

## **Flooding**

### **General**

Flooding is the leading cause of death among all types of natural disasters throughout the United States, with its ability to roll boulders the size of cars, tear out trees, and destroy buildings and bridges. Typically the result of heavy precipitation, snowmelts, and ice jams, major flood events can last several days or even weeks. Unfortunately, many homeowners fail to realize that the average insurance policy does not cover flooding. For this reason, floods are a costly hazard.

A property's vulnerability to a flood depends on its location in the floodplain. The properties that lie along the banks of a waterway are the most vulnerable. The property within the floodplain is broken into sections depending on its distance from the waterway. The 10-year flood zone is the area that has a 10 percent chance of being flooded every year. However, this label does not mean that this area cannot flood **more than** once every 10 years. It simply designates the probability of a flood of this magnitude every year. Further away from this area is the 50-year floodplain. This area includes the 10-year floodplain, plus additional property. The probability of a flood of this magnitude occurring during a one-year period is two percent. A summary of flood probability is shown above.

<b>Flood Probability Summary</b>	
<b>Flood Recurrence Intervals</b>	<b>Chance of Occurrence</b>
10-year	10.00%
50-year	2.00%
100-year	1.00%
500-year	0.20%

*Source: FEMA*

In the past, heavy rains caused most of Juniata County's flood problems. Heavy rains cause small creeks and streams to overflow their banks, leading to road closures and other damage.

Flooding poses the biggest threat to those who reside or conduct business in the floodplain. The most significant hazard exists for businesses in the floodplain that process, use, and/or store hazardous materials. A flood could potentially allow for hazardous materials to leak out of these areas. As the water recedes, it would spread the hazardous materials throughout the area. Also threatened are the agricultural areas in the floodplain. Most flood damage to property and structures located in the floodplain is caused by water exposure to the interior, high-velocity water, and debris flow.

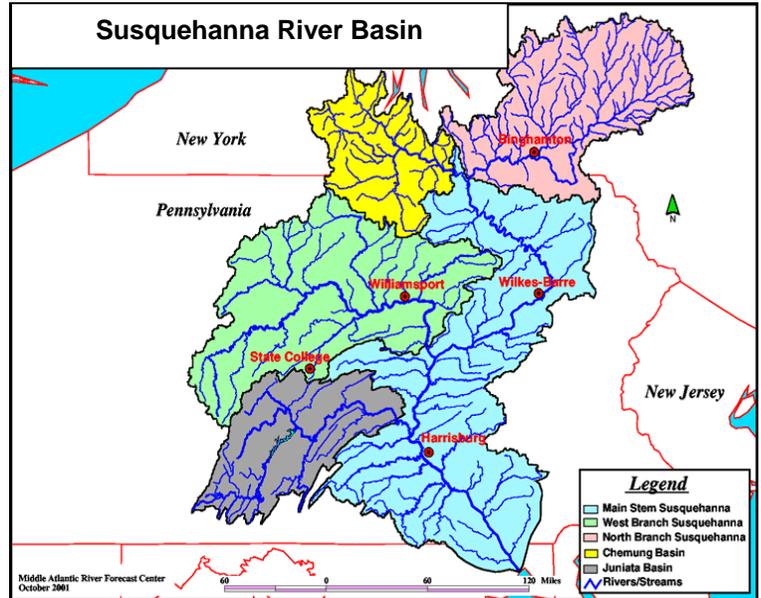
Juniata County is prone to two types of floods:

- Riverine Flood – Occurs in the floodplain of a river or stream when the amount of water and the rate at which it is moving increases.

- Flash Flood – A type of riverine flood that occurs after a heavy storm, when the ground cannot absorb the high amount of precipitation. This can occur when heavy precipitation falls on frozen or already-saturated soil.

