Table 4.3.4-7 Estimated jurisdictional losses in Extreme Cold Temperature areas			
COUNTY	**2010 POPULATION**	**NUMBER OF IMPACTED BUILDINGS**	**DOLLAR VALUE OF EXPOSURE, BUILDING AND CONTENTS (THOUSANDS $)**
Juniata	24,636	1,659	$325,872
Lackawanna	214,437	25,781	$5,219,143
Luzerne	320,918	20,215	$4,462,777
Lycoming	116,111	19,227	$3,283,274
McKean	43,450	42,505	$8,092,723
Monroe	169,842	17,742	$4,063,891
Pike	57,369	23,443	$5,073,245
Potter	17,457	44,250	$7,662,393
Snyder	39,702	2,388	$458,096
Somerset	77,742	16,435	$3,439,765
Sullivan	6,428	3,099	$569,719
Susquehanna	43,356	21,996	$4,146,447
Tioga	41,981	36,021	$6,383,217
Union	44,947	9,483	$1,807,132
Warren	41,815	34,588	$6,517,426
Wayne	52,822	75,638	$15,998,764
TOTAL	***2,205,222***	***587,380***	**$112,592,068**

4.3.4.9. State Facility Loss Estimation

The estimated replacement cost of all state critical facilities located in extreme heat hazard zones is approximately $2,267,745,935. The estimated replacement cost of all state critical facilities located in extreme cold hazard zones is approximately $2,267,740,062.

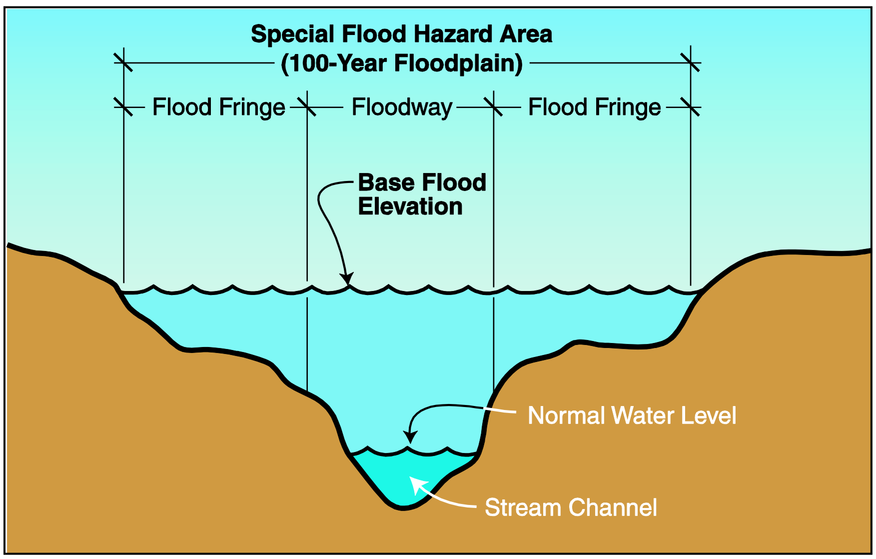
4.3.5. Flood, Flash Flood, Ice Jam

4.3.5.1. Location and Extent

Flooding in Pennsylvania is usually associated with abnormally high and intense rainfall amounts. However, flooding can also be caused by sudden snowmelt, landslides (see Section 4.3.9), dam failures, lock failures, or levee failures. Heavy rainfall events have the potential to produce localized or widespread flooding. Events such as a 1-inch cloudburst lasting thirty minutes may affect only a small watershed and be considered insignificant regionally. Large events, such as a broad-scale tropical storm lasting more than twenty-four hours, may affect drainage basins several thousand square miles in size. In either case, flood sources in Pennsylvania include rivers, creeks, streams, and lakes. Riverine, as opposed to coastal, flood mechanisms cause most flooding in the Commonwealth. However, portions of southeastern Pennsylvania along the Delaware River are subject to tidal or storm surge flooding. This section focuses on riverine and storm-based flooding, but floods of record caused by hurricanes and dam failures are also mentioned and cross referenced to the appropriate hazard profile. Also, the role of dams and levees as flood protection methods is mentioned in this section. Please see Sections 4.3.7, 4.3.18, and 4.3.20 to get a full picture of flood impacts, because hurricanes, dam failure, and levee failure all impact flooding.

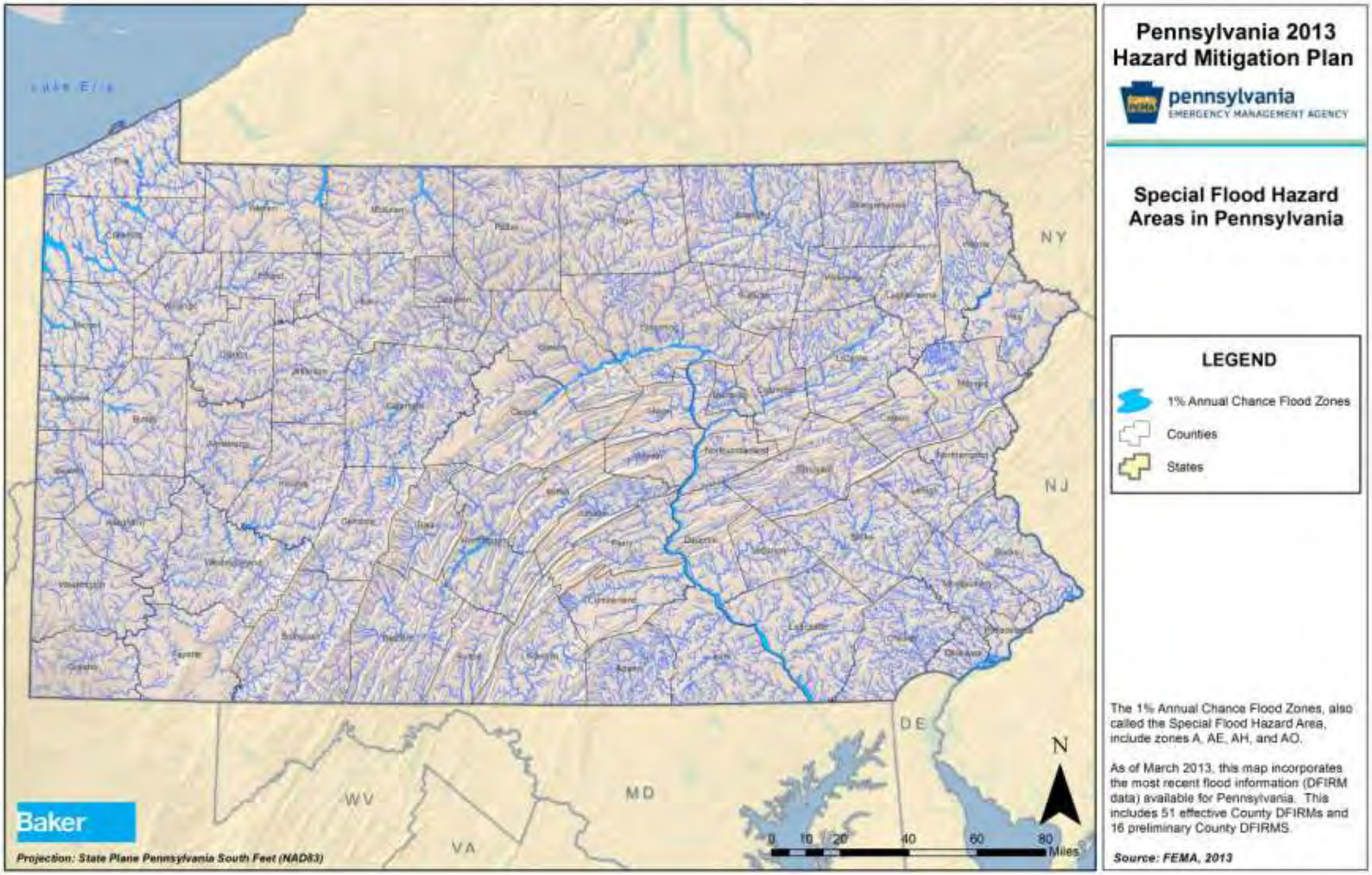
Floodplains found in lowlands, adjacent to rivers, streams, creeks, lakes, or other large water bodies are subject to recurring floods. The size of the floodplain is described by the recurrence interval of a given flood. In assessing the potential spatial extent of flooding it is important to know that a floodplain associated with a flood that has a 10% chance of occurring in a given year is smaller than the floodplain associated with a flood that has a 0.2%-annual-chance of occurring. The National Flood Insurance Program (NFIP) for which Digital Flood Insurance Rate Maps (DFIRM) are published identifies the 1%-annual-chance flood which is used to delineate the *Special Flood Hazard Area* and identify *Base Flood Elevations*. Figure 4.3.5-1 illustrates these terms.

Figure 4.3.5-1 Diagram identifying Special Flood Hazard Area, 1%-annual-chance (100-Year) floodplain, floodway and flood fringe.



The Special Flood Hazard Area serves as the primary regulatory boundary used by FEMA and the Commonwealth of Pennsylvania. DFIRMs, paper Flood Insurance Rate Maps (FIRM), and other flood hazard information for counties throughout Pennsylvania can be obtained from the FEMA Map Service Center (http://www.msc.fema.gov). These maps can be used to identify the expected spatial extent of flooding from a 1%- and 0.2%-annual-chance event. Figure 4.3.5-2 shows the location of Special Flood Hazard Areas throughout Pennsylvania. In Pennsylvania, the 1%-annual-chance zones include A, AE, AH, and AO. Note that there is typically higher uncertainty in the delineation of flood hazard areas in broad, flat floodplains in comparison to areas of steeper topography.

Figure 4.3.5-2 Map showing Special Flood Hazard Areas throughout Pennsylvania (FEMA).



4.3.5.2. Range of Magnitude

Both localized and widespread floods are considered hazards when people and property are 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 snowmelt. Water runoff is greater in areas with steep slopes and little or no vegetative ground cover. Many areas of the Commonwealth have relatively steep topography which promotes quick and flashy surface water runoff. Most storms track from west to east, but some originate in the Great lakes or Atlantic Ocean. Rapidly changing weather patterns and temperatures may cause large-scale snow-melting events in which ice jams in the receiving streams may aggravate the already serious problem of large water volumes contributed by thousands of small tributaries.

Rainfall in Pennsylvania is about average for the eastern United States. When classified according to amount of precipitation, rainfall can be divided into several categories:

- Very light rain – when precipitation rate is <0.01 inches/hour
- Light rain – when precipitation rate is between 0.01 to 0.04 inches/hour
- Moderate rain – when the precipitation rate is between 0.04 to 0.16 inches/hour
- Heavy rain – when the precipitation rate is between 0.16 to 0.63 inches/hour
- Very heavy rain – when the precipitation rate is between 0.63 to 2 inches/hour
- Extreme rain – when the precipitation rate is >2 inches/hour

While significant flood events are typically associated with very heavy and extreme rain, rainfall events of lesser intensity may also cause flooding given sufficient duration.

