



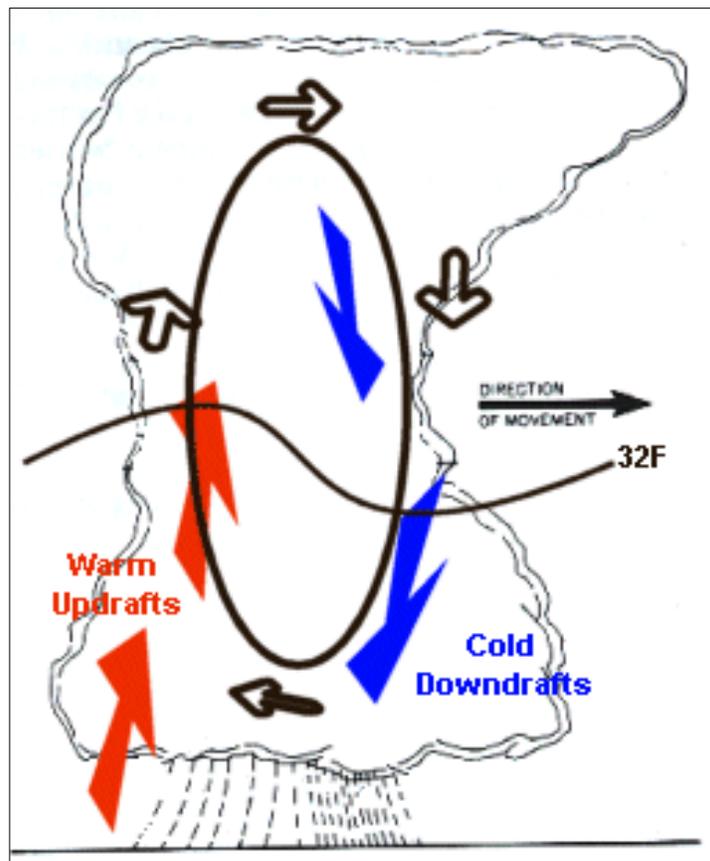
4.3.6 Hailstorm

This section describes the location and extent, range of magnitude, past occurrence, future occurrence, and vulnerability assessment for the hailstorm hazard for Westmoreland County.

A hailstorm is a storm accompanied by hail, which is precipitation in the form of small balls or lumps of clear ice or compact snow (Merriam Webster 2017). Hail forms inside a thunderstorm when strong updrafts of warm air and downdrafts of cold water are present. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32°F or colder. As the frozen droplet begins to fall, it may thaw as it moves into warmer air toward the bottom of the thunderstorm. However, the droplet may be picked up again by another updraft, carried back into the cold air, and re-frozen. The frozen droplet adds another layer of ice with each trip above and below the freezing level. The frozen droplet, with many layers of ice, falls to the ground as hail. Most hail is small and typically less than 2 inches in diameter (National Weather Service [NWS] 2009). Figure 4.3.6-1 illustrates the process that occurs in hail formulation.

The size of hailstones is directly related to the size and severity of the storm. The higher the temperatures at the earth’s surface, the greater the strength of the updrafts, and the greater the amount of time the hailstones are suspended, giving them more time to increase in size. Damage to crops and vehicles is typically the most significant impact of hailstorms.