### **Flooding – Susquehanna River Basin**

The Susquehanna River Basin encompasses much of Pennsylvania and portions of New York to the north and Maryland to the south. It is composed of the Main Stem Susquehanna, North Branch Susquehanna, West Branch Susquehanna, Chemung Sub-basin and Juniata Sub-basin. The Susquehanna River Basin is one of the most flood-prone watersheds in the entire nation. The main stem of the Susquehanna and its many tributaries drain 27,510 square miles of New York, Pennsylvania, and Maryland. Since the early 1800s, the main stem of the Susquehanna has flooded every 20 years, on average. The Susquehanna Basin also is vulnerable to frequent, localized flash floods every year. Since flood records were first kept in 1810, the Susquehanna River Basin's most devastating floods occurred in: 1936 (St. Patrick's Day Flood); 1955 (Hurricanes Connie and Diane); 1972 (Hurricane Agnes); 1975 (Hurricane Eloise); 1996 (January flooding); and 2004 (Tropical Storm Ivan). In 1972, Hurricane Agnes caused the worst recorded flooding in the basin. The flooding caused 72 deaths and \$2.8 billion in damage; flood levels exceeded the record levels of 1936 by as much as six feet in some places.



Despite frequent flooding, seven upstream dams contribute to the reduction of flood hazards on the Susquehanna River: Stillwater Reservoir, located approximately nine miles north of Carbondale, Pennsylvania, on the Lackawanna River; East Sidney Lake, located approximately eight miles east of Sidney, New York, on Ouleout Creek; Whitney Point Dam, located approximately one mile north of Whitney Point, New York, on the Otselic river; Almond Dam, located approximately two miles northwest of Hornell, New York, on Canacadea Creek; Arkport Dam, located approximately five miles northeast of Hornell, New York, on the Canisteo River; Tioga-Hammond Dam, located approximately 20 miles southwest of Elmira, New York, on the Tioga River and Crooked Creek; and Cowanesque Lake, located on the Cowanesque River approximately two miles above the confluence with the Tioga River at Lawrenceville, Pennsylvania.

**Flooding – Municipal Hazard Analysis**

**History**

The National Climatic Data Center maintains a historical record of flooding since 1993 in its Storm Event Database. This database measures all weather events from 1993 – 2005. According to the Storm Event Database, Juniata County has experienced 12 flood events since 1993. Of these, 11 events were categorized as flash floods, and one as combination flood/flash flood. Floods are caused by a variety of factors. The most significant occurrence of flooding is due to heavy rains. A summary of the flood history of Juniata County since November 1993 can be seen on the following pages.

The major cause of flooding in Juniata County is slow moving rain storms, originating from the south or southwest, with an abundance of moisture that has been transported from the Gulf of Mexico and re-supplied with Atlantic Ocean moisture by strong, stationary, Bermuda highs. A blocking high pressure area to the northeast of Pennsylvania contributes to these conditions. Intense local flash floods are most likely to occur in squall lines just to the east of a slow moving north-south oriented cold front. These are usually warm weather phenomena, where afternoon heating adds to the instability of the already unstable, moist air mass. Storms of tropical origin affect the Susquehanna River valley an average of once in three years. Their usual path is from the south to the northeast, but a few have traveled from the southeast to the northwest. The tropical storm season runs from June to November.

