



4.3.10 Nuclear Incident

This section provides a profile and vulnerability assessment of the nuclear incident hazard profile for the Chester County Hazard Mitigation Plan (HMP).

Nuclear hazards and incidents generally refer to incidents involving (1) a release of significant levels of radioactive materials or (2) exposure of workers or the general public to radiation. Primary concerns following a nuclear incident or accident are the impact on public health from (1) direct exposure to a radioactive plume; (2) inhalation of radioactive materials; (3) ingestion of contaminated food, water, and milk; and (4) long-term exposure to deposited radioactive materials in the environment that may lead to either acute (radiation sickness or death) or chronic (cancer) health effects.

The nuclear industry has adopted pre-determined, site-specific Emergency Action Levels (EAL). The EALs provide the framework and guidance for observing, addressing, and classifying the severity of site-specific incidents and conditions that are communicated to off-site emergency response organizations (Nuclear Regulatory Commission [NRC] 2008). Additional EALs specifically deal with issues of security, such as threats of airborne attack, hostile action within the facility, or attack on the facility. These EALs ensure that appropriate notifications of a security threat will occur in a timely manner.

The NRC encourages the use of probabilistic risk assessments (PRA) to estimate quantitatively the potential risk to public health and safety considering the design, operations, and maintenance practices at nuclear power plants. PRAs typically focus on accidents that can severely damage the core and that may challenge containment. Federal Emergency Management Agency (FEMA), Pennsylvania Emergency Management Agency (PEMA), and county governments have formulated radiological emergency response plans to prepare for radiological emergencies at the five nuclear power-generating facilities in the Commonwealth of Pennsylvania. These plans include a plume exposure pathway emergency planning zone (EPZ) (an area with a radius of 10 miles from each nuclear power facility) and an ingestion exposure pathway EPZ (an area with a radius of 50 miles from each facility).

Location and Extent

Stationary Facilities

There are five nuclear power generation stations located in Pennsylvania. While Chester County has no nuclear facilities within its borders, it falls within a 10-mile radius of two nuclear facilities. The Peach Bottom Atomic Power Station (Peach Bottom) is located to the west of West Nottingham Township and Limerick Generating Station is located to the northeast of East Coventry Township. Peach Bottom has two operating licensed units. Figure 4.3.10-1 provides illustrates Chester County location within the plume exposure pathway EPZ and ingestion exposure pathway EPZ of the nearby nuclear power plants.



Figure 4.3.10-1. Chester County Jurisdictions in the 10-Mile Plume Exposure Pathways

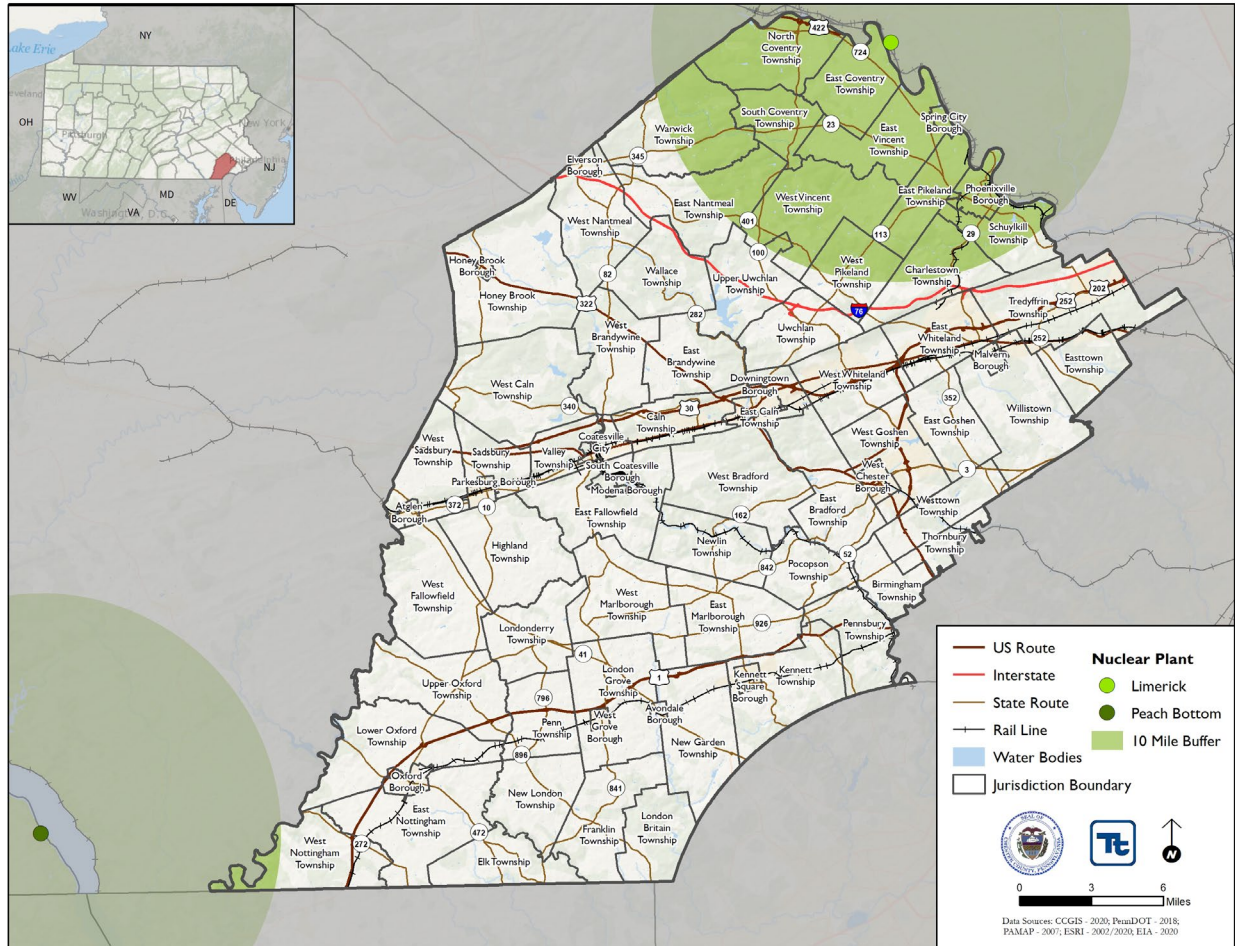


Table 4.3.10-1 lists the jurisdictions in Chester County that are located within the 10-mile EPZs for Limerick Generating Station and Peach Bottom.