Flood effects can be volume or force related. Major floods along larger streams having wide floodplains tend to result in large-scale inundations. This causes widespread damage through soaking and silt deposits in homes, businesses, and industrial plants. In hilly regions where runoff paths are steep, flash floods may be prevalent. Flash floods are short in duration and usually occur in a somewhat localized area. In these floods, the velocity rather than the volume of water causes flood damages. Torrents of water can rush down minor hillside gullies at 30-50 miles per hour, carrying trees, debris, and rocks. These floods are often unpredictable and, particularly if they occur at night, can cause major panic and loss of life. Frozen surfaces can more than double normal runoff velocities, particularly in small drainage areas. This causes flash floods which can be compounded by ice and debris jams in channels and culverts. Also obstructions within the floodplain such as bridges and undersized culverts can also increase flooding.

The three worst flooding events experienced in Pennsylvania were the Johnstown Flood of 1889 Tropical Storm Agnes in 1972, and Tropical Storm Lee; each of these events are discussed in Section 4.3.5.3 and Tropical Storms Agnes and Lee are also addressed in Section 4.3.7.

4.3.5.3. Past Occurrence

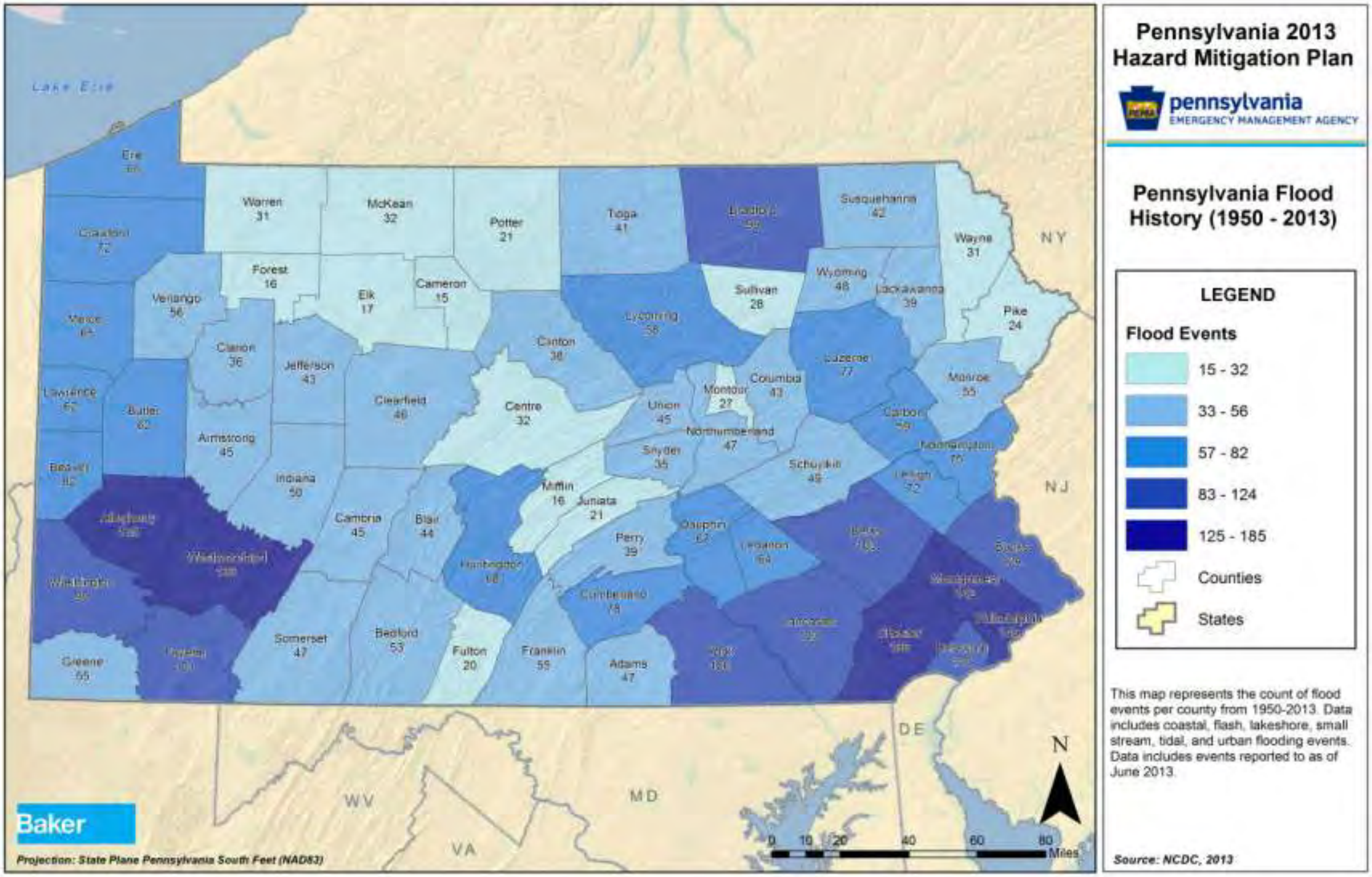
Pennsylvania has a long and continuous history of floods. Over half of the Presidential Disaster and Emergency Declarations in Pennsylvania have been in response to hazard events related to flooding (see Table 4.2.1-1). Additional declarations issued for hurricane, tropical storm, or nor'easter events were likely issued at least in part to flood impacts as well. Table 4.3.5-1 provides a tabulation of the number of flood events recorded for each county in the Commonwealth between 1950 and 2013. Figure 4.3.5-3 provides this information in map form. Allegheny, Chester, Montgomery, Philadelphia, and Westmoreland Counties have experienced the highest number of events over this 63 year period, but 24 of the counties have had over 63 events, or an average of one flood event per year.

Table 4.3.5-1 Number of flood events by county between 1950 and 2013 (NCDC, 2013).

COUNTY	NUMBER OF EVENTS	COUNTY	NUMBER OF EVENTS
Adams	47	Lackawanna	39
Allegheny	185	Lancaster	103
Armstrong	45	Lawrence	62
Beaver	82	Lebanon	64
Bedford	53	Lehigh	72
Berks	103	Luzerne	77
Blair	44	Lycoming	58
Bradford	99	McKean	32
Bucks	124	Mercer	65
Butler	62	Mifflin	16
Cambria	45	Monroe	55
Cameron	15	Montgomery	142
Carbon	59	Montour	27
Centre	32	Northampton	75
Chester	136	Northumberland	47
Clarion	36	Perry	39
Clearfield	46	Philadelphia	146
Clinton	38	Pike	24
Columbia	43	Potter	21
Crawford	72	Schuylkill	49
Cumberland	78	Snyder	35
Dauphin	67	Somerset	47
Delaware	120	Sullivan	28
Elk	17	Susquehanna	42
Erie	65	Tioga	41
Fayette	101	Union	45
Forest	16	Venango	56
Franklin	55	Warren	31
Fulton	20	Washington	90
Greene	55	Wayne	31

Table 4.3.5-1 Number of flood events by county between 1950 and 2013 (NCDC, 2013).			
COUNTY	NUMBER OF EVENTS	COUNTY	NUMBER OF EVENTS
Huntingdon	68	Westmoreland	133
Indiana	50	Wyoming	48
Jefferson	43	York	106
Juniata	21	**TOTAL**	**4,088**

Figure 4.3.5-3 Number of flood events by county between 1950 and 2013 (NCDC, 2013).



Previous versions of the SSAHMP found that approximately 57% flood events occur during the months of June, July, and August. Although most of the major historic Pennsylvania floods have occurred in the summer, occasionally flooding has been caused by a moderate warm winter rain following a deep snow pack. This type of flooding occurred in March 1936 and again in January 1996.

Pennsylvania has the most intense recorded rainfall event in the history of the U.S. In August 1942, more than thirty inches fell within a span of five hours near Smethport, a small town near the New York state border in McKean County (Eisenlohr, 1952). Whereas Smethport received the largest rainfall, it was estimated that more than twenty inches fell over a 200 square-mile area between Emporium and Austin. A peak flow rate of 80,000 cubic feet per second was estimated in Sinnemahoning Creek from high-water marks; almost ten times as large as any other flood recorded in that stream. The storm and resulting floods undoubtedly caused a large amount of destruction, but possibly owing to more pressing World War II problems, the event never received a great amount of publicity.

Floods in March 1936 were caused by a large accumulation of snow during a cold January, followed by a steady warming trend in February and rainfall. There was rapid snow and ice melting in almost all major watersheds in Pennsylvania. Ice jams caused enormous back-up effects on bridges, and many cities experienced the highest flood levels ever recorded. In reaction to the severe damages suffered in the 1936 flood, major flood-control structures were built throughout much of Pennsylvania. A more recent flood occurred in January 1996. Water levels in many rivers and municipalities exceeded the March 1936 level and in some cases was the second highest flood of record.

In June 1972, Tropical Storm Agnes caused widespread flooding which resulted in the largest total flood damage event in Pennsylvania. The storm lasted between two and three days, during which rainfall varied from four inches in western Pennsylvania up to twenty inches in some regions north of Harrisburg. Most major streams rose to record stages, causing hundreds of millions of dollars in damages in cities such as Wilkes-Barre, Lock Haven, and Harrisburg. In Pittsburgh, the Allegheny and Monongahela Rivers rose to within a few inches of the top of their banks. Pittsburgh avoided major flood damage due to the large capacities of several flood-control reservoirs, notably the Allegheny and Conemaugh. It is estimated that these structures held back a combined volume of over one million acre-feet. In the Susquehanna River watershed, the recently completed Curwensville (Clearfield County), Foster Joseph Sayers (Centre County), and Alvin R. Bush (Clinton County) Dams, together with some older dams, held back a total volume of roughly 250,000 acre-feet. This reduced potential Susquehanna River stages by several feet, but storage volumes were not nearly large enough to prevent flooding in the downstream reaches of the river. Agnes caused 122 deaths, 50 of which were in Pennsylvania. More information regarding Tropical Storm Agnes can be found in Section 4.3.7.