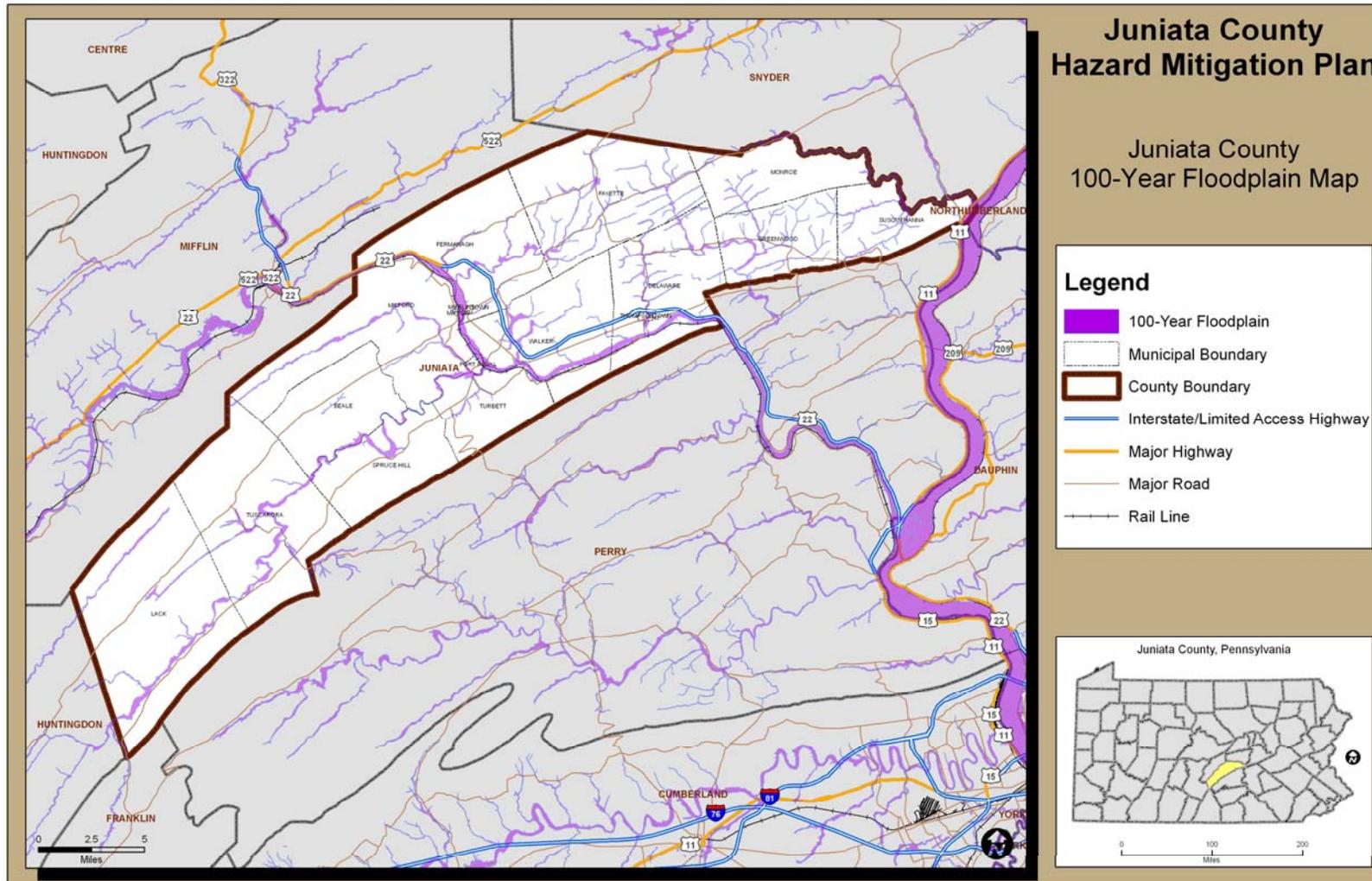
The Pennsylvania Emergency Management Agency (PEMA) maintains historical records of declared disasters since 1954. According to PEMA, four flooding events since 1954 that resulted in a declared disaster, affected Juniata County. The flooding in 2006 resulted in a Governor's and Presidential Major Disaster Declaration, individual and public assistance, and Hazard Mitigation.

<b>Juniata County Flooding Event History, 1950-2006</b>	
<b>Date</b>	<b>Type</b>
10/21/1995	Flood/Flash Flood
1/19/1996	Flood
1/19/1996	Flash Flood
9/6/1996	Flash Flood
9/13/1996	Flash Flood
12/13/1996	Flash Flood
9/11/1997	Flash Flood
1/8/1998	Flash Flood
4/19/1998	Flash Flood
1/23/1999	Flash Flood
8/20/1999	Flash Flood
6/20/2001	Flash Flood
9/17/2004	Flood
3/28/2005	Flood
6/27/2006	Flash Flood