Table 4.3.10-1. Chester County Jurisdictions in the Plume Exposure Pathway EPZs

Jurisdiction	10-Mile Plume Exposure Pathway EPZ – Limerick Generating Station	10-Mile Plume Exposure Pathway EPZ – Peach Bottom
Atglen (B)	No	No
Avondale (B)	No	No
Birmingham (Twp.)	No	No
Caln (Twp.)	No	No
Charlestown (Twp.)	Yes	No
Coatesville (C)	No	No
Downingtown (B)	No	No
East Bradford (Twp.)	No	No
East Brandywine (Twp.)	No	No
East Caln (Twp.)	No	No
East Coventry (Twp.)	Yes	No





Jurisdiction	10-Mile Plume Exposure Pathway EPZ – Limerick Generating Station	10-Mile Plume Exposure Pathway EPZ – Peach Bottom
East Fallowfield (Twp.)	No	No
East Goshen (Twp.)	No	No
East Marlborough (Twp.)	No	No
East Nantmeal (Twp.)	Yes	No
East Nottingham (Twp.)	No	No
East Pikeland (Twp.)	Yes	No
East Vincent (Twp.)	Yes	No
East Whiteland (Twp.)	No	No
Easttown (Twp.)	No	No
Elk (Twp.)	No	No
Elverson (B)	No	No
Franklin (Twp.)	No	No
Highland (Twp.)	No	No
Honey Brook (B)	No	No
Honey Brook (Twp.)	No	No
Kennett (Twp.)	No	No
Kennett Square (B)	No	No
London Britain (Twp.)	No	No
London Grove (Twp.)	No	No
Londonderry (Twp.)	No	No
Lower Oxford (Twp.)	No	No
Malvern (B)	No	No
Modena (B)	No	No
New Garden (Twp.)	No	No
New London (Twp.)	No	No
Newlin (Twp.)	No	No
North Coventry (Twp.)	Yes	No
Oxford (B)	No	No
Parkesburg (B)	No	No
Penn (Twp.)	No	No
Pennsbury (Twp.)	No	No
Phoenixville (B)	Yes	No
Pocopson (Twp.)	No	No
Sadsbury (Twp.)	No	No
Schuylkill (Twp.)	Yes	No
South Coatesville (B)	No	No
South Coventry (Twp.)	Yes	No
Spring City (B)	Yes	No
Thornbury (Twp.)	No	No
Tredyffrin (Twp.)	No	No
Upper Oxford (Twp.)	No	No
Upper Uwchlan (Twp.)	Yes	No
Uwchlan (Twp.)	No	No
Valley (Twp.)	No	No
Wallace (Twp.)	No	No
Warwick (Twp.)	Yes	No
West Bradford (Twp.)	No	No
West Brandywine (Twp.)	No	No
West Caln (Twp.)	No	No
West Chester (B)	No	No
West Fallowfield (Twp.)	No	No
West Goshen (Twp.)	No	No
West Grove (B)	No	No



Jurisdiction	10-Mile Plume Exposure Pathway EPZ – Limerick Generating Station	10-Mile Plume Exposure Pathway EPZ – Peach Bottom
West Marlborough (Twp.)	No	No
West Nantmeal (Twp.)	No	No
West Nottingham (Twp.)	No	Yes
West Pikeland (Twp.)	Yes	No
West Sadsbury (Twp.)	No	No
West Vincent (Twp.)	Yes	No
West Whiteland (Twp.)	No	No
Westtown (Twp.)	No	No
Willistown (Twp.)	No	No

Sources: Chester County Geographic Information System (GIS) 2020; Energy Information Administration 2020

Notes: % = Percent; B = Borough; C = City; EPZ = Emergency planning zone; Twp. = Township

Hazards in Transit

The U.S. Department of Energy transports used nuclear fuel to the repository by rail and road inside sealed containers. The used fuel may be shipped along specified highway routes. Rail is used to transport nuclear waste as well. However, no nuclear fuel is transported through Chester County.

Range of Magnitude

Plume exposure pathway EPZ are designed to consider whole-body external exposure to radiation from a radioactive plume and from deposited materials and inhalation exposure from the passing radioactive plume. The duration of primary exposures could range in length from hours to days. The 50-mile ingestion exposure pathway EPZ consider exposure primarily from ingestion of water or foods such as milk and fresh vegetables that have been contaminated with radiation. This kind of exposure can stem from any of the three categories of nuclear accident listed below. Although the 10-mile plume exposure EPZs include only portions of Chester County (shown in Figure 4.3.9-1 and Table 4.3.9-1), the entire county has the potential to be impacted through the ingestion exposure pathway.

Nuclear facility accidents are classified into three categories, and exposure to radiation can stem from any of the following three types of accidents:

- *Criticality accidents:* Involves loss of control of nuclear assemblies or power reactors.
- *Loss-of-coolant accidents:* Occurs whenever a reactor coolant system experiences a break or opening large enough that the coolant inventory in the system cannot be maintained by the normally operating make-up system.
- *Loss-of-containment accidents:* Involves the release of radioactivity from materials such as tritium; fission products; plutonium; and natural, depleted, or enriched uranium. Points of release have been containment vessels at fixed facilities or damaged packages during transportation accidents.

In accordance with regulations specified by FEMA and NRC, each facility is required to notify jurisdictional agencies of an incident or occurrence within that facility. NRC uses four classification levels for nuclear incidents (NRC 2008). PEMA and facility owners with whom PEMA coordinates use the following notification levels based on an internal trigger:

- *Unusual Event:* Incidents are occurring or have occurred that indicate potential degradation in the level of safety of the plant. No release of radioactive material requiring off-site response or monitoring is expected unless further degradation occurs.





- *Alert:* Incidents are in process or have occurred that involve actual or potential substantial degradation in the level of safety of the plant. Any releases of radioactive material from the plant are expected to be limited to a small fraction of the U.S. Environmental Protection Agency (EPA) Protective Action Guides (PAG).
- *Site Area Emergency:* Incidents are in process or have occurred that resulted in actual or likely major failures of plant functions needed for protection of the public. Any releases of radioactive material are not expected to exceed EPA PAGs except near the site boundary.
- *General Emergency:* Incidents are in process or have occurred that have caused actual or imminent substantial core damage or melting of reactor fuel with potential for loss-of-containment integrity. Radioactive releases during a General Emergency can reasonably be expected to exceed the EPA PAGs over more than the immediate site area.

