as well as taller buildings that can act as lightning rods; therefore, they naturally have experienced greater vulnerability and loss during past lightning events. Additionally, those counties experiencing more than 20 lightning events over the NCDC reporting period are considered vulnerable to lightning events: Allegheny, Berks, Bucks, Chester, Delaware, Lehigh, Monroe, Montgomery, and Northampton Counties. These counties also have some large tracts of forested land that would be prone to a lightning-ignited wildfire event.

Twelve of the 67 counties identify lightning strikes as a hazard, as seen Table 4.3.10-1. As stated in Section 4.1, the decision by a county to profile a hazard is one indicator of the presence of risk from that hazard. This indicator should be viewed complementary to other analysis in this section. Together this analysis from reputable sources addresses different aspects of risk for a full risk profile.

All counties currently profiling lightning strike have a calculated risk factor values. The average RF is 1.8; this average does not include Lebanon, Montour, Perry, and Philadelphia, who use an alternate Risk Factor/Ranking system. The State Risk Factor for Lightning Strikes is 2.2, while

the Pennsylvania THIRA scored lightning a 6 out of 10. For more details on the State Risk Factor and THIRA rankings, please see Section 4.1.

Table 4.3.10-1 Counties profiling lightning strike hazards with hazard ranking and risk factor (if available).

COUNTY	PROFILED HAZARD	DID NOT PROFILE HAZARD	RANKING (IF AVAILABLE)	RISK FACTOR (IF AVAILABLE)
Adams		X		
Allegheny		X		
Armstrong		X		
Beaver		X		
Bedford	X		Low	1.5
Berks		X		
Blair		X		
Bradford		X		
Bucks	X		Medium	2.0
Butler		X		
Cambria	X		Low	1.5
Cameron		X		
Carbon		X		
Centre	X		Low	1.3
Chester		X		
Clarion		X		
Clearfield		X		
Clinton		X		
Columbia		X		
Crawford	X		Medium	2.4
Cumberland		X		
Dauphin		X		
Delaware		X		
Elk		X		
Erie		X		
Fayette	X		Low	1.8
Forest		X		
Franklin		X		
Fulton		X		
Greene		X		
Huntingdon		X		

Table 4.3.10-1 Counties profiling lightning strike hazards with hazard ranking and risk factor (if available).				
COUNTY	PROFILED HAZARD	DID NOT PROFILE HAZARD	RANKING (IF AVAILABLE)	RISK FACTOR (IF AVAILABLE)
Indiana		X		
Jefferson		X		
Juniata		X		
Lackawanna		X		
Lancaster		X		
Lawrence	X		Low	1.9
Lebanon*		X		
Lehigh	X		Medium	2.0
Luzerne		X		
Lycoming		X		
McKean		X		
Mercer		X		
Mifflin		X		
Monroe		X		
Montgomery	X		Medium	2.1
Montour*		X		
Northampton	X		Medium	2.0
Northumberland		X		
Perry*		X		
Philadelphia**		X		
Pike		X		
Potter		X		
Schuylkill		X		
Snyder		X		
Somerset		X		
Sullivan		X		
Susquehanna	X		Low	1.4
Tioga		X		
Union		X		
Venango		X		
Warren	X		Low	1.6
Washington		X		
Wayne		X		

Table 4.3.10-1 Counties profiling lightning strike hazards with hazard ranking and risk factor (if available).

COUNTY	PROFILED HAZARD	DID NOT PROFILE HAZARD	RANKING (IF AVAILABLE)	RISK FACTOR (IF AVAILABLE)
Westmoreland		X		
Wyoming		X		
York	X		Medium	2.4

* Lebanon, Montour, and Perry use an alternate weighted ranking where Risk Factor = Frequency x [(0.25 x Critical facilities) + (0.40 x Social) + (0.25 x Economic) + (0.10 x Environmental)]. While this risk factor was used to comparatively rank hazards, the number does not correspond to a high-medium-low rating.

**Philadelphia uses an A, B, C rating system where A is high, B is medium, and C is low.

The fourteen counties vulnerable to lightning strike hazards host 1,631 state critical facilities, as seen in Table 4.3.10-2. Of the vulnerable counties, Allegheny has the most critical facilities, followed by Montgomery County.

Table 4.3.10-2 State critical facilities vulnerable to lightning strikes by county.