Parts of Crawford, Venango, Clarion, Jefferson, and Forest Counties were devastated during a summer storm on June 9, 1981. Flash flooding occurred with recorded local rainfall totals of 4.5 inches in the City of Franklin and 6.4 inches in Cooperstown. One death and at least $65 million in damages were reported. Twomile Run and Sage Run in Cranberry Township, Venango County, were especially hard hit. Flash floods of this kind are not uncommon across the Allegheny Plateau in western Pennsylvania. Similar floods caused by intense rainfall over a limited area occurred include:

- Johnstown Flood of May 1889 (see Section 4.3.5.3 for discussion of the Johnstown Flood);
- Johnstown in July 1977 (78 lives lost);
- Eastern Pennsylvania in August 1955 (101 deaths);
- East Brady, Armstrong County, in August 1980;
- Hyndman, Bedford County, in August 1984; and
- Northern suburbs of Pittsburgh in May 1986 (eight deaths) and 1987.

More recently, Tropical Storm Lee caused catastrophic flooding in eastern and central Pennsylvania in 2011. Hurricane Irene made landfall in the US on August 27, 2011 and again on August 28, dumping between 2 and 8 inches of rain in eastern Pennsylvania, with its worst rain occurring in the Delaware River basin. One and a half weeks later, beginning on September 5, Tropical Storm Lee and its associated heavy rainfall moved through Pennsylvania and New York. With large portions of the Susquehanna River Basin already saturated by Hurricane Irene, Lee's rain caused flash flooding and riverine flooding in and east of the Susquehanna River Valley. The heavy rain broke previous precipitation records set by the former worst-case, Tropical Storm Agnes, and caused multiple new floods of record throughout the state.

Lee/Irene left significant amounts of water over nearly all of central and eastern Pennsylvania with the worst occurring in Northeastern Pennsylvania communities of Towanda, Wilkes-Barre, Bloomsburg, Danville, and Sunbury. According to the NWS, over 2,000 people were evacuated and 3,000 homes and businesses flooded in Bradford County alone. Bradford County's agricultural community was severely damaged with about $7 million in crop damage. In Luzerne County, 60,000 people were evaluated and while the Wyoming Valley levee system held, unprotected communities saw flood depths worse than in Hurricane Agnes. Lee/Irene forced the first ever closure of the Bloomsburg Fair, since fairgrounds were covered in 10-12 feet of water. There were ten fatalities statewide due to the storm: one in Bradford County, four in Dauphin, three in Lancaster, one in Lebanon, and one in Philadelphia. Of these fatalities, half occurred as a result of cars being washed away. The NWS reported at least 23,780 structures as being affected by the event, with over 1,000 completely destroyed and nearly 8,000 substantially damaged. With the event occurring in the active growing season, there was widespread crop damage reported to the Department of Agriculture. The State and many county EOCs were activated for extended periods, and the event received both a Presidential Emergency Declaration and a Declaration of Major Disaster. As of May 2012, damages (including debris removal, emergency protective measures, road repair, bridge repair, buildings, utilities, and parks) topped $200 million for this event (NWS, 2012).

Oil City, located in western Pennsylvania, has historically been plagued with ice jams and ice-related flooding more so than most other communities throughout the Commonwealth. Records show that events have occurred from as far back as the mid-1800s. These floods have caused extreme hardships for the community and heavy economic and personal losses as well. A floating ice control structure on the Allegheny River and a fixed concrete weir on Oil Creek are designed to eliminate flood-causing ice jams on the Allegheny River at the mouth of Oil Creek. The floating structure on the Allegheny River was installed in 1982 and modified in 1983 at a federal cost of $1,110,000. It has effectively reduced ice formation on the river. The ice control structure on Oil Creek cost approximately $2.3 million and was completed in December 1989.

A HMGP award of $450,000 was provided though DR 1898 in 2011 to improve the Oil City Ice Boom. The project went out for bid in January of 2013 for the fabrication of 23 yellow pontoons and one boom. The USACE reviewed the design for the project and it is expected that the new installation will break up the ice on the Allegheny River and Oil Creek, thus protecting nearby properties from ice jam related flooding. (

In the last 20 years, flooding impacted Pennsylvania with state-wide declarations in January 1996, Hurricane Floyd in September 1999, Hurricane Isabel/Henri in September 2003, Lee/Irene in 2011, and Sandy in 2012. Flooding impacting another Region of the country resulted in a Proclamation of Emergency for Hurricane Katrina in September 2005 for Pennsylvania to assist with mutual aid and housing evacuees. In just the last 10 years, there have been a total of 15 flooding related disaster and emergency declarations impacting Pennsylvania in. In addition, since 2000, there have been 27,605 closed flood loss instances totaling over $820 million, as shown in Table 4.3.5-2. The average claims payment over this 13-year period is over $22,000. There are an additional 173 open claims, which may be pending ICC payment to the policy holder.

Table 4.3.5-2 Historic Flood Losses and Payments (PEMA, 2013).

YEAR	LOSS COUNT	BUILDING PAYMENTS	CONTENTS PAYMENTS	ICC PAYMENTS	TOTAL PAYMENTS	AVERAGE PAYMENT
CLOSED CLAIMS						
2001	552	$18,252,071	$7,785,369	$99,650	$26,137,089	$47,349.80
2002	81	$669,940	$235,597	$0	$,537	$11,179.47
2003	775	$7,807,144	$2,610,445	$20,000	$10,437,589	$13,467.86
2004	8944	$164,744,399	$43,573,103	$2,016,735	$210,334,238	$23,516.80
2005	1804	$50,444,034	$8,096,100	$2,123,125	$60,663,259	$33,627.08
2006	3918	$101,996,714	$21,074,105	$3,067,437	$126,138,256	$32,194.55
2007	395	$3,752,164	$743,275	$15,000	$4,510,438	$11,418.83
2008	155	$1,414,932	$270,861	$0	$1,685,793	$10,876.08
2009	564	$10,778,429	$3,659,713	$0	$14,438,142	$25,599.54
2010	1096	$15,749,511	$3,984,221	$66,059	$19,799,790	$18,065.50
2011	9077	$282,398,269	$55,806,724	$3,369,869	$341,574,862	$37,630.81
2012	243	$2,552,146	$1,009,495	$0	$3,561,640	$14,656.96
2013	1	$8,001	$0	$0	$8,001	$8,000.99
OPEN CLAIMS						
2004	12	$281,647	$35,846	$38,183	$355,676	$29,639.70
2005	6	$245,463	$42,250	$74,900	$362,613	$60,435.50
2006	1	$114,210	$782	$15,000	$129,991	$129,991.39

Table 4.3.5-2 Historic Flood Losses and Payments (PEMA, 2013).						
YEAR	**LOSS COUNT**	**BUILDING PAYMENTS**	**CONTENTS PAYMENTS**	**ICC PAYMENTS**	**TOTAL PAYMENTS**	**AVERAGE PAYMENT**
2010	1	$0	$0	$0	$0	$0.00
2011	136	$9,379,678	$1,622,685	$110,050	$11,112,413	$81,708.92
2012	5	$0	$0	$0	$0	$0.00
2013	12	$0	$0	$0	$0	$0.00

4.3.5.4. Future Occurrence

In Pennsylvania, flooding occurs commonly and can take place during any season of the year. Every two to three years, serious flooding occurs along one or more of Pennsylvania's major rivers or streams and it is not unusual for such events to happen several years in succession. Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and related probability of occurrence. Historical records are used to determine the probability of occurrence (percent chance) for a flood of specific extent to occur.

The NFIP recognizes the 1%-annual-chance flood, also known as the *base flood*, as the standard for identifying properties subject to federal flood insurance purchase requirements. A 1%-annual-chance flood is a flood which has a 1% chance of occurring over a given year. DFIRMs and FIRMs published by FEMA can be used to identify areas subject to the 1%- and 0.2%-annual-chance flooding. Areas subject to 2%- and 10%-annual-chance events are not shown on maps; however, water surface elevations associated with these events are included in the flood source profiles contained in associated Flood Insurance Study Reports. The most recent Flood Insurance Study for each county in Pennsylvania is available from the FEMA Map Service Center (http://www.msc.fema.gov)

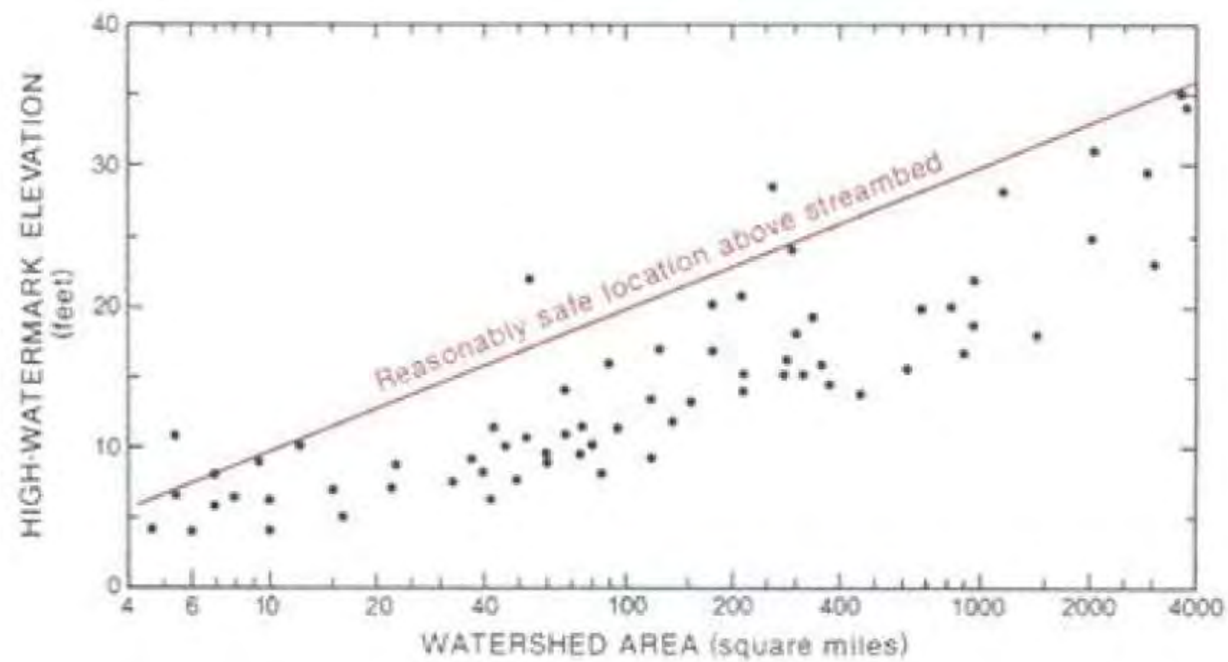
4.3.5.5. Environmental Impacts

Floods are naturally occurring events that benefit riparian systems which have not been disrupted by human actions. Such benefits include groundwater recharge and the introduction of nutrient rich sediment improving soil fertility. However, the destruction of riparian buffers, changes to land-use and landcover throughout a watershed, and 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 (see Section 4.3.19). Other environmental impacts of flooding include: water-borne diseases, heavy siltation, erosion of streambanks and riverbeds, destruction of aquatic habitat, damage to water and sewer infrastructure located in floodplains, increased acid mine drainage, damage or loss of crops and drowning of both humans and animals.