Figure 4.3.6-1. Hail Formation



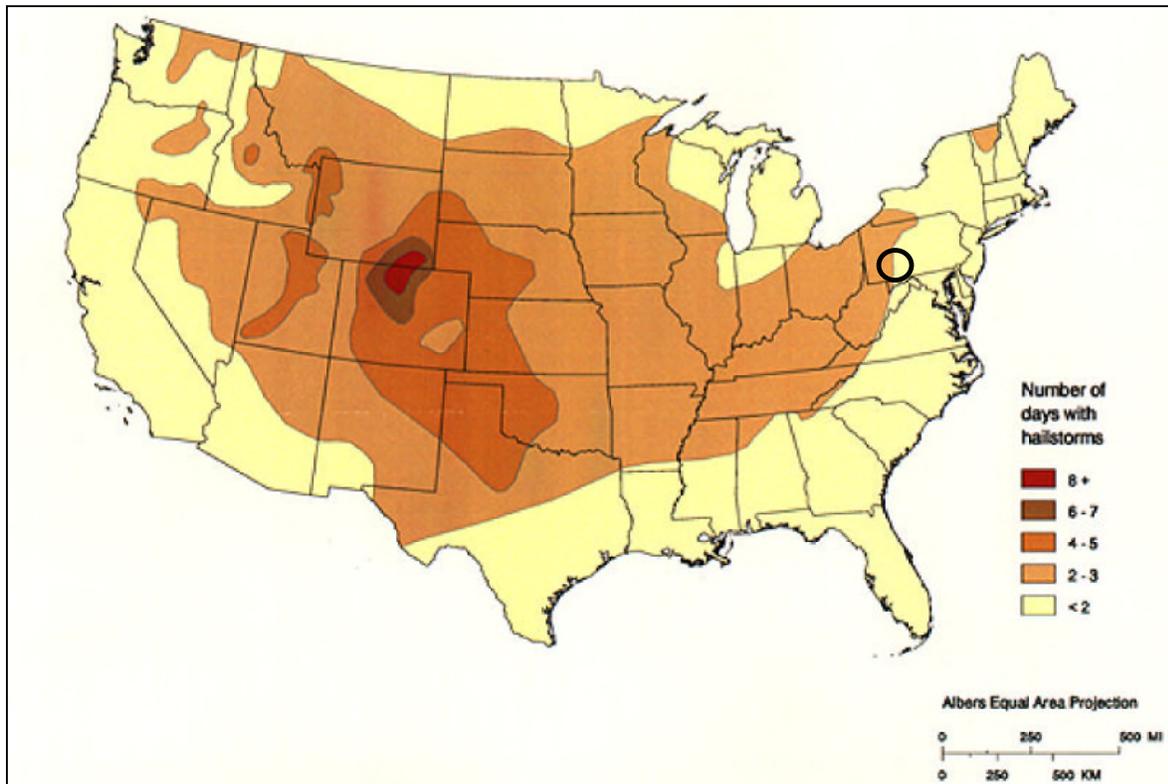
Source: National Oceanic and Atmospheric Administration (NOAA) 2012
°F degrees Fahrenheit



4.3.6.1 Location and Extent

Hail causes nearly \$2 billion in crop and property damages, on average, each year in the United States. Hail occurs most frequently in states within the southern and central plains; however, hail damage is possible throughout the entire United States because hail may accompany a thunderstorm (Federal Alliance for Safe Homes 2013). As indicated on Figure 4.3.6-2, Westmoreland County experiences up to three hailstorms per year, on average.

Figure 4.3.6-2. Annual Frequency of Hailstorms in the U.S.



Source: Federal Emergency Management Agency (FEMA) 1997

Note: The black oval indicates the approximate location of Westmoreland County.

The National Oceanic and Atmospheric Administration’s (NOAA) National Severe Storms Laboratory (NSSL) started a project to estimate the likelihood of severe weather hazards in the United States. “Severe thunderstorms” were defined as having one or more of the following characteristics: associated tornados, gusts at least 58 miles per hour (mph), or hail at least 0.75 inch in diameter.

4.3.6.2 Range of Magnitude

Hail can vary in size from less than 1 inch to several inches in diameter and can cause significant damage to crops and property. Damage depends on the size, duration, and intensity of hail precipitation. Individuals who do not seek shelter could face serious injury. Automobiles and aircraft are particularly susceptible to damage. Effects of other hazards associated with thunderstorms (strong winds, intense precipitation, and lightning) often occur concurrently because hail precipitation usually occurs during thunderstorms.

Westmoreland County has experienced hail ranging in size from 0.75 to 2.75 inches in diameter. No deaths or injuries due to hail have been recorded in the County. Westmoreland County’s worst hailstorm occurred on April



4, 1984, when thunderstorms produced tennis ball-sized hail (National Centers for Environmental Information [NCEI] 2019).

Based on reports from NCEI and Westmoreland County residents, the worst-case scenario for a hailstorm would be a storm that dropped tennis ball-sized hail (the largest observed in the County). This hail would cause widespread damage to property and crops.

Hail can be produced during many different types of storms. Typically, hail occurs with thunderstorms. The size of hail is estimated by comparing it with a known object. During most hailstorms, hail is produced in a variety of sizes, and only the very largest hail stones pose serious risk to people who are exposed. Table 4.3.6-1 shows the various sizes of hail as compared to real-world objects.

Table 4.3.6-1. Hail Size

Size	Inches in Diameter	Updraft Speed (mph)
BB	<0.25	< 24
Pea	0.25	24
Marble	0.50	35
Dime	0.70	38
Penny	0.75	40
Nickel	0.88	46
Quarter	1.0	49
Half-dollar	1.25	54
Walnut	1.5	60
Golf Ball	1.75	64
Hen Egg	2.0	69
Tennis Ball	2.5	77
Baseball	2.75	81
Tea Cup	3.0	84
Grapefruit	4.0	98
Softball	4.5	103

Source: NWS, n.d.

4.3.6.3 Past Occurrence

Hailstorms occur as a routine part of severe weather in Westmoreland County. The potential for hail storms exists throughout the County, with a few minor incidents occurring each year. While the future occurrence of hailstorms in the County can be considered likely, Westmoreland County has a high potential for significant hail events based on previous records.