After a nuclear incident, the primary concern is the effect on the health of the population located near the incident. The duration of primary exposure could range in length from hours to months depending on the proximity to the point of radioactive release. External radiation and inhalation and ingestion of radioactive isotopes can cause acute health effects (e.g., death, severe health impairment), chronic health effects (e.g., cancers) and psychological effects.

Potential environmental impacts specific to the 50-mile ingestion exposure pathway EPZ include the long-term effects of radioactive contamination in the environment and in agricultural products. Chester County can expect some radioactive contamination in very small amounts in the case of a nuclear incident. This is not a significant concern in terms of external exposure and immediate health risks, but even a small amount of radiation will require the protection of the food chain, particularly milk supplies. Small amounts of radiation ingested over time could lead to future health issues. As a result, in the case of a nuclear incident, foodstuffs, crops, milk, livestock feed and forage, and farm water supplies will need to be protected from and tested for contamination, in accordance with Commonwealth and local radiological emergency response procedures. Additionally, spills and releases of radiologically active materials from accidents can result in the contamination of soil and public water supplies.

Scenario

The worst-case scenario nuclear incidents for Chester County would be if a General Emergency occurred at Limerick Generating Station or Peach Bottom that leaked sufficient radiation to create injuries and fatalities as well as longer-term damage in the form of contaminated water, soil, and food supplies in the county.

Past Occurrence

Nuclear incidents rarely occur, but the incident at Three-Mile Island (TMI) is the worst fixed-nuclear facility accident in U.S. history. The resulting contamination and state of the reactor core led to the development of a 14-year cleanup and scientific effort. Additionally, the President’s Commission on the Accident at TMI examined the costs of the accident, concluding that, “the accident at TMI on March 28, 1979, generated considerable economic disturbance. Some of the impacts were short term, occurring during the first days of the accident. Many of the impacts were experienced by the local community; others will be felt at the regional and national levels.” The report concluded: “It appears clear that the major costs of the TMI Unit 2 accident are associated with the emergency management replacement power and the plant refurbishment or replacement. The minimum cost estimate of nearly \$1 billion supports the argument that considerable additional resources can be cost effective if spent to guard against future accidents” (President’s Commission on the Accident at TMI 1978).

Despite the severity of the damage, no injuries due to radiation exposure occurred. However, numerous studies were conducted to determine the measurable health effects related to radiation and/or stress. More than a dozen



epidemiological and stress-related studies conducted to date have found no discernible direct health effects on the population in the vicinity of the plant. However, one study conducted by the Pennsylvania Department of Health’s (PA DOH) TMI Health Research Program did find evidence of psychological stress “lasting in some cases for five to six years,” as stated in the study report. According to the Program Chief, “the people suffering from stress perceived their health as being poorer than it actually was when the Health Department checked the medical records”(PA DOH, n.d.).

The issue of radiation effects resulting from the accident at TMI will continue to be debated. Radiation science does accept thresholds of expected mortality and morbidity resulting from the exposure to radiation. Administrative standards have been incorporated into plans used by public health officials and emergency planners for the purpose of making protective action decisions pertaining to sheltering and evacuation.

The accident at TMI had a profound effect on the residents, emergency management community, government officials, and nuclear industry, not only in Pennsylvania but nationwide. There were minimal requirements for off-site emergency planning for nuclear power stations prior to this accident. After the accident, comprehensive, coordinated, and exercised plans were developed for the state, counties, school districts, special facilities (hospitals, nursing homes, and detention facilities), and municipalities to ensure the safety of the population. Costs associated with an incident at one of the Commonwealth’s nuclear facilities, whether real or perceived, are significant. The mitigation efforts put in place immediately following the 1979 accident continue until today. The Commonwealth’s nuclear/radiological plan, which is a successor of the original “Annex E,” is a result of the Commonwealth’s efforts to address the many components of mitigation planning. The comprehensive planning involved with the five nuclear facilities is an ongoing effort. Plans are reviewed and amended on an annual basis. Recent amendments to various planning documents and station procedures include the efforts to enhance station security measures and the means to bolster communications and response in the incident of terrorist activities.

Another incident occurred at TMI on February 7, 1993, when an individual drove his car through a chain-link fence and then slammed into a roll-up garage door leading into the facility’s turbine building. Plant officials, fearing the worst, immediately declared a Site Area Emergency. Fortunately, the person who crashed the gate was found and apprehended.

An Alert was also declared at TMI on October 5, 2015. A small electrical fire occurred at the power plant, which was extinguished quickly and with no threat of the release of radiation (Associated Press 2015).

In addition to the TMI incidents, one Alert-level incident occurred at Peach Bottom. On July 4, 1992, a fire occurred around an off-site transformer, causing a loss of electrical power to the facility. Other than the power outage, there were no other consequences.

No large-scale nuclear incidents have taken place in the history of Chester County. The last incident involving a radioactive source occurred in 2005 when a Traxler gauge used by contractors for ground sampling fell off a truck. The device was found with no impact to the public.

Future Occurrence

Pennsylvania has the distinction of having experienced the only nuclear power plant General Emergency in the nation. Since the TMI incident, nuclear power has become significantly safer and is one of the most heavily regulated industries in the nation. Despite the knowledge gained since then, the potential still exists for a similar accident to occur again at one of the five nuclear-generating facilities in the Commonwealth.

Across the United States, several Unusual Event and Alert classification-level events occur each year at the 100+ nuclear facilities that warrant notification of local emergency managers. Of these, Alert emergencies occur less



frequently. For example, in 1997, 40 notifications of Unusual Events and three Alert events occurred nationwide. Based on historical events, Site Area Emergency and General Emergency incidents are very rare. Based on available historical data and the lack of nuclear incident events impacting Chester County, the future occurrence of nuclear incident events can be considered *unlikely* as defined by the Risk Factor Methodology probability criteria (further discussed in Section 4.4).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed or vulnerable within the identified hazard area. Effects of and risk from nuclear incidents are examined. The following sections evaluate and estimate potential impacts in Chester County:

- Overview of vulnerability
- Impacts on (1) life, health, and safety; (2) general building stock; (3) critical facilities, (4) the economy, and (5) the environment
- Cascading effect on other hazards
- Future growth and development

Overview of Vulnerability

Effects from a radiological incident at a fixed facility would vary depending on the product released (type of radiation), amount of radiation released, current weather conditions, and time of day. The vulnerability analysis discussed in the following sections examined exposure from three different nuclear power plants:

1. Peach Bottom Atomic Power Station
2. Limerick Generating Station
3. Salem-Hope Creek Nuclear Power Plant

The priority following an incident at any of the facilities within the Commonwealth of Pennsylvania is the life and safety of all individuals within the area impacted. Secondary to health and safety would be effects on critical infrastructure, environment, property, and the economy.