4.3.5.6. Jurisdictional Vulnerability Assessment

A major concern for those involved in almost any activity in the vicinity of a stream is the area's vulnerability to flooding. While maps identifying the 1%- and 0.2%-annual-chance flood hazard areas, many unmapped floodplain areas are prone to flooding. The potential flooding depth above a streambed depends mostly (but not entirely) on the upstream drainage area. The drainage area includes that portion of the watershed that is located upstream from a point of interest, excluding areas subject to the influence of major flood-control dams. Figure 4.3.5-4 shows a plot of historic high watermarks for Pennsylvania floods as a function of watershed area. Using historic high watermark elevations (above streambed), a “reasonably safe” zone can be defined based on the area of a watershed a give property is located in. For example, a resident of Millerstown in Allegheny County, which occupies about ten square miles of Bull Creek watershed, could feel relatively safe if located ten feet above the streambed, whereas a resident of Chadds Ford in Chester County, which occupies about 290 square miles of the Brandywine Creek watershed, should be located approximately twenty-five feet above the streambed. Note that this graph provides only a rough approximation of flood hazards. Detailed hydraulic and hydrologic analyses are needed to assess the impact of low-permeability soils, steep slopes, and dense urbanization on flood potential for a specific jurisdiction.

Figure 4.3.5-4 Plot of historic high watermarks in Pennsylvania vs. watershed area.



All counties in Pennsylvania identify flooding as a hazard. Of the 37 counties which currently have calculated risk factor values for flood hazards, the average value is 3.1. This average does not include Lebanon, Montour, Perry, and Philadelphia, who use an alternate Risk Factor/Ranking system. The State Risk Factor for flood, flash flood, and ice jam is 3.4, while the Pennsylvania THIRA scored flood, flash flood, and ice jam as a 9 out of 10 – the number one prioritized threat in Pennsylvania. For more details on the State Risk Factor and THIRA rankings, please see Section 4.1.

The widespread recognition of flooding as a hazard and high risk factor reveal the sentiment from individual jurisdictions that flood impacts significantly increase community vulnerability throughout the Commonwealth. The complete list of counties profiling flooding is found in Table 4.3.5-3. 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.

Table 4.3.5-3 Counties profiling flood 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		High	3.9
Allegheny	X		High	3.3
Armstrong	X		Not Ranked	No RF
Beaver	X		High	3.1
Bedford	X		High	3.7
Berks	X		Not Ranked	No RF
Blair	X		Not Ranked	No RF
Bradford	X		Not Ranked	No RF
Bucks	X		High	3.2
Butler	X		High	2.8
Cambria	X		High	3.4
Cameron	X		High	3.6
Carbon	X		High	3.0
Centre	X		High	2.7
Chester	X		Not Ranked	No RF
Clarion	X		Not Ranked	No RF
Clearfield	X		High	2.5
Clinton	X		High	3.3
Columbia	X		High	3.2
Crawford	X		High	2.9
Cumberland	X		High	2.7
Dauphin	X		Not Ranked	No RF
Delaware	X		High	3.5
Elk	X		High	2.9
Erie	X		High	3.2
Fayette	X		High	3.0
Forest	X		Not Ranked	No RF
Franklin	X		Not Ranked	No RF
Fulton	X		High	3.9

Table 4.3.5-3 Counties profiling flood hazards with hazard ranking and risk factor (if available).				
COUNTY	**PROFILED HAZARD**	**DID NOT PROFILE HAZARD**	**RANKING (IF AVAILABLE)**	**RISK FACTOR (IF AVAILABLE)**
Greene	X		High	3.1
Huntingdon	X		Not Ranked	No RF
Indiana	X		High	3.3
Jefferson	X		High	2.9
Juniata	X		High	2.7
Lackawanna	X		Not Ranked	No RF
Lancaster	X		High	3.2
Lawrence	X		High	2.8
Lebanon*	X		Not Ranked	12.0
Lehigh	X		High	2.5
Luzerne	X		Not Ranked	No RF
Lycoming	X		High	3.9
McKean	X		High	3.3
Mercer	X		High	2.8
Mifflin	X		Not Ranked	No RF
Monroe	X		High	3.2
Montgomery	X		High	3.0
Montour*	X		Not Ranked	12.0
Northampton	X		High	2.5
Northumberland	X		High	3.2
Perry*	X		Not Ranked	15.0
Philadelphia**	X		High	A
Pike	X		High	3.2
Potter	X		Not Ranked	No RF
Schuylkill	X		Not Ranked	No RF
Snyder	X		High	3.1
Somerset	X		High	3.9
Sullivan	X		Not Ranked	No RF
Susquehanna	X		High	3.2
Tioga	X		High	3.2
Union	X		Not Ranked	No RF
Venango	X		High	2.5
Warren	X		High	2.7

Table 4.3.5-3 Counties profiling flood hazards with hazard ranking and risk factor (if available).

COUNTY	PROFILED HAZARD	DID NOT PROFILE HAZARD	RANKING (IF AVAILABLE)	RISK FACTOR (IF AVAILABLE)
Washington	X		Not Ranked	No RF
Wayne	X		Not Ranked	No RF
Westmoreland	X		Not Ranked	No RF
Wyoming	X		Not Ranked	No RF
York	X		High	2.5

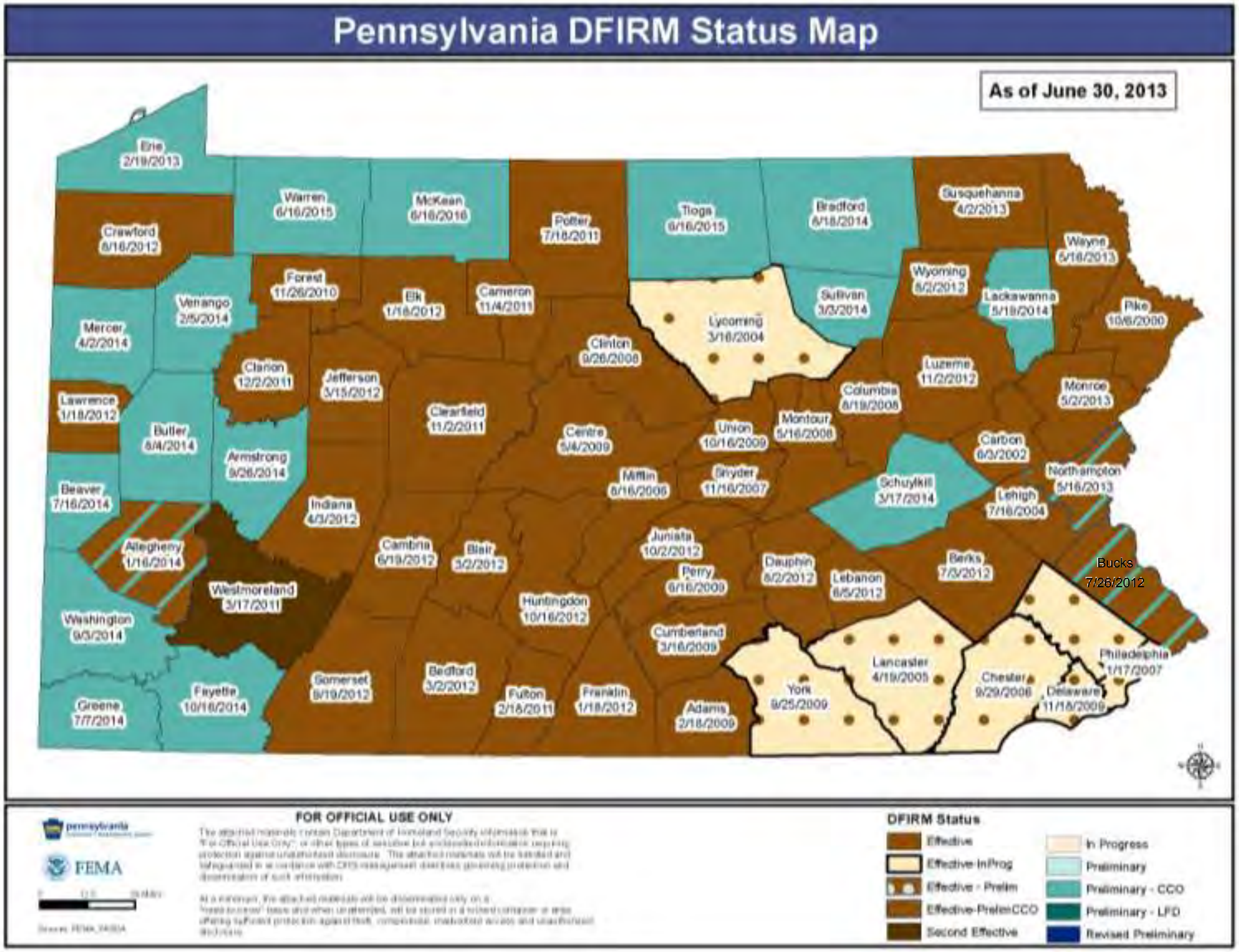
* Lebanon, Montour, and Perry use an alternate weighted ranking where Risk Factor = Frequency x [(0.25 x Critical facilities) + (0.40 x Social) + (0.25 x Economic) + (0.10 x Environmental)]. While this risk factor was used to comparatively rank hazards, the number does not correspond to a high-medium-low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

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

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 where 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.

The NFIP recognizes the 1%-annual-chance flood as the standard for identifying properties subject to federal flood insurance purchase requirements. Identifying these special flood hazard areas is essential when determining facilities that are vulnerable to flood. Therefore, the latest available flood information was used for GIS analysis. County flood hazard areas were collected on a county by county basis. A total of 51 effective DFIRMs were used, as well as 16 Preliminary DFIRMs so that the most recent data for that county was used. With the most current flood data, a reliable list of vulnerable critical facilities can be obtained. A map of counties and their DFIRM status as of June 2013 is presented in Figure 4.3.5-5. While Effective data was obtained from the FEMA via PASDA, Preliminary data was obtained internally through FEMA. No Q3 data was used in the development of the SSAHMP. Having new DFIRM data available nearly statewide adds significant value to communities' ability to discern flood risk. The Effective and Preliminary DFIRM data is based on strong hydrologic and hydraulic modeling and presents a better, more up-to-date reflection of actual flood risk than the original Q3 maps did.

Figure 4.3.5-5 DFIRM Status by county as of June 2013.