A hailstorm event is defined as a storm with hail that is 0.75 inch or greater in diameter. Previous versions of the State HMP found that approximately 96 percent of hailstorm events occurred during the months of April, May, June, July, August, and September. In addition, approximately 87 percent of historic events occurred during the afternoon or evening. Both of these results are consistent with the relationship between hail and thunderstorms, which most often occur during late spring, summer, and early fall months (Pennsylvania Emergency Management Agency [PEMA] 2018).

The NOAA-NCEI Storm Events database includes reports of hail appearing during storm incidents in Westmoreland County from 1950 to December 31, 2018, as shown in Figure 4.3.6-3. The database indicates that 237 separate reports were issued throughout the County from 1950 to 2018. Some reports specified different times of day or different localities regarding the same storm. According to these reports, Westmoreland County



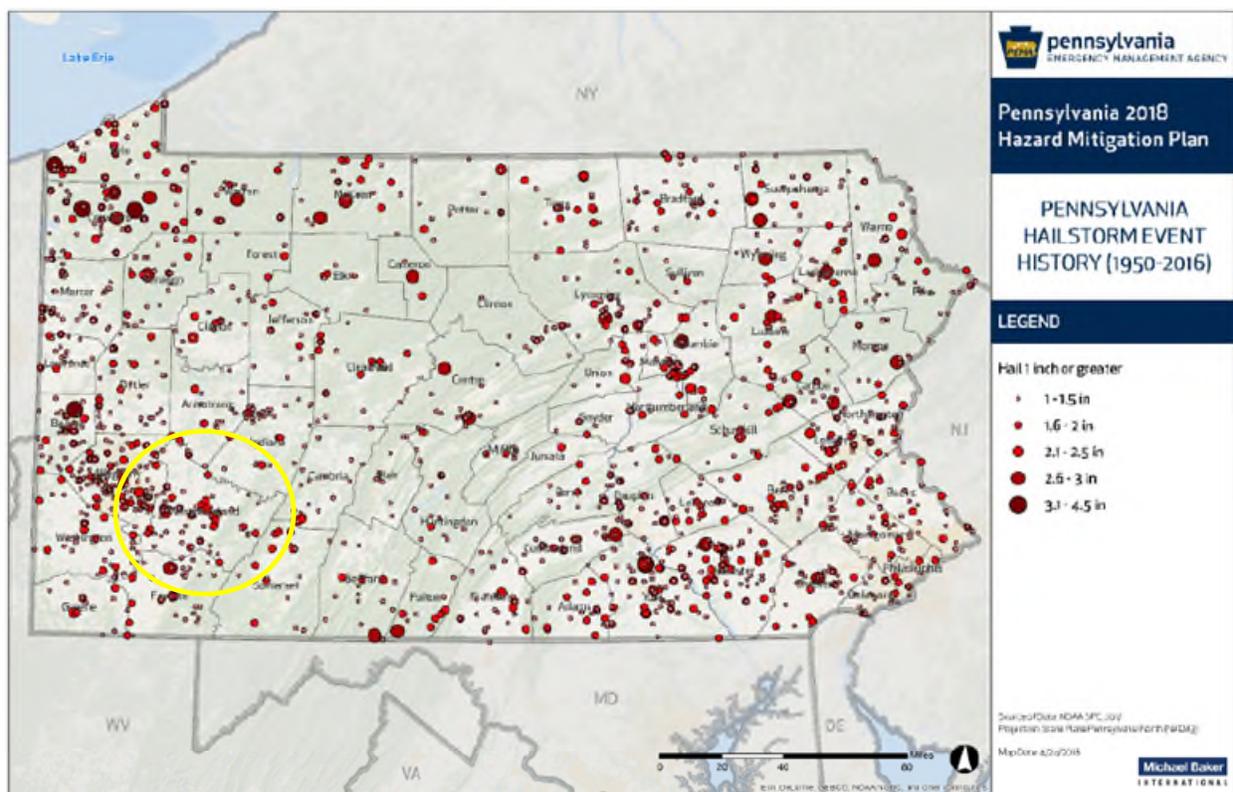
has experienced hail ranging in size from 0.75 inch to 2.50 inches in diameter, with no deaths, injuries, or property damages reported to NOAA. This information differs from U.S. Department of Agriculture (USDA) records. According to the U.S. Department of Agriculture (USDA) Risk Management Agency, hailstorm events that have occurred within Westmoreland County between 1989 and 2018 have resulted in \$2,661.20 in crop insurance claims. The claims were submitted due to hail events from only 2 years, 2001 and 2005 (USDA 2019).

Pennsylvania has never received a federal disaster declaration because of a hail event. In the Pennsylvania Disaster History events list maintained by PEMA, Pennsylvania has experienced only three noteworthy hail events, none of which affected Westmoreland County. Only two of these events were eligible for Small Business Administration (SBA) Economic Injury benefits, while the third was not eligible for any recovery actions.