Impact on Life, Health, and Safety

Nuclear power plants use energy from the decay of radioactive isotopes. If an accident occurs and these isotopes are released, they can pose a great danger to human health. The younger population is considered particularly vulnerable to this hazard (National Cancer Institute 2020). According to the 2018 American Community Survey 5-year estimate, 29,076 persons under 5 years old reside in the county (U.S. Census 2018).

Only portions of Chester County are located within the 10-mile plume EPZ of Limerick Generating Station or Peach Bottom, while the entire county is located within the 50-mile ingestion EPZ. West Nottingham Township is the only jurisdiction within the Peach Bottom Atomic Power Station 10-mile EPZ. Approximately 69 people reside within this plume area. The remaining exposed persons are within the 10-mile Limerick Generating Station. Phoenixville Borough has the greatest number of exposed residents, with 16,815 people or 100 percent of the jurisdiction considered exposed to a potential release from the Limerick Station. Along with the population residing in these areas, first responders on scene are also at risk. First responders potentially might not have access to incidents due to damaged infrastructure. Electrical/utility fires may increase with disruptions to lines as well, so first responders would have additional tasks during nuclear incident events.

Table 4.3.10-2 summarizes the population exposed in nuclear power plant buffer zones within Chester County.



Table 4.3.10-2. Population Exposed to Nuclear Power Plant Buffer Areas

Jurisdiction	Total Population	Number of Persons Within 10 Miles of Peach Bottom Atomic Power Station		Number of Persons Within 10 Miles of the Limerick Generating Station	
		Number of People	Percent of Total	Number of People	Percent of Total
Atglen (B)	1,459	0	0.0%	0	0.0%
Avondale (B)	1,295	0	0.0%	0	0.0%
Birmingham (Twp.)	4,207	0	0.0%	0	0.0%
Caln (Twp.)	14,198	0	0.0%	0	0.0%
Charlestown (Twp.)	5,813	1,933	33.3%	0	0.0%
Coatesville (C)	13,147	0	0.0%	0	0.0%
Downingtown (B)	7,929	0	0.0%	0	0.0%
East Bradford (Twp.)	9,959	0	0.0%	0	0.0%
East Brandywine (Twp.)	8,416	0	0.0%	0	0.0%
East Caln (Twp.)	4,876	0	0.0%	0	0.0%
East Coventry (Twp.)	6,770	6,770	100.0%	0	0.0%
East Fallowfield (Twp.)	7,567	0	0.0%	0	0.0%
East Goshen (Twp.)	18,199	0	0.0%	0	0.0%
East Marlborough (Twp.)	7,326	0	0.0%	0	0.0%
East Nantmeal (Twp.)	1,723	520	30.2%	0	0.0%
East Nottingham (Twp.)	8,929	0	0.0%	0	0.0%
East Pikeland (Twp.)	7,331	7,331	100.0%	0	0.0%
East Vincent (Twp.)	10,603	10,603	100.0%	0	0.0%
East Whiteland (Twp.)	7,062	0	0.0%	0	0.0%
Easttown (Twp.)	11,415	0	0.0%	0	0.0%
Elk (Twp.)	1,786	0	0.0%	0	0.0%
Elverson (B)	1,405	0	0.0%	0	0.0%
Franklin (Twp.)	4,506	0	0.0%	0	0.0%
Highland (Twp.)	1,370	0	0.0%	0	0.0%
Honey Brook (B)	1,865	0	0.0%	0	0.0%
Honey Brook (Twp.)	8,205	0	0.0%	0	0.0%
Kennett (Twp.)	8,177	0	0.0%	0	0.0%
Kennett Square (B)	6,159	0	0.0%	0	0.0%
London Britain (Twp.)	3,241	0	0.0%	0	0.0%
London Grove (Twp.)	2,450	0	0.0%	0	0.0%
Londonderry (Twp.)	8,615	0	0.0%	0	0.0%
Lower Oxford (Twp.)	5,058	0	0.0%	0	0.0%
Malvern (B)	3,440	0	0.0%	0	0.0%



Jurisdiction	Total Population	Number of Persons Within 10 Miles of Peach Bottom Atomic Power Station		Number of Persons Within 10 Miles of the Limerick Generating Station	
		Number of People	Percent of Total	Number of People	Percent of Total
Modena (B)	873	0	0.0%	0	0.0%
New Garden (Twp.)	12,111	0	0.0%	0	0.0%
New London (Twp.)	1,312	0	0.0%	0	0.0%
Newlin (Twp.)	5,921	0	0.0%	0	0.0%
North Coventry (Twp.)	7,996	7,973	99.7%	0	0.0%
Oxford (B)	5,420	0	0.0%	0	0.0%
Parkesburg (B)	3,781	0	0.0%	0	0.0%
Penn (Twp.)	5,511	0	0.0%	0	0.0%
Pennsbury (Twp.)	3,649	0	0.0%	0	0.0%
Phoenixville (B)	16,815	16,815	100.0%	0	0.0%
Pocopson (Twp.)	4,838	0	0.0%	0	0.0%
Sadsbury (Twp.)	3,919	0	0.0%	0	0.0%
Schuylkill (Twp.)	8,639	4,063	47.0%	0	0.0%
South Coatesville (B)	1,276	0	0.0%	0	0.0%
South Coventry (Twp.)	2,631	2,631	100.0%	0	0.0%
Spring City (B)	3,320	3,320	100.0%	0	0.0%
Thornbury (Twp.)	3,181	0	0.0%	0	0.0%
Tredyffrin (Twp.)	29,481	0	0.0%	0	0.0%
Upper Oxford (Twp.)	2,518	0	0.0%	0	0.0%
Upper Uwchlan (Twp.)	11,509	11	0.1%	0	0.0%
Uwchlan (Twp.)	18,869	0	0.0%	0	0.0%
Valley (Twp.)	7,661	0	0.0%	0	0.0%
Wallace (Twp.)	3,678	0	0.0%	0	0.0%
Warwick (Twp.)	2,543	614	24.1%	0	0.0%
West Bradford (Twp.)	12,869	0	0.0%	0	0.0%
West Brandywine (Twp.)	7,482	0	0.0%	0	0.0%
West Caln (Twp.)	9,080	0	0.0%	0	0.0%
West Chester (B)	19,888	0	0.0%	0	0.0%
West Fallowfield (Twp.)	2,596	0	0.0%	0	0.0%
West Goshen (Twp.)	23,021	0	0.0%	0	0.0%
West Grove (B)	2,846	0	0.0%	0	0.0%
West Marlborough (Twp.)	771	0	0.0%	0	0.0%
West Nantmeal (Twp.)	1,999	0	0.0%	0	0.0%
West Nottingham (Twp.)	2,718	0	0.0%	69	2.5%