A total of 370 critical facilities were found to fall within the 1%-annual-chance flood hazard areas. As seen in Table 4.3.5-4, Allegheny, Cambria, Dauphin, Lackawanna, and Schuylkill Counties have the most critical facilities impacted by flooding. Forest, Fulton, Montour, Pike, Sullivan, and Venango Counties did not have any critical facilities within their special flood hazard areas.

Table 4.3.5-4 Number of Critical Facilities within the 1%-annual-chance flood hazard areas in each county

COUNTY	NUMBER OF CRITICAL FACILITIES	COUNTY	NUMBER OF CRITICAL FACILITIES
Adams	1	Juniata	5
Allegheny	31	Lackawanna	14
Armstrong	8	Lancaster	6
Beaver	3	Lawrence	2
Bedford	1	Lebanon	1
Berks	6	Lehigh	1
Blair	8	Luzerne	7
Bradford	11	Lycoming	13
Bucks	6	McKean	4
Butler	9	Mercer	1
Cambria	15	Mifflin	2
Cameron	1	Monroe	3
Carbon	6	Montgomery	9
Centre	6	Northampton	4
Chester	5	Northumberland	3
Clarion	1	Perry	2
Clearfield	9	Philadelphia	9
Clinton	9	Potter	2
Columbia	8	Schuylkill	18
Crawford	9	Snyder	2
Cumberland	5	Somerset	7
Dauphin	15	Susquehanna	2
Delaware	5	Tioga	4
Elk	1	Union	1
Erie	4	Warren	2
Fayette	11	Washington	12
Franklin	2	Wayne	3
Greene	6	Westmoreland	13
Huntingdon	5	Wyoming	1
Indiana	4	York	4
Jefferson	2	***TOTAL***	***370***

4.3.5.7. State Facility Vulnerability Assessment

Table 4.3.5-5 lists a breakdown of the types of facilities contained within the flood hazard zones. Due to the large number of schools, fire departments, and police stations in the Commonwealth, it is unsurprising that those categories of facilities have the highest number of critical facilities.

Table 4.3.5-5 State Critical Facilities within the 1%-annual-chance flood hazard area by Facility Type

STATE CRITICAL FACILITY TYPE	NUMBER OF IMPACTED FACILITIES
Agriculture	10
Banking	2
Chemical	2
Commercial Facilities	5
Communications	2
Dams	10
Defense Industrial Base	1
Education	1
Emergency Services	2
Energy	3
Fire Departments (Non-HSIP)	188
Healthcare & Public Health	2
Hospital (Non-HSIP)	3
Nuclear Reactors, Materials & Waste	2
Police (Non-HSIP)	72
Postal & Shipping	3
School (Non-HSIP)	45
Transportation	10
Water	7
TOTAL VULNERABLE CRITICAL FACILITIES	***370***

4.3.5.8. Jurisdictional Loss Estimation

The National Flood Insurance Program identifies *repetitive loss* (RL) and *severe repetitive loss* (SRL) properties. The following definition of RL and SRL properties from the Hazard Mitigation Assistance (HMA) Unified Guidance from July 2013 reflects changes made in the Biggert-Waters Flood Insurance Reform Act of 2012:

- A **repetitive loss** property is a structure covered by a contract for flood insurance made available under the NFIP that:

  (a) Has incurred flood-related damage on 2 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

(b) At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage. (Please note: Homes are eligible for ICC coverage after first loss however cost for ICC is part of all policies.)

- A **severe repetitive loss** property is a structure that:

  (a) Is covered under a contract for flood insurance made available under the NFIP; and

  (b) Has incurred flood related damage

    (i) For which 4 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 2 separate claims payments have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

Table 4.3.5-6 and Table 4.3.5-7 show the number and type of RL and SRL properties for each county in Pennsylvania, respectively. This data was obtained from FEMA in July 2013 and joined with data on mitigated properties from the following sources:

- Commonwealth of Pennsylvania 2010 State Standard All-Hazard Mitigation Plan
- PEMA mitigated properties tracking from July 2013
- ICC data export from July 2013
- FEMA Greatest Savings to the Fund (GSTF) data from August 2013

Information between data sources and within each of the data sources improved between 2010 and 2013. Database updates were completed as part of disaster recovery projects in the Commonwealth at the local, state and federal level. Though the databases have improved information on mitigation does not exactly match between Bureaunet, PEMA tracking, ICC, and GSTF. The mitigation strategy reflects both the progress made and the continuing need for updates to capture all mitigation in the Commonwealth.

Table 4.3.5-6 shows the number and type of RL properties for each county in Pennsylvania. As of July 2013, Pennsylvania had 8,180 repetitive loss properties with total losses of $658,455,490.56. Of the 8,180 properties, 1,070 properties have been mitigated, which is 13% of the total repetitive loss properties in the Commonwealth. Additionally, 70 RL properties were removed from the FEMA BureauNet database between 2010 and 2013; this is a reflection of both mitigation to acquire and remove the risk of many RL properties and database improvement projects. Completing FEMA Form AW-501was a task promoted in grant related presentations for recent Disaster Declarations in the Commonwealth.

Based on input from the DCED, an assumption is made that *non-residential* type is anything other than "residential" including, but not necessarily limited to "commercial" building types. Also, *ASSMD Condo* type refers to a situation where an individual owns the structure, or portion of the structure, but not any of the land.

Table 4.3.5-6 Total and mitigated Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (July 2013).												
COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Adams	28	2	2	0	1	0	1	0	1	0	33	2
Allegheny	236	19	25	1	3	1	5	0	82	6	351	27
Armstrong	29	1	0	0	1	0	1	0	4	0	35	1
Beaver	61	17	1	0	0	0	4	0	10	0	76	17
Bedford	120	36	0	0	6	4	3	1	1	0	130	41
Berks	59	17	4	0	2	0	4	0	17	0	86	17
Blair	98	20	0	0	2	0	5	0	7	0	112	20
Bradford	72	13	3	0	2	0	0	0	8	1	85	14
Bucks	670	127	38	2	15	2	19	0	104	7	846	138
Butler	59	8	0	0	1	0	0	0	6	0	66	8
Cambria	9	0	2	0	0	0	0	0	5	0	16	0
Cameron	9	0	0	0	0	0	0	0	1	0	10	0
Carbon	5	2	0	0	0	0	0	0	0	0	5	2
Centre	14	1	2	0	0	0	0	0	4	0	20	1
Chester	123	3	8	0	3	0	6	0	24	1	164	4
Clarion	3	0	1	0	2	0	0	0	5	1	11	1
Clearfield	28	4	2	0	1	0	3	1	8	1	42	6
Clinton	65	2	2	0	1	0	1	0	6	1	75	3
Columbia	310	32	36	1	12	0	4	1	38	1	400	35
Crawford	20	4	1	0	0	0	0	0	4	0	25	4
Cumberland	114	4	16	0	1	0	6	0	20	1	157	5
Dauphin	611	115	36	9	9	2	15	2	84	5	755	133
Delaware	198	28	12	0	5	0	4	0	66	2	285	30
Elk	8	0	0	0	0	0	0	0	3	0	11	0
Erie	33	8	1	1	2	0	0	0	8	1	44	10
Fayette	28	0	3	0	0	0	1	0	21	0	53	0
Forest	1	0	0	0	0	0	0	0	0	0	1	0
Franklin	7	1	0	0	0	0	0	0	0	0	7	1
Fulton	0	0	0	0	0	0	0	0	1	0	1	0
Greene	24	3	1	0	1	0	0	0	8	0	34	3
Huntingdon	49	3	3	0	0	0	0	0	6	0	58	3
Indiana	18	2	2	0	0	0	0	0	0	0	20	2
Jefferson	27	7	0	0	0	0	1	0	10	2	38	9
Juniata	16	0	2	0	0	0	0	0	2	0	20	0
Lackawanna	101	7	26	1	2	0	0	0	18	1	147	9
Lancaster	93	9	5	0	7	0	2	0	42	4	149	13

Table 4.3.5-6 Total and mitigated Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (July 2013).

COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Lawrence	10	0	1	0	0	0	0	0	2	0	13	0
Lebanon	66	5	3	0	1	0	1	0	5	0	76	5
Lehigh	70	7	0	0	3	0	3	0	35	1	111	8
Luzerne	345	40	72	2	6	0	2	0	66	3	491	45
Lycoming	461	65	39	5	16	1	5	1	28	3	549	75
McKean	7	1	1	0	0	0	0	0	4	1	12	2
Mercer	6	1	0	0	1	0	0	0	3	1	10	2
Mifflin	32	5	0	0	0	0	1	0	12	1	45	6
Monroe	28	6	2	0	1	0	0	0	11	0	42	6
Montgomery	448	49	24	2	14	1	30	0	112	2	628	54
Montour	6	0	0	0	1	1	0	0	3	1	10	2
Northampton	212	59	14	2	4	0	5	0	27	1	262	62
Northumberland	163	38	18	12	10	0	5	3	52	7	248	60
Perry	68	0	11	0	3	0	4	0	14	0	100	0
Philadelphia	79	0	3	0	2	0	5	0	22	0	111	0
Pike	28	1	0	0	0	0	0	0	3	0	31	1
Potter	2	0	0	0	0	0	0	0	1	0	3	0
Schuylkill	55	1	10	0	1	0	0	0	16	0	82	1
Snyder	130	18	13	2	5	1	0	0	9	1	157	22
Somerset	10	0	0	0	0	0	1	0	3	0	14	0
Sullivan	15	1	0	0	2	1	0	0	0	0	17	2
Susquehanna	64	7	2	0	1	0	0	0	6	1	73	8
Tioga	11	1	0	0	0	0	0	0	3	0	14	1
Union	98	27	19	10	2	1	3	2	16	3	138	43
Venango	16	4	1	1	8	7	0	0	27	26	52	38
Warren	8	2	0	0	0	0	0	0	1	0	9	2
Washington	35	0	5	0	1	0	2	0	22	1	65	1
Wayne	28	1	0	0	0	0	0	0	3	0	31	1
Westmoreland	79	5	9	2	6	1	1	0	15	1	110	9
Wyoming	158	32	7	1	8	1	1	1	15	2	189	37
York	97	16	1	0	4	0	2	0	15	2	119	18
TOTAL	**6181**	**887**	**489**	**54**	**179**	**24**	**156**	**12**	**1175**	**93**	**8180**	**1070**

A sub-set of the repetitive loss properties is severe repetitive loss properties; the Commonwealth has 475 severe repetitive loss properties with claims totaling $74,999,965.48.

Table 4.3.5-7 illustrates the number and type of properties by county in Pennsylvania. Of the 475 SRL properties, 46 have been mitigated, or 9.7% of all SRL properties, as documented on the PEMA Mitigated Properties spreadsheet included in *Appendix G – Repetitive Loss and Severe Repetitive Loss Properties Inventory*. Like the RL property data, this data was obtained from FEMA and cross referenced with PEMA, ICC, and GSTF data in July 2013. Additionally, 81 SRL properties were removed from the FEMA Bureaunet database between 2010 and 2013; this is a reflection of both mitigation to acquire and remove the risk of many SRL properties and database improvement projects.