COUNTY	NUMBER OF CRITICAL FACILITIES	COUNTY	NUMBER OF CRITICAL FACILITIES
Allegheny	703	Fayette	1
Beaver	1	Lehigh	77
Berks	147	Monroe	32
Bucks	124	Montgomery	199
Butler	1	Northampton	82
Chester	122	Philadelphia	1
Delaware	139	Westmoreland	2

4.3.10.7. State Facility Vulnerability Assessment

State critical facilities that are vulnerable to lightning strikes have historically been isolated to southeastern Pennsylvania, but for this analysis the vulnerability measure is any state critical facility located in the nine aforementioned most vulnerable counties. The precise vulnerability of lightning strikes will depend on a facility’s height vis-à-vis surrounding buildings as well as the absence or presence of a lightning rod or other lightning channeling technology in the structure. As expected, the categories of facility most vulnerable to lightning strikes include fire departments, schools, and police departments (Table 4.3.10-3). Any of the 22 food and agriculture facilities that raise livestock may be more vulnerable to lightning strikes as these animals tend to shelter under trees in storm situations; should lightning strike the tree, it could kill all the animals under it at once. It is important to note that most of the food and agriculture-related critical facilities are privately owned farms that may own sizeable herds of livestock, but the Commonwealth critical facilities list does not indicate which of the twenty two do own herds.

Finally, if the entertainment and recreation facilities are outdoor recreation spaces with wide open spaces, there may be added lightning strike vulnerability.

Table 4.3.10-3 State Critical Facilities vulnerable to lightning by Critical Facility Type	
STATE CRITICAL FACILITY TYPE	NUMBER OF IMPACTED FACILITIES
Agriculture	22
Banking	10
Chemical	3
Commercial Facilities	28
Communications	1
Dams	5
Defense Industrial Base	8
Education	53
Emergency Services	15
Energy	14
Fire Departments (Non-HSIP)	643
Government Facilities	9
Healthcare & Public Health	19
Hospital (Non-HSIP)	79
Nuclear Reactors, Materials & Waste	1
Police (Non-HSIP)	389
Postal & Shipping	5
School (Non-HSIP)	294
Transportation	21
Water	12
TOTAL VULNERABLE CRITICAL FACILITIES	1,631

4.3.10.8. Jurisdictional Loss Estimation

During the years of 1950-2013, the NCDC reports that in Pennsylvania, lightning has caused 28 deaths, 2250 injuries. The highest reported loss in property damage occurred in Braddock Borough, Allegheny County in 1995 when lightning caused \$5 million dollars in damage after striking a deodorizer manufacturing plant. The subsequent fire completely engulfed and destroyed the entire facility.

Using GIS, jurisdictional losses were estimated to total \$827 billion, as shown in Table 4.3.10-4. The total number of buildings that may be impacted by lightning strikes in the twenty-one vulnerable counties is \$2,793,805. The jurisdiction most threatened by lightning strikes in terms of dollar amount of loss is Allegheny County, with \$170 billion in exposed buildings and contents.

Table 4.3.10-4 Estimated jurisdictional losses due to lightning strikes.

COUNTY	NUMBER OF IMPACTED BUILDINGS	DOLLAR VALUE OF EXPOSURE, BUILDING AND CONTENTS (THOUSANDS \$)
Allegheny	666,754	\$170,090,579
Beaver	14,265	\$4,735,685
Berks	214,878	\$56,231,792
Bucks	319,283	\$107,502,439
Butler	10,453	\$3,740,680
Carbon	6,450	\$1,640,614
Chester	256,870	\$88,796,727
Delaware	268,456	\$84,115,326
Lackawanna	3,379	\$700,643
Lancaster	18,105	\$4,944,082
Lebanon	5,582	\$1,592,987
Lehigh	215,706	\$59,301,465
Monroe	113,484	\$28,932,611
Montgomery	439,397	\$149,314,686
Northampton	178,622	\$49,582,595
Philadelphia	18,123	\$5,453,004
Pike	12,180	\$2,775,393
Schuylkill	7,666	\$1,820,286
Washington	1,556	\$302,176
Wayne	3,379	\$700,643
Westmoreland	19,217	\$4,948,641
TOTAL	2,793,805	\$827,223,054

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.

4.3.10.9. State Facility Loss Estimation

The total replacement cost of all state critical facilities located in areas vulnerable to lightning strike is \$10,692,310,083. Note that losses due to lightning strikes will differ based on the magnitude of the event and the lightning protection measures on a given facility.

4.3.11. Pandemic and Infectious Disease

4.3.11.1. 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 extensively epidemic. Generally, pandemic diseases cause sudden, pervasive illness in all age groups on a global scale. Infectious diseases are also highly virulent, but are not spread person-to-person.