Jurisdiction	Total Population	Number of Persons Within 10 Miles of Peach Bottom Atomic Power Station		Number of Persons Within 10 Miles of the Limerick Generating Station	
		Number of People	Percent of Total	Number of People	Percent of Total
West Pikeland (Twp.)	4,069	1,528	37.6%	0	0.0%
West Sadsbury (Twp.)	2,393	0	0.0%	0	0.0%
West Vincent (Twp.)	5,257	3,315	63.1%	0	0.0%
West Whiteland (Twp.)	18,403	0	0.0%	0	0.0%
Westtown (Twp.)	10,916	0	0.0%	0	0.0%
Willistown (Twp.)	10,895	0	0.0%	0	0.0%
Chester County (Total)	517,156	67,359	13.0%	69	0.01%

Sources: U.S. Census 2018; Chester County GIS 2020

Notes: % = Percent; B = Borough; C = City; Twp. = Township

Impact on General Building Stock

A nuclear explosion can have similar effects to those produced by conventional explosives. The resulting shock from a nuclear explosion can collapse structures and generate flying debris. Additionally, thermal radiation resulting from a nuclear explosion could ignite fires or coalesce into a firestorm (National Research Council 2005). Other potential damages to the general building stock from a nuclear plant incident can be difficult to qualify, as potential losses may include inaccessibility, and/or potential structural and content losses.

To estimate the buildings exposed to a nuclear incident event, the EPZ areas were overlaid upon the building level. The replacement cost value of the structures with their center in the buffer areas were totaled and summarized in Table 4.3.10-3.

Table 4.3.10-3. Total Building Exposure to Nuclear Power Plant Buffer Areas

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value	Number of Buildings Within 10 Miles of Peach Bottom Atomic Power Station or the Limerick Generating Station			
			Number of Buildings	Percent Total	Replacement Cost Value	Percent Total
Atglen (B)	583	\$300,171,233	0	0.0%	\$0	0.0%
Avondale (B)	436	\$275,491,131	0	0.0%	\$0	0.0%
Birmingham (Twp.)	1,774	\$1,521,752,088	0	0.0%	\$0	0.0%
Caln (Twp.)	5,696	\$4,389,258,174	0	0.0%	\$0	0.0%
Charlestown (Twp.)	2,655	\$2,334,124,537	924	34.8%	\$692,835,856	29.7%
Coatesville (C)	3,545	\$2,658,702,748	0	0.0%	\$0	0.0%
Downingtown (B)	2,619	\$2,678,308,815	0	0.0%	\$0	0.0%
East Bradford (Twp.)	4,033	\$3,166,888,223	0	0.0%	\$0	0.0%
East Brandywine (Twp.)	4,201	\$2,499,920,165	0	0.0%	\$0	0.0%
East Caln (Twp.)	1,509	\$1,864,909,402	0	0.0%	\$0	0.0%
East Coventry (Twp.)	3,832	\$2,200,926,728	3,832	100.0%	\$2,200,926,728	100.0%



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Jurisdiction	Total Number of Buildings	Total Replacement Cost Value	Number of Buildings Within 10 Miles of Peach Bottom Atomic Power Station or the Limerick Generating Station			
			Number of Buildings	Percent Total	Replacement Cost Value	Percent Total
East Fallowfield (Twp.)	4,025	\$1,984,687,476	0	0.0%	\$0	0.0%
East Goshen (Twp.)	6,498	\$5,680,635,001	0	0.0%	\$0	0.0%
East Marlborough (Twp.)	3,888	\$3,646,563,821	0	0.0%	\$0	0.0%
East Nantmeal (Twp.)	1,509	\$1,131,945,456	397	26.3%	\$280,649,181	24.8%
East Nottingham (Twp.)	4,960	\$3,185,167,607	0	0.0%	\$0	0.0%
East Pikeland (Twp.)	3,959	\$2,751,413,608	3,959	100.0%	\$2,751,413,608	100.0%
East Vincent (Twp.)	3,872	\$2,764,012,516	3,872	100.0%	\$2,764,012,516	100.0%
East Whiteland (Twp.)	5,002	\$8,143,686,632	0	0.0%	\$0	0.0%
Easttown (Twp.)	4,583	\$3,998,338,009	0	0.0%	\$0	0.0%
Elk (Twp.)	1,361	\$754,193,647	0	0.0%	\$0	0.0%
Elverson (B)	716	\$516,332,051	0	0.0%	\$0	0.0%
Franklin (Twp.)	2,468	\$1,537,535,450	0	0.0%	\$0	0.0%
Highland (Twp.)	1,304	\$1,067,555,265	0	0.0%	\$0	0.0%
Honey Brook (B)	771	\$446,825,932	0	0.0%	\$0	0.0%
Honey Brook (Twp.)	4,871	\$3,389,705,910	0	0.0%	\$0	0.0%
Kennett (Twp.)	4,166	\$4,134,894,338	0	0.0%	\$0	0.0%
Kennett Square (B)	1,956	\$1,600,982,472	0	0.0%	\$0	0.0%
London Britain (Twp.)	1,782	\$1,064,040,035	0	0.0%	\$0	0.0%
London Grove (Twp.)	4,233	\$3,148,102,405	0	0.0%	\$0	0.0%
Londonderry (Twp.)	1,755	\$1,034,199,367	0	0.0%	\$0	0.0%
Lower Oxford (Twp.)	2,585	\$2,325,017,464	0	0.0%	\$0	0.0%
Malvern (B)	1,149	\$1,256,307,741	0	0.0%	\$0	0.0%
Modena (B)	226	\$143,886,459	0	0.0%	\$0	0.0%
New Garden (Twp.)	5,418	\$5,996,313,471	0	0.0%	\$0	0.0%
New London (Twp.)	2,955	\$1,850,994,293	0	0.0%	\$0	0.0%
Newlin (Twp.)	1,188	\$767,919,221	0	0.0%	\$0	0.0%
North Coventry (Twp.)	4,367	\$2,814,129,243	4,354	99.7%	\$2,805,409,434	99.7%
Oxford (B)	1,795	\$1,620,222,123	0	0.0%	\$0	0.0%
Parkesburg (B)	1,478	\$791,790,495	0	0.0%	\$0	0.0%
Penn (Twp.)	2,962	\$3,335,917,017	0	0.0%	\$0	0.0%
Pennsbury (Twp.)	1,793	\$1,741,030,601	0	0.0%	\$0	0.0%
Phoenixville (B)	6,031	\$4,404,373,172	6,031	100.0%	\$4,404,373,172	100.0%
Pocopson (Twp.)	1,781	\$1,616,048,060	0	0.0%	\$0	0.0%
Sadsbury (Twp.)	2,244	\$1,514,078,865	0	0.0%	\$0	0.0%
Schuylkill (Twp.)	4,116	\$3,296,773,180	1,988	48.3%	\$1,592,917,751	48.3%