Table 4.3.5-7 Total and mitigated Severe Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (July 2013).

COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Adams	5	0	0	0	0	0	0	0	0	0	5	0
Allegheny	2	0	0	0	0	0	0	0	0	0	2	0
Armstrong	3	0	0	0	0	0	0	0	0	0	3	0
Beaver	3	3	0	0	0	0	0	0	0	0	3	3
Bedford	10	1	0	0	0	0	1	0	0	0	11	1
Berks	1	0	0	0	0	0	0	0	0	0	1	0
Blair	2	1	0	0	0	0	0	0	0	0	2	1
Bradford	7	2	0	0	0	0	0	0	0	0	7	2
Bucks	91	17	6	0	0	0	1	0	0	0	98	17
Butler	6	1	0	0	0	0	0	0	0	0	6	1
Cambria	0	0	0	0	0	0	0	0	0	0	0	0
Cameron	0	0	0	0	0	0	0	0	0	0	0	0
Carbon	0	0	0	0	0	0	0	0	0	0	0	0
Centre	0	0	0	0	0	0	0	0	0	0	0	0
Chester	9	0	0	0	0	0	0	0	0	0	9	0
Clarion	0	0	0	0	0	0	0	0	0	0	0	0
Clearfield	1	0	0	0	0	0	0	0	0	0	1	0
Clinton	2	0	0	0	0	0	0	0	0	0	2	0
Columbia	15	0	1	0	0	0	0	0	0	0	16	0
Crawford	0	0	0	0	0	0	0	0	0	0	0	0
Cumberland	5	0	1	0	0	0	1	0	0	0	7	0
Dauphin	19	2	1	1	0	0	2	0	0	0	22	3
Delaware	25	1	5	0	0	0	1	0	0	0	31	1
Elk	0	0	0	0	0	0	0	0	0	0	0	0
Erie	1	0	0	0	0	0	0	0	0	0	1	0
Fayette	0	0	0	0	0	0	0	0	0	0	0	0
Forest	0	0	0	0	0	0	0	0	0	0	0	0
Franklin	0	0	0	0	0	0	0	0	0	0	0	0

Table 4.3.5-7 Total and mitigated Severe Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (July 2013).

COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Fulton	0	0	0	0	0	0	0	0	0	0	0	0
Greene	0	0	0	0	0	0	0	0	0	0	0	0
Huntingdon	3	0	1	0	0	0	0	0	0	0	4	0
Indiana	0	0	0	0	0	0	0	0	0	0	0	0
Jefferson	0	0	0	0	0	0	0	0	0	0	0	0
Juniata	0	0	0	0	0	0	0	0	0	0	0	0
Lackawanna	4	0	3	0	0	0	0	0	0	0	7	0
Lancaster	12	0	1	0	0	0	0	0	0	0	13	0
Lawrence	0	0	0	0	0	0	0	0	0	0	0	0
Lebanon	2	0	0	0	0	0	0	0	0	0	2	0
Lehigh	3	0	0	0	0	0	0	0	0	0	3	0
Luzerne	21	4	6	0	0	0	0	0	0	0	27	4
Lycoming	23	2	4	0	0	0	0	0	0	0	27	2
McKean	0	0	0	0	0	0	0	0	0	0	0	0
Mercer	1	0	0	0	0	0	0	0	0	0	1	0
Mifflin	1	0	0	0	0	0	0	0	0	0	1	0
Monroe	3	0	0	0	0	0	0	0	0	0	3	0
Montgomery	65	1	4	0	0	0	8	0	0	0	77	1
Montour	0	0	0	0	0	0	0	0	0	0	0	0
Northampton	26	6	2	0	0	0	1	0	0	0	29	6
Northumberland	10	1	0	0	0	0	0	0	0	0	10	1
Perry	1	0	0	0	0	0	0	0	0	0	1	0
Philadelphia	10	0	0	0	0	0	0	0	0	0	10	0
Pike	1	0	0	0	0	0	0	0	0	0	1	0
Potter	0	0	0	0	0	0	0	0	0	0	0	0
Schuylkill	2	0	1	0	0	0	0	0	0	0	3	0
Snyder	4	0	1	0	0	0	0	0	0	0	5	0
Somerset	1	0	0	0	0	0	0	0	0	0	1	0
Sullivan	0	0	0	0	0	0	0	0	0	0	0	0
Susquehanna	2	1	0	0	0	0	0	0	0	0	2	1
Tioga	0	0	0	0	0	0	0	0	0	0	0	0
Union	3	0	4	2	0	0	0	0	0	0	7	2
Venango	0	0	0	0	0	0	0	0	0	0	0	0
Warren	0	0	0	0	0	0	0	0	0	0	0	0
Washington	0	0	0	0	0	0	0	0	0	0	0	0
Wayne	3	0	0	0	0	0	0	0	0	0	3	0

Table 4.3.5-7 Total and mitigated Severe Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (July 2013).

COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Westmoreland	1	0	0	0	0	0	0	0	0	0	1	0
Wyoming	7	0	0	0	0	0	0	0	0	0	7	0
York	3	0	0	0	0	0	0	0	0	0	3	0
TOTAL	**419**	**43**	**41**	**3**	**0**	**0**	**15**	**0**	**0**	**0**	**475**	**46**

Figure 4.3.5-6 displays geocoded mitigated SRL and RL properties from the combined *Repetitive Loss and Severe Repetitive Loss Properties Inventory.* Addresses were mapped using provided spatial coordinates and, where coordinates were missing, GoogleMaps. Due to incomplete or inadequate address information, not all properties are shown on the map; a total of 976 of the 1,116 mitigated RL and SRL properties were able to be mapped. This, however, represents 86.6% of all mitigated properties, a significant improvement over the number of properties able to be mapped in the 2010 SSAHMP. Additionally, a closer look at the spatial data shows that often SRL and RL properties were located adjacent to one another on the ground, making it appear as if there are fewer SRL and RL properties statewide.

As of July 2013, Pennsylvania had 8,180 RL properties with claims totaling $658,455,490.60. At least 1,070 (13%) of these properties have been mitigated. The Commonwealth has 475 SRL properties with claims totaling $74,999,965.48. At least 46 (9.7%) of these properties have been mitigated. A majority (65.5%) of the 475 SRL properties within the Commonwealth are located in Bucks, Montgomery, Delaware Northampton, Luzerne, Lycoming, and Dauphin Counties, while most other counties have less than 20 SRL properties. Twenty four counties have no SRL properties at all. Bucks, Dauphin, Montgomery, Lycoming, Luzerne, Columbia, Allegheny, Delaware, Northampton, and Northumberland are among the counties which the Commonwealth has targeted to provide mitigation options to property owners since they have the highest numbers of RL properties.

The mitigation of RL and SRL properties is a high priority, especially since the losses experienced by these tend to be high and frequent. Losses avoided during Hurricane Sandy for RL and SRL properties may be estimated at $12,029,031. These avoided losses are based on a brief study based on RL and SRL properties mitigated prior to Hurricane Sandy in Sandy-declared counties, regardless of their location vis-à-vis Sandy-related flooding. This analysis provides a generalized idea of the losses that may have been prevented by mitigating RL and SRL structures and can help community members, local officials, and floodplain managers understand in conceptual terms how much less money may be paid out due to a flood because of mitigation activity. Table 4.3.5-8 shows that last payment prior to Hurricane Sandy for RL and SRL structures in the declared counties. A more robust losses avoided study would incorporate the following information:

- Property location
- Pre-mitigation structure type
- Pre-mitigation square footage
- Pre-mitigation first floor elevation
- Post-mitigation first floor elevation
- Pre-mitigation number of floors
- Elevation certificates
- Detailed flood depth data for Sandy-impacted areas
- Data on structure and contents replacement value
- Defined depth-damage curves (used to define the relationship between flood depth and structure damage).

Because of this missing data, Action 4-1d in the Mitigation Strategy is not complete. However, PEMA and FEMA continue to work together to refine a Pennsylvania-specific losses avoided study and better quantify the value of mitigation in Pennsylvania.

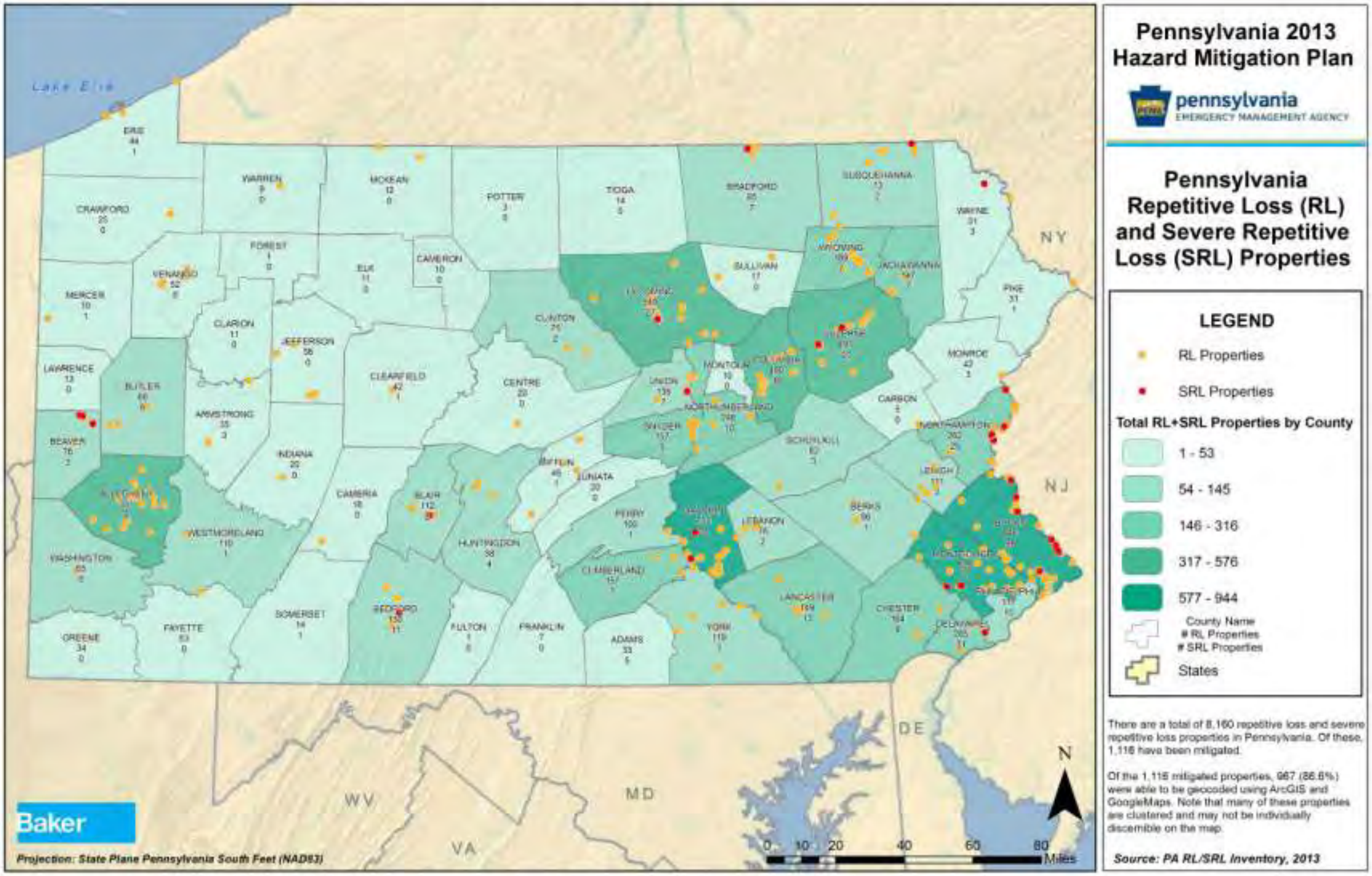
Table 4.3.5-8 Losses Avoided in Hurricane Sandy Based on Last Payment to RL and SRL Properties Prior to Hurricane Sandy. Data from PA RL & SRL Inventory (July 2013).