4.3.6.4 Future Occurrence

The formation of a hailstorm is not possible to predict with more than a few days’ lead time. The past occurrences described above, however, indicate that hailstorm events in Westmoreland County probably will occur every year throughout the months of May through September. Figure 4.3.6-3 below shows the number of hail events across Pennsylvania from 1950-2016.

Figure 4.3.6-3. Hail Events in Pennsylvania (1950-2016)



Source: PEMA 2018

Note: The yellow oval indicates the location of Westmoreland County.

Future occurrences of hailstorms can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (further discussed in Section 4.4).



4.3.6.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets that are exposed or vulnerable within the identified hazard area. Regarding hail events, the entire County has been identified as the hazard area. Therefore, all assets in Westmoreland County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 2), are vulnerable. This section evaluates and estimates the potential impact of hailstorm events on the County in the following sections:

- Overview of vulnerability
- Impacts on: (1) life, health, and safety of residents; (2) general building stock, critical facilities, and economy; (3) the environment; and (4) future growth and development
- Effect of climate change on vulnerability
- Collection of further data that will assist in understanding this hazard

Overview of Vulnerability

The entire County, including all critical infrastructure, is vulnerable to the effects of hail, as the storm cells that produce this hazard can develop over any part of the region. The area of damage caused by these storms is relatively small because a single storm does not cause widespread devastation, but may cause damage within a focused area.

Hail can cause serious damage to automobiles, aircraft, skylights, livestock, and crops. Areas of the County with large amounts of farmland and high agricultural yields are more likely to be affected by hailstorm hazards.

Impact on Life, Health, and Safety

The entire population of the County is considered exposed to the hail hazard. People outdoors (for example, pursuing recreational activities and farming) are considered most vulnerable to the hazard because they ordinarily would receive little to no warning, and shelter may not be available to them. Moving to a lower-risk location decreases a person's vulnerability.

Impact on General Building Stock, Critical Facilities, and the Economy

Hailstorms primarily affect agricultural products. The facilities most vulnerable to hailstorm threats are food- and agriculture-related producers and manufacturers. These facilities are present within both urban and rural areas and would be directly or indirectly affected by a hailstorm event. According to the Pennsylvania HMP (PEMA 2018), Westmoreland County has 251,478 people and 112,370 structures valued at \$29,548,682 vulnerable to hailstorms. Number of structures and structural value for the 2018 Pennsylvania HMP are based on HAZUS-MH v4.0 values.

As discussed above in Section 4.3.6.3 (Past Occurrence), Westmoreland County has not experienced historical hailstorm property damage and significant crop damage (\$0 in property damage claims [per NCEI records] and \$2,661.20 in USDA crop damage claims [per USDA records, which differ from the NCEI records]). However, given the unpredictability of hailstorms, significant property and crop damage is possible during any hailstorm event. Jurisdictional loss estimation is based on lost agricultural revenues throughout the County. The USDA Census of Agriculture enumerates farmland acreage by county, as well as the annual market value of all agricultural products sold by county, from year 2017. If a hailstorm would eliminate the entire agricultural yield in Westmoreland County, total losses on the County's 144,278 acres of farmland could reach over \$66 million.



Impact on the Environment

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 (PEMA 2018).

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 to 10 years have been identified across Westmoreland County, and are further discussed in Section 2.4 of this HMP. New developments and new residents are expected to be exposed to the hailstorm hazard in the future.

Effect of Climate Change on Vulnerability

The definition of “climate” is not restricted to average temperature and precipitation, but also includes type, frequency, and intensity of weather events. On both global and local scales, climate change could alter the prevalence and severity of extremes such as hailstorms. While predicting changes of storm events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating effects of future climate change on human health, society, and the environment (U.S. Environmental Protection Agency [EPA] 2006).

As directed by the Climate Change Act (Act 70 of 2008), Pennsylvania’s Department of Environmental Protection (PADEP) initiated a study of potential impacts of global climate change on the Commonwealth. The June 2009 Pennsylvania Climate Impact Assessment’s main findings indicate likelihood that Pennsylvania will undergo increased temperatures in the 21st century. An increase in variability of temperature and precipitation may well lead to increased frequency and severity of hailstorm events. Future improvements in modeling smaller-scale climatic processes such as thunderstorms and associated hailstorms can be expected and will lead to improved understanding of the ways in which the changing climate will alter storms, such as hailstorm events, in Pennsylvania (Shortle et al. 2009).

Additional Data and Next Steps

The assessment above identifies vulnerable populations and potential structural and economic losses associated with this hazard of concern. Collection of additional information and actual loss data specific to the plan participants will further enhance Westmoreland County’s vulnerability assessment.