Jurisdiction	Total Number of Buildings	Total Replacement Cost Value	Number of Buildings Within 10 Miles of Peach Bottom Atomic Power Station or the Limerick Generating Station			
			Number of Buildings	Percent Total	Replacement Cost Value	Percent Total
South Coatesville (B)	669	\$656,482,254	0	0.0%	\$0	0.0%
South Coventry (Twp.)	1,655	\$1,175,837,157	1,655	100.0%	\$1,175,837,157	100.0%
Spring City (B)	1,282	\$913,935,869	1,282	100.0%	\$913,935,869	100.0%
Thornbury (Twp.)	1,222	\$1,249,939,720	0	0.0%	\$0	0.0%
Tredyffrin (Twp.)	10,751	\$13,427,976,905	0	0.0%	\$0	0.0%
Upper Oxford (Twp.)	2,098	\$1,327,197,078	0	0.0%	\$0	0.0%
Upper Uwchlan (Twp.)	4,459	\$3,757,709,779	4	0.1%	\$1,840,193	0.0%
Uwchlan (Twp.)	6,633	\$7,025,589,763	0	0.0%	\$0	0.0%
Valley (Twp.)	3,430	\$2,597,377,442	0	0.0%	\$0	0.0%
Wallace (Twp.)	2,069	\$1,322,743,721	0	0.0%	\$0	0.0%
Warwick (Twp.)	2,175	\$1,133,542,100	498	22.9%	\$256,768,129	22.7%
West Bradford (Twp.)	6,163	\$3,995,074,181	0	0.0%	\$0	0.0%
West Brandywine (Twp.)	4,149	\$2,231,906,820	0	0.0%	\$0	0.0%
West Caln (Twp.)	6,021	\$2,765,167,902	0	0.0%	\$0	0.0%
West Chester (B)	4,156	\$5,374,643,016	0	0.0%	\$0	0.0%
West Fallowfield (Twp.)	2,171	\$1,743,066,295	0	0.0%	\$0	0.0%
West Goshen (Twp.)	8,399	\$9,444,801,871	0	0.0%	\$0	0.0%
West Grove (B)	1,053	\$499,625,186	0	0.0%	\$0	0.0%
West Marlborough (Twp.)	967	\$997,081,475	0	0.0%	\$0	0.0%
West Nantmeal (Twp.)	1,830	\$1,139,858,316	0	0.0%	\$0	0.0%
West Nottingham (Twp.)	1,989	\$1,196,217,005	30	1.5%	\$22,674,327	1.9%
West Pikeland (Twp.)	2,120	\$1,506,034,830	869	41.0%	\$690,529,898	45.9%
West Sadsbury (Twp.)	1,876	\$1,651,357,888	0	0.0%	\$0	0.0%
West Vincent (Twp.)	3,532	\$2,587,356,437	2,334	66.1%	\$1,596,514,061	61.7%
West Whiteland (Twp.)	7,022	\$7,660,221,171	0	0.0%	\$0	0.0%
Westtown (Twp.)	4,175	\$3,282,102,771	0	0.0%	\$0	0.0%
Willistown (Twp.)	6,043	\$4,727,817,226	0	0.0%	\$0	0.0%
Chester County (Total)	232,759	\$194,736,735,824	32,029	13.8%	\$22,150,637,879	11.4%

Sources: Chester County GIS 2020; RSMeans 2019

Notes: % = Percent; B = Borough; C = City; Twp. = Township

Impact on Land Use

The county’s primary vulnerability to nuclear incidents comes in the form of food, soil, and water contamination. A 50-mile radioactive plume from the Peach Bottom Atomic Power Station or the Limerick Generation Station would extend over the entire county. Approximately 168,349 acres of agricultural land in Chester County are vulnerable to radiological contamination in a nuclear incident.





A 50-mile agricultural plume exposure analysis was also conducted from the Salem-Hope Creek Nuclear Power Plant in Salem, New Jersey. This plume would cover 446,839 acres (92 percent) of the county. Of the agricultural land in the county, the plume would extend over 162,897 acres. Agricultural land in each Chester County jurisdiction that would be exposed to an nuclear incident from the Salem-Hope Creek Power Plant is summarized in Table 4.3.10-4.

Table 4.3.10-4. Agricultural Land Exposed to a 50-Mile Salem-Hope Creek Power Plant EPZ Plume