COUNTY	Last Building Payment Prior to Hurricane Sandy	Last Contents Payment Prior to Hurricane Sandy	Last Total Payment Prior to Hurricane Sandy
Bedford	$342,179	$135,279	$477,458
Bucks	$3,729,905	$664,121	$4,394,026
Cameron	$0	$0	$0
Dauphin	$3,439,963	$207,272	$3,647,235
Forest	$0	$0	$0
Franklin	$9,331	$5,000	$14,331
Fulton	$0	$0	$0
Huntingdon	$33,712	$18,363	$52,074
Juniata	$0	$0	$0
Monroe	$202,996	$50,628	$253,624
Northampton	$2,037,044	$175,167	$2,212,211
Philadelphia	$0	$0	$0
Pike	$141,947	$43,000	$184,947
Potter	$0	$0	$0
Somerset	$0	$0	$0
Sullivan	$0	$13,720	$13,720
Wyoming	$637,617	$141,785	$779,402
TOTAL	**$10,574,695**	**$1,454,335**	**$12,029,031**

PEMA has worked to mitigate RL and SRL properties since the inception of the SRL and Repetitive Flood Claims (RFC) grant programs. Since 2008, emphasis has been placed on mitigating SRL properties in particular. Twenty-three of the 46 SRL mitigated properties are identified as having been mitigated through PEMA and FEMA. The remaining 23 properties have been mitigated using ICC program funds. Additionally, 900 of the mitigated RL properties have been mitigated using PEMA and FEMA grant program funding. A total of 298 properties used ICC program fund, with 170 of those properties using just ICC program funds.

Figure 4.3.5-6 shows clusters of RL and SRL properties exist in Allegheny County near Pittsburgh, in Lycoming County near Williamsport, in Luzerne and Lackawanna Counties in the Wilkes-Barre-Scranton area, along the Susquehanna in Central Pennsylvania, and in the communities surrounding the Philadelphia Metropolitan area. Additional projects are underway and will be listed once the supporting grant project has been closed and FEMA Form AW-501 is complete.

Figure 4.3.5-6 Map showing the location of mitigated Repetitive Loss and Severe Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (July 2013).



According to the National Climatic Data Center, previous flood events occurring between 1950 and 2013 have caused over $1 billion in property damage, over $3 million in crop damage, 86 deaths, and 166 injuries. Note that the quality of this data is uncertain; many events are listed as having caused no property or crop damage. This may mean estimates are conservative.

The 2013 Plan incorporates a Statewide Level 2 HAZUS Flood Study. A Level 2 HAZUS study is defined as one in which the user supplements the HAZUS default data with more recent, more local, or more accurate data. This is a Level 2 study because the model incorporates more up-to-date Census 2010 demographic data in conjunction with previously delineated depth grids. This was done to speed processing and leverage previously completed analysis. For more information on the data and methodology used in this analysis, see Section 4.1.4.

The flood study is an aggregation of flood model results from each county which provide estimates of total economic loss, building damage, content damage, and other economic impacts that can be used in local flood response and mitigation planning activities. “Buildings at least moderately damaged” are defined as the number of buildings at least 11% damaged and up to 100% damaged (FEMA, February 2012). The potential loss estimates due to flooding were calculated using HAZUS-MH 2.1 in 2013 to take advantage of updated Census demographic data in this Level 2 analysis.

Estimated total economic losses for a 1%-annual-chance flood event across the entire Commonwealth sum to $31,316,150,000, of which $31,071,150,000 are building-related losses. The 1%-annual-chance flood simulation estimated the displacement of 138,651 households and a corresponding shelter requirement of 301,556 people. Allegheny and Montgomery Counties are expected to see the highest total economic loss in a 1% annual-chance flood event, while Fulton County is expected to experience the least. This data is also mapped in Figure 4.3.5-6.

Table 4.3.5-9 HAZUS-MH results for a 1%-annual-chance flood event in Pennsylvania.

COUNTY	NO. OF BUILDINGS AT LEAST MODERATELY DAMAGED	NUMBER OF HOUSEHOLDS DISPLACED	SHELTER REQUIREMENT (PEOPLE)	TOTAL ECONOMIC LOSS (BUILDING-RELATED AND BUSINESS INTERRUPTION, MILLIONS $)	TOTAL BUILDING-RELATED LOSSES (BUILDING AND CONTENTS, MILLIONS $)
Adams	50	941	1,891	72.14	71.61
Allegheny	3,885	12,801	31,495	7,990.12	7,920.96
Armstrong	1,940	3,726	8,623	1,002.08	994.07
Beaver	527	2,143	4,601	533.54	530.67
Bedford	261	1,254	1,658	203.74	202.44
Berks	490	2,683	5,269	770.57	767.18
Blair	167	2,093	4,738	159.50	158.35
Bradford	348	1,710	3,034	197.98	196.33
Bucks	2,397	8,964	23,535	1,323.43	1,315.81
Butler	254	2,132	4,507	272.26	270.43

Table 4.3.5-9 HAZUS-MH results for a 1%-annual-chance flood event in Pennsylvania.

COUNTY	NO. OF BUILDINGS AT LEAST MODERATELY DAMAGED	NUMBER OF HOUSEHOLDS DISPLACED	SHELTER REQUIREMENT (PEOPLE)	TOTAL ECONOMIC LOSS (BUILDING-RELATED AND BUSINESS INTERRUPTION, MILLIONS $)	TOTAL BUILDING-RELATED LOSSES (BUILDING AND CONTENTS, MILLIONS $)
Cambria	702	2,019	3,557	939.07	932.74
Cameron	348	347	641	159.42	158.29
Carbon	247	1,095	2,581	113.01	131.75
Centre	132	1,356	2,544	135.22	134.25
Chester	656	3,319	7,366	573.49	570.78
Clarion	80	259	279	71.41	70.62
Clearfield	250	1,360	2,182	309.87	306.63
Clinton	394	2,306	4,606	337.53	333.82
Columbia	1,124	2,380	6,142	664.00	659.16
Crawford	525	2,160	4,095	414.20	411.45
Cumberland	502	2,315	5,029	330.71	328.79
Dauphin	261	1,763	3,362	195.93	194.96
Delaware	1,284	5,374	13,969	809.67	805.98
Elk	182	563	962	139.90	138.73
Erie*	182	1,706	3,084	229.56	228.65
Fayette	349	2,023	3,889	276.68	272.97
Forest	48	51	63	12.94	12.90
Franklin	312	1,912	4,286	190.92	189.85
Fulton**	0	109	15	12.07	12.04
Greene	41	697	964	85.10	84.25
Huntingdon	195	2,086	4,089	128.09	127.05
Indiana	111	1,166	2,149	97.24	96.65
Jefferson	201	1,413	2,809	239.41	237.29
Juniata	50	496	539	58.57	28.06
Lackawanna	1,069	3,287	7,776	631.88	627.80
Lancaster	671	3,766	7,650	655.32	652.03
Lawrence	312	1,263	2,329	425.77	423.71
Lebanon	91	868	1,634	126.98	126.32
Lehigh	278	1,495	3,127	238.17	236.95
Luzerne	1,180	6,899	17,829	1,061.23	1,052.11
Lycoming	898	3,466	8,025	616.48	610.69
McKean	120	1,113	2,334	142.20	140.75
Mercer	127	1,641	3,323	468.12	464.99
Mifflin	273	1,317	2,885	198.51	197.46

Table 4.3.5-9 HAZUS-MH results for a 1%-annual-chance flood event in Pennsylvania.