**Source: National Climatic Data Center**

**Vulnerability**

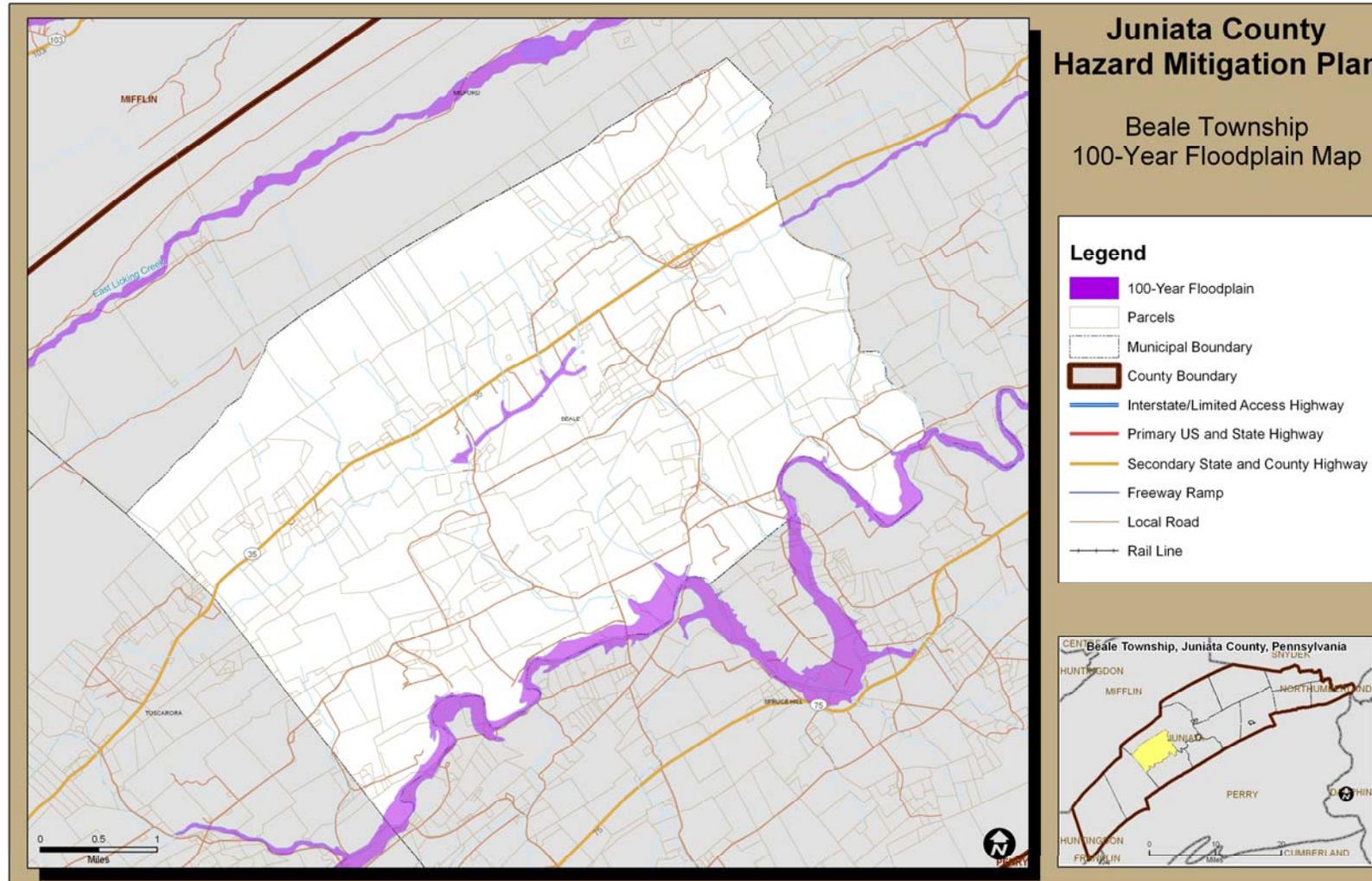
The following municipal summaries detail flood threats within Juniata County. This analysis was taken from the Federal Emergency Management Agency (FEMA) Flood Insurance Study.



**Beale Township**

Beale Township is located in the central portion of Juniata County. It is bordered by Milford Township to the north and east; Spruce Hill Township to the south; and Tuscarora Township to the west.

While Beale Township was not identified in the FEMA Flood Insurance Study, the 100 year floodplain map on the following page illustrates that the greatest risk of flooding in Beale Township occurs along the southern border with Spruce Hill Township and in the north central portion of the Township along the Tuscarora Creek.