Jurisdiction	Acres of Agriculture	Acres of Agriculture within 50-Mile Salem Power Plant Plume	Percent of Total
Atglen (B)	144	144	100.0%
Avondale (B)	24	24	100.0%
Birmingham (Twp.)	838	838	100.0%
Caln (Twp.)	415	415	100.0%
Charlestown (Twp.)	1,714	1,714	100.0%
Coatesville (C)	12	12	100.0%
Downingtown (B)	34	34	100.0%
East Bradford (Twp.)	2,333	2,333	100.0%
East Brandywine (Twp.)	2,196	2,196	100.0%
East Caln (Twp.)	38	38	100.0%
East Coventry (Twp.)	2,858	708	24.8%
East Fallowfield (Twp.)	3,507	3,507	100.0%
East Goshen (Twp.)	652	652	100.0%
East Marlborough (Twp.)	4,521	4,521	100.0%
East Nantmeal (Twp.)	3,178	3,178	100.0%
East Nottingham (Twp.)	7,644	7,644	100.0%
East Pikeland (Twp.)	1,542	1,542	100.0%
East Vincent (Twp.)	4,239	4,088	96.4%
East Whiteland (Twp.)	567	567	100.0%
Easttown (Twp.)	530	530	100.0%
Elk (Twp.)	3,356	3,356	100.0%
Elverson (B)	166	84	50.5%
Franklin (Twp.)	3,621	3,621	100.0%
Highland (Twp.)	7,760	7,760	100.0%
Honey Brook (B)	59	59	100.0%
Honey Brook (Twp.)	8,549	8,549	100.0%
Kennett (Twp.)	2,530	2,530	100.0%
Kennett Square (B)	6	6	100.0%
London Britain (Twp.)	1,663	1,663	100.0%
London Grove (Twp.)	5,404	5,404	100.0%
Londonderry (Twp.)	4,405	4,405	100.0%
Lower Oxford (Twp.)	6,884	6,884	100.0%
Malvern (B)	65	65	100.0%
Modena (B)	4	4	100.0%
New Garden (Twp.)	2,916	2,916	100.0%
New London (Twp.)	2,929	2,929	100.0%
Newlin (Twp.)	3,349	3,349	100.0%
North Coventry (Twp.)	1,696	0	0.0%
Oxford (B)	340	340	100.0%
Parkesburg (B)	88	88	100.0%
Penn (Twp.)	3,090	3,090	100.0%
Pennsbury (Twp.)	1,581	1,581	100.0%
Phoenixville (B)	61	61	100.0%
Pocopson (Twp.)	2,048	2,048	100.0%
Sadsbury (Twp.)	1,551	1,551	100.0%



Jurisdiction	Acres of Agriculture	Acres of Agriculture within 50-Mile Salem Power Plant Plume	Percent of Total
Schuylkill (Twp.)	663	663	100.0%
South Coatesville (B)	90	90	100.0%
South Coventry (Twp.)	1,242	913	73.5%
Spring City (B)	40	40	100.0%
Thornbury (Twp.)	316	316	100.0%
Tredyffrin (Twp.)	931	931	100.0%
Upper Oxford (Twp.)	7,242	7,242	100.0%
Upper Uwchlan (Twp.)	1,841	1,841	100.0%
Uwchlan (Twp.)	876	876	100.0%
Valley (Twp.)	507	507	100.0%
Wallace (Twp.)	1,922	1,922	100.0%
Warwick (Twp.)	2,776	1,747	62.9%
West Bradford (Twp.)	2,768	2,768	100.0%
West Brandywine (Twp.)	2,809	2,809	100.0%
West Caln (Twp.)	4,568	4,568	100.0%
West Chester (B)	3	3	100.0%
West Fallowfield (Twp.)	8,017	8,017	100.0%
West Goshen (Twp.)	281	281	100.0%
West Grove (B)	1	1	100.0%
West Marlborough (Twp.)	7,592	7,592	100.0%
West Nantmeal (Twp.)	4,275	4,260	99.7%
West Nottingham (Twp.)	3,256	3,256	100.0%
West Pikeland (Twp.)	1,806	1,806	100.0%
West Sadsbury (Twp.)	3,797	3,797	100.0%
West Vincent (Twp.)	4,054	4,054	100.0%
West Whiteland (Twp.)	948	948	100.0%
Westtown (Twp.)	836	836	100.0%
Willistown (Twp.)	3,784	3,784	100.0%
Chester County (Total)	168,349	162,897	96.8%

Sources: Chester County GIS 2020; U.S. Geological Survey (USGS) 2016
 Notes: % = Percent; B = Borough; C = City; Twp. = Township

According to the U.S. Department of Agriculture (USDA) 2017 Census of Agriculture, the market value of all agricultural products of farms totaled approximately \$712 million for the county. While unlikely that all agricultural products would be lost in the event of a nuclear incident, the county can expect some portion to be lost. Time of year also impacts the vulnerability and losses estimated for a nuclear incident; an incident that occurs during the prime growing and harvesting season will have a larger impact on the county (USDA 2017).

Impact on Critical Facilities

Potential damages to critical facilities from a nuclear plant incident can be difficult to qualify, as potential losses may include loss of service and/or potential structural and content losses. A significant incident causing contamination or an explosion within an urban area may force businesses, public services, and utility services to close for an extended period.

Table 4.3.10-5 summarizes critical facilities located in the nuclear power plant buffer areas. Overall, 535 critical facilities are exposed to a nuclear incident event. Of these 535 critical facilities, 376 are considered lifelines (70.3 percent of all critical facilities).



Table 4.3.10-5. Critical Facilities Exposure to Nuclear Power Plant Buffer Areas

Jurisdiction	Total CFs Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Within 10 Miles of Peach Bottom Atomic Power Station or the Limerick Generating Station			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Atglen (B)	20	17	0	0.0%	0	0.0%
Avondale (B)	19	15	0	0.0%	0	0.0%
Birmingham (Twp.)	34	26	0	0.0%	0	0.0%
Caln (Twp.)	101	70	0	0.0%	0	0.0%
Charlestown (Twp.)	64	45	28	43.8%	25	55.6%
Coatesville (C)	79	45	0	0.0%	0	0.0%
Downingtown (B)	86	53	0	0.0%	0	0.0%
East Bradford (Twp.)	73	61	0	0.0%	0	0.0%
East Brandywine (Twp.)	49	40	0	0.0%	0	0.0%
East Caln (Twp.)	64	29	0	0.0%	0	0.0%
East Coventry (Twp.)	49	37	49	100.0%	37	100.0%
East Fallowfield (Twp.)	77	58	0	0.0%	0	0.0%
East Goshen (Twp.)	76	43	0	0.0%	0	0.0%
East Marlborough (Twp.)	53	34	0	0.0%	0	0.0%
East Nantmeal (Twp.)	31	25	6	19.4%	4	16.0%
East Nottingham (Twp.)	46	37	0	0.0%	0	0.0%
East Pikeland (Twp.)	50	35	50	100.0%	35	100.0%
East Vincent (Twp.)	60	40	60	100.0%	40	100.0%
East Whiteland (Twp.)	185	100	0	0.0%	0	0.0%
Easttown (Twp.)	69	37	0	0.0%	0	0.0%
Elk (Twp.)	18	17	0	0.0%	0	0.0%
Elverson (B)	13	5	0	0.0%	0	0.0%
Franklin (Twp.)	29	23	0	0.0%	0	0.0%
Highland (Twp.)	24	18	0	0.0%	0	0.0%
Honey Brook (B)	17	11	0	0.0%	0	0.0%
Honey Brook (Twp.)	45	26	0	0.0%	0	0.0%
Kennett (Twp.)	81	56	0	0.0%	0	0.0%
Kennett Square (B)	42	25	0	0.0%	0	0.0%
London Britain (Twp.)	22	20	0	0.0%	0	0.0%
London Grove (Twp.)	77	60	0	0.0%	0	0.0%
Londonderry (Twp.)	23	18	0	0.0%	0	0.0%
Lower Oxford (Twp.)	57	46	0	0.0%	0	0.0%
Malvern (B)	29	18	0	0.0%	0	0.0%
Modena (B)	11	8	0	0.0%	0	0.0%
New Garden (Twp.)	97	53	0	0.0%	0	0.0%
New London (Twp.)	21	18	0	0.0%	0	0.0%