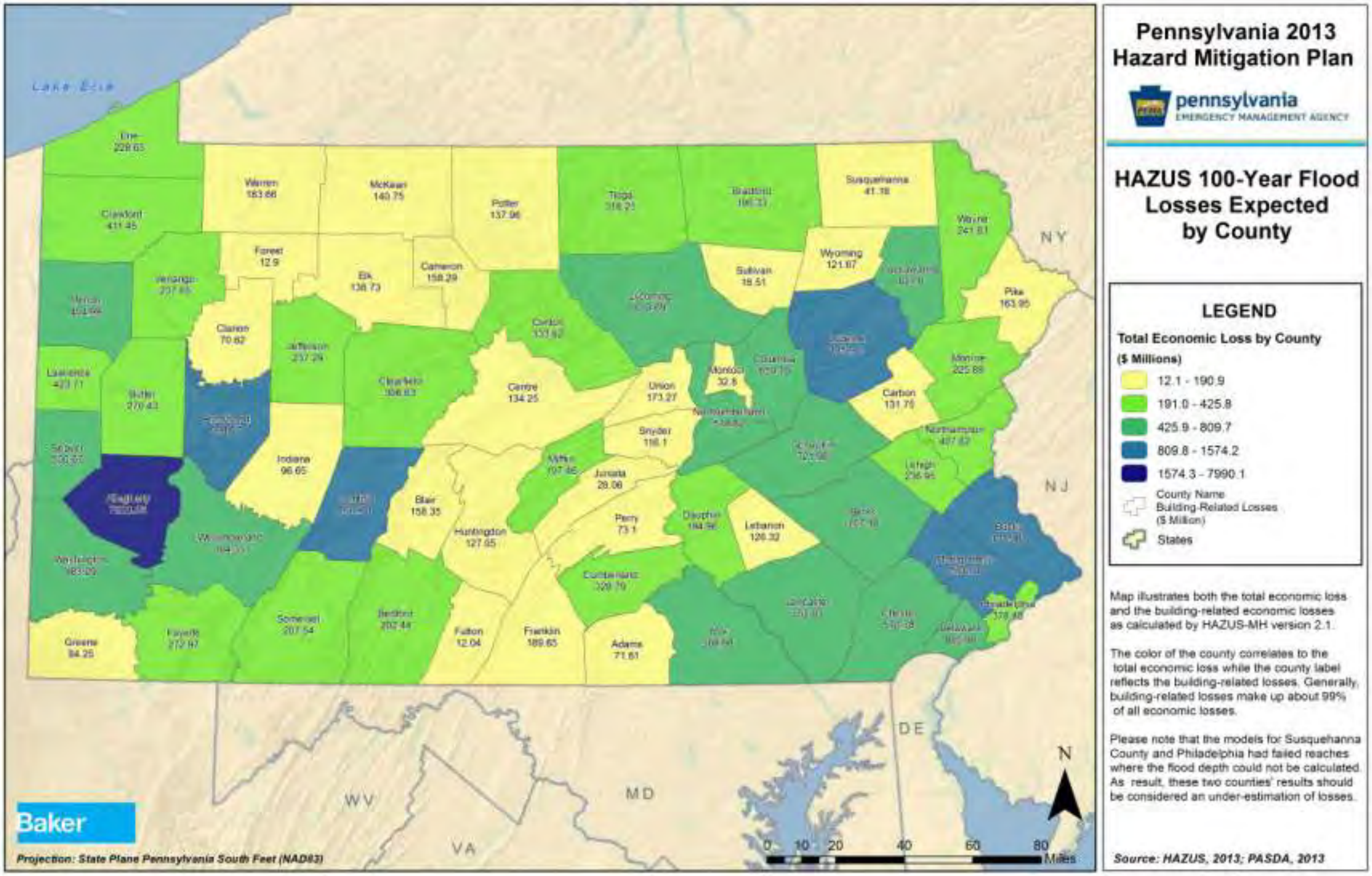
COUNTY	NO. OF BUILDINGS AT LEAST MODERATELY DAMAGED	NUMBER OF HOUSEHOLDS DISPLACED	SHELTER REQUIREMENT (PEOPLE)	TOTAL ECONOMIC LOSS (BUILDING-RELATED AND BUSINESS INTERRUPTION, MILLIONS $)	TOTAL BUILDING-RELATED LOSSES (BUILDING AND CONTENTS, MILLIONS $)
Monroe	209	1,107	1,985	226.89	225.88
Montgomery	1,217	4,181	9,450	1,574.18	1,566.38
Montour	35	229	356	33.37	32.80
Northampton	264	2,356	5,364	410.40	407.82
Northumberland	1,305	3,006	6,683	523.44	518.82
Perry	63	834	1,473	73.82	73.10
Philadelphia***	325	2,036	5,395	381.37	378.48
Pike	264	829	1,369	165.44	163.95
Potter	149	799	1,356	139.81	137.96
Schuylkill	847	3,782	8,349	728.16	721.96
Snyder	50	362	314	116.64	116.10
Somerset	297	1,282	1,841	210.57	207.54
Sullivan	44	97	70	18.83	18.51
Susquehanna***	12	442	486	41.40	41.18
Tioga	692	2,417	5,171	321.58	318.25
Union	296	1,214	2,205	174.63	173.27
Venango	266	815	1,633	238.62	237.05
Warren	344	1,149	2,262	185.17	183.66
Washington	195	1,763	3,083	487.50	483.29
Wayne	193	837	1,896	244.77	241.83
Westmoreland	904	3,980	8,623	771.44	764.35
Wyoming	197	706	1,256	122.56	121.67
York	441	2,591	5,471	511.53	508.98
TOTAL	**32,123**	**138,651**	**301,556**	**31,316.15**	**31,071.15**

*Erie County's results include both riverine and coastal flood losses.

**In Fulton County, no buildings are expected to be at least moderately damaged in the 100-year flood event; this does not preclude buildings that are only very slightly impacted from experiencing building-related losses or causing displacement that would require shelter. This is the calculated result.

***The Susquehanna County and Philadelphia models included failed reaches for which the flood depth and floodplain could not be calculated. As a result, these results are likely an underestimation of potential flood losses.

Figure 4.3.5-7 HAZUS-calculated loss estimates by county.



Between 2003 and 2013, over $1.3 billion in U.S. Small Business Administration (SBA), Individual Assistance, Public Assistance, and Hazard Mitigation Assistance funds have been distributed in response to eight federal disaster declarations. The SBA provides low interest loans to residential home-owners and small businesses located in SBA-approved disaster areas who have incurred eligible property and/or business losses. Individual Assistance funds are provided by FEMA to homeowners and renters living in Presidentially-declared disaster areas who have incurred eligible housing damages. Public Assistance funds are re-imbursements provided by FEMA to the Commonwealth and its agencies, local governments, and certain non-profits for the repair, reconstruction, etc… of public infrastructure having incurred eligible damage in Presidentially-declared disaster areas. Such reimbursements include, but are not limited to repairs for the eligible costs of repairs for highways, roads, and bridges, water and sewer facilities, and certain costs to provide emergency assistance during and immediately after a disaster event. Hazard mitigation funds are made available through the FEMA Hazard Mitigation Grant Program based on a percentage of the total federal cost of a Presidentially-declared disaster awarded to the Commonwealth for eligible hazard mitigation activities. All of these funds are summarized in Table 4.3.5-10. The largest distribution of funds occurred in response to significant flood events in September 2004 and June 2006.

Table 4.3.5-10 Summary of funds distributed in Pennsylvania as a result of disaster declarations related to flooding between 2003 and 2013 (PEMA, 2010, and FEMA, 2013).

YEAR	DECLARATION		NUMBER OF COUNTIES DECLARED	INDIVIDUAL ASSISTANCE APPLICANTS	SMALL BUSINESS ADMIN.	INDIVIDUAL ASSISTANCE $	PUBLIC ASSISTANCE $	HAZARD MITIGATION	TOTAL ASSISTANCE
	DATE	NUMBER							
2003	8/23/2003	DR-1485	11	2,010	$1,712,000	$2,965,355	$4,880,320	$3,104,189	**$12,661,864**
	9/26/2003	DR-1497	1	674	$843,500	$1,009,837	$0	$83,000	**$1,936,337**
2004	8/6/2004	DR-1538	3	11,284	$5,500,000	$10,000,000	$0	$1,000,000	**$16,500,000**
	9/19/2004	DR-1555	10	2,766	$1,751,400	$3,500,000	$0	$370,000	**$5,621,400**
	9/19/2004	DR-1557	54	43,509	$74,900,000	$86,800,000	$112,300,000	$16,700,000	**$290,700,000**
2005	4/14/2005	DR-1587	9	3,103	$4,600,000	$3,800,000	$27,300,000	$1,300,000	**$37,000,000**
2006	7/4/2006	DR-1649	28	13,889	$57,000,000	$206,000,000	$106,900,000	$9,700,000	**$379,600,000**
2007	2/23/2007	DR-1684	8	0	$0	$0	$15,600,000	$2,700,000	**$18,300,000**
2008	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
2009	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
2010	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
2011	4/25/2011	DR-4003	5	*none*	*none*	*none*	10,568,582.47	$1,724,035	**$12,292,617**
	8/26/2011	DR-4025	14	18,283	82,500,000	$41,734,054	$29,638,679	$14,956,724	**$168,829,457**
	9/3/2011	DR-4030	32	25,406	50,400,000	$103,554,187	$147,395,311	$51,007,332	**$352,356,830**
2012	10/26/2012	DR-4099	18	*none*	*none*	*none*	$10,741,638	$2,623,955	**$13,365,593**
2013 (as of 8/13)	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
TOTALS			**193**	**120,924**	**$279,206,900**	**$459,363,433**	**$465,324,531**	**$105,269,235**	**$1,309,164,098**

The most effective solution to reducing flood damages is to minimize development in the floodplain. However, this is often challenging in the face of development pressure. Programs of floodplain zoning and flood insurance have been successful in reducing, but not eliminating, losses.

The U.S. Army Corps of Engineers, the U.S. Department of Agriculture's Natural Resources Conservation Service (formerly the Soil Conservation Service), and the Pennsylvania Department of Environmental Protection have constructed many flood protection projects throughout the Commonwealth. Most of the projects consist of concrete floodwalls, concrete channels, compacted earth levees, channel improvements, or any combination of these methods. All of the current flood protection projects were constructed because that particular community had a history of flooding and the main purpose of these projects was to prevent recurrent flood damages. Although flood protection projects are still constructed today, many of the existing projects were built in the 1940's, 1950's and 1960's. These projects are in need of rehabilitation and in some cases major improvements are needed due to the many watershed changes that have occurred since their original construction. Other potential ways of eliminating flood damages involve either a watershed approach (this could consist of many small projects throughout the watershed to detain or protect an area) or a non-structural solution. Non-structural alternatives can include buyouts (purchase flood-prone homes and businesses and remove them from the floodplain), flood warning systems, elevate structures, or flood-proof structures. Future flood protection feasibility studies should consider all of the potential alternatives for flood damage reduction. Building new and maintaining existing flood protection projects are both addressed in the beginning of the 2013 mitigation strategy with Actions 1-1a and 1-1b.

Large flood-control reservoirs can be highly effective in storing storm runoff and thus reducing downstream flood magnitudes. The Kinzua Dam serves as a good example of efficient flood control provided by large dams. With over 500,000 acre-feet of active flood-storage capacity, the Kinzua Dam is capable of reducing flood peaks on the Allegheny River near West Hickory, Forest County. The flood-peak reduction varies between forty percent for the 50%-annual-chance flood and sixty percent for the 1%-annual-chance flood. A number of large flood control dams have been constructed throughout Pennsylvania. These are multi-purpose dams constructed by the U.S. Army Corps of Engineers and provide Pennsylvania residents with excellent recreational opportunities as well as save millions of dollars in reduced flood damages. It remains important for coordination between agencies regarding flooding risks as a result of potential flood-control structure failures to continue. This coordination is addressed in actions addressing Objectives 1-5 and 1-7.

4.3.5.9. State Facility Loss Estimation

The state facility loss estimation was calculated by summing the replacement value of all state critical facilities located in the 1%-annual-chance flood hazard area. The estimated replacement value of all State Critical Facilities located in the 1%-annual-chance flood hazard area is $1,853,267,443.