Section 4.3.10: Risk Assessment – Nuclear Incident

Jurisdiction	Total CFs Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Within 10 Miles of Peach Bottom Atomic Power Station or the Limerick Generating Station			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Newlin (Twp.)	34	33	0	0.0%	0	0.0%
North Coventry (Twp.)	63	40	63	100.0%	40	100.0%
Oxford (B)	52	24	0	0.0%	0	0.0%
Parkesburg (B)	36	23	0	0.0%	0	0.0%
Penn (Twp.)	45	29	0	0.0%	0	0.0%
Pennsbury (Twp.)	46	34	0	0.0%	0	0.0%
Phoenixville (B)	88	54	88	100.0%	54	100.0%
Pocopson (Twp.)	40	35	0	0.0%	0	0.0%
Sadsbury (Twp.)	46	28	0	0.0%	0	0.0%
Schuylkill (Twp.)	75	45	52	69.3%	28	62.2%
South Coatesville (B)	22	12	0	0.0%	0	0.0%
South Coventry (Twp.)	43	36	43	100.0%	36	100.0%
Spring City (B)	17	10	17	100.0%	10	100.0%
Thornbury (Twp.)	21	18	0	0.0%	0	0.0%
Tredyffrin (Twp.)	303	186	0	0.0%	0	0.0%
Upper Oxford (Twp.)	27	19	0	0.0%	0	0.0%
Upper Uwchlan (Twp.)	61	43	0	0.0%	0	0.0%
Uwchlan (Twp.)	110	47	0	0.0%	0	0.0%
Valley (Twp.)	60	43	0	0.0%	0	0.0%
Wallace (Twp.)	34	31	0	0.0%	0	0.0%
Warwick (Twp.)	46	35	7	15.2%	5	14.3%
West Bradford (Twp.)	60	44	0	0.0%	0	0.0%
West Brandywine (Twp.)	49	39	0	0.0%	0	0.0%
West Caln (Twp.)	39	27	0	0.0%	0	0.0%
West Chester (B)	100	59	0	0.0%	0	0.0%
West Fallowfield (Twp.)	31	24	0	0.0%	0	0.0%
West Goshen (Twp.)	178	99	0	0.0%	0	0.0%
West Grove (B)	18	10	0	0.0%	0	0.0%
West Marlborough (Twp.)	27	24	0	0.0%	0	0.0%
West Nantmeal (Twp.)	31	21	0	0.0%	0	0.0%
West Nottingham (Twp.)	28	16	0	0.0%	0	0.0%
West Pikeland (Twp.)	44	39	33	75.0%	29	74.4%
West Sadsbury (Twp.)	37	19	0	0.0%	0	0.0%
West Vincent (Twp.)	47	39	39	83.0%	33	84.6%
West Whiteland (Twp.)	217	149	0	0.0%	0	0.0%
Westtown (Twp.)	46	31	0	0.0%	0	0.0%
Willistown (Twp.)	90	49	0	0.0%	0	0.0%





Jurisdiction	Total CFs Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Within 10 Miles of Peach Bottom Atomic Power Station or the Limerick Generating Station			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Chester County (Total)	4,202	2,783	535	12.7%	376	13.5%

Sources: Chester County GIS 2020; RSMeans 2019

Notes: % = Percent; B = Borough; C = City; CF = Critical facilities; Twp. = Township

Impact on Economy

Contamination of agriculture, livestock, and production can lead to loss of commerce with other regions of the state, country, and even the world. Recently, many countries halted imports of products from Japan for fear of contamination following the tsunami-related nuclear incident at the Fukushima Power Plant. This loss in revenue compounded losses that Japan and region surrounding the power plant were already encountering following the initial disaster.

Impact on the Environment

The release of radioactive materials has a profound impact on animals. Radiation causes genetic anomalies, leading to decreased reproduction, deformities, and death. High levels of contamination can also appear in plants and last for decades. For instance, Caesium-137, a radioactive fission product of nuclear plants, still appears around the 1986 Chernobyl incident site (Wai, et al 2020).

Cascading Impacts to Other Hazards

A nuclear event can cause utility failure. If an explosion or contamination occurred, water quality and supply could stop or drastically decrease while the facility restored service. Thermal radiation from a nuclear explosion can also cause firestorms, leading to structural fires among buildings (National Research Council 2005). Section 4.3.18, Utility Interruption, and Section 4.3.14, Structural Fires, provides more information.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the county can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The county considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

An increase in development and population can increase vulnerability in the event of a nuclear incident. Future development can also increase the likelihood of an incident. The tables and hazard maps included in the jurisdictional annexes in this HMP contain additional information regarding the specific areas of development that would increase county vulnerability to the nuclear incident hazard.

Projected Changes in Population

Estimated population projections provided by the Center of Rural Pennsylvania indicates that Chester’s population will continue to increase into 2040, increasing total population to approximately 603,068 persons (Center of Rural Pennsylvania 2013). Persons that move into nuclear incident exposure areas are at greater risk impact in the event of a spill or toxin release.





Climate Change

Nuclear power plants do not produce greenhouse gas emissions and therefore no immediate climate change impacts are associated with the hazard.

Change of Vulnerability Since the 2015 HMP

Since the 2015 analysis, population statistics have been updated using the 5-Year 2014-2018 American Community Survey Population Estimates. The general building stock was also established using RSMeans 2019 building valuations that estimated replacement cost value for each building in the inventory. Additionally, a critical facility dataset was provided from the county. Overall, exposure and vulnerability of the entire county to a nuclear event will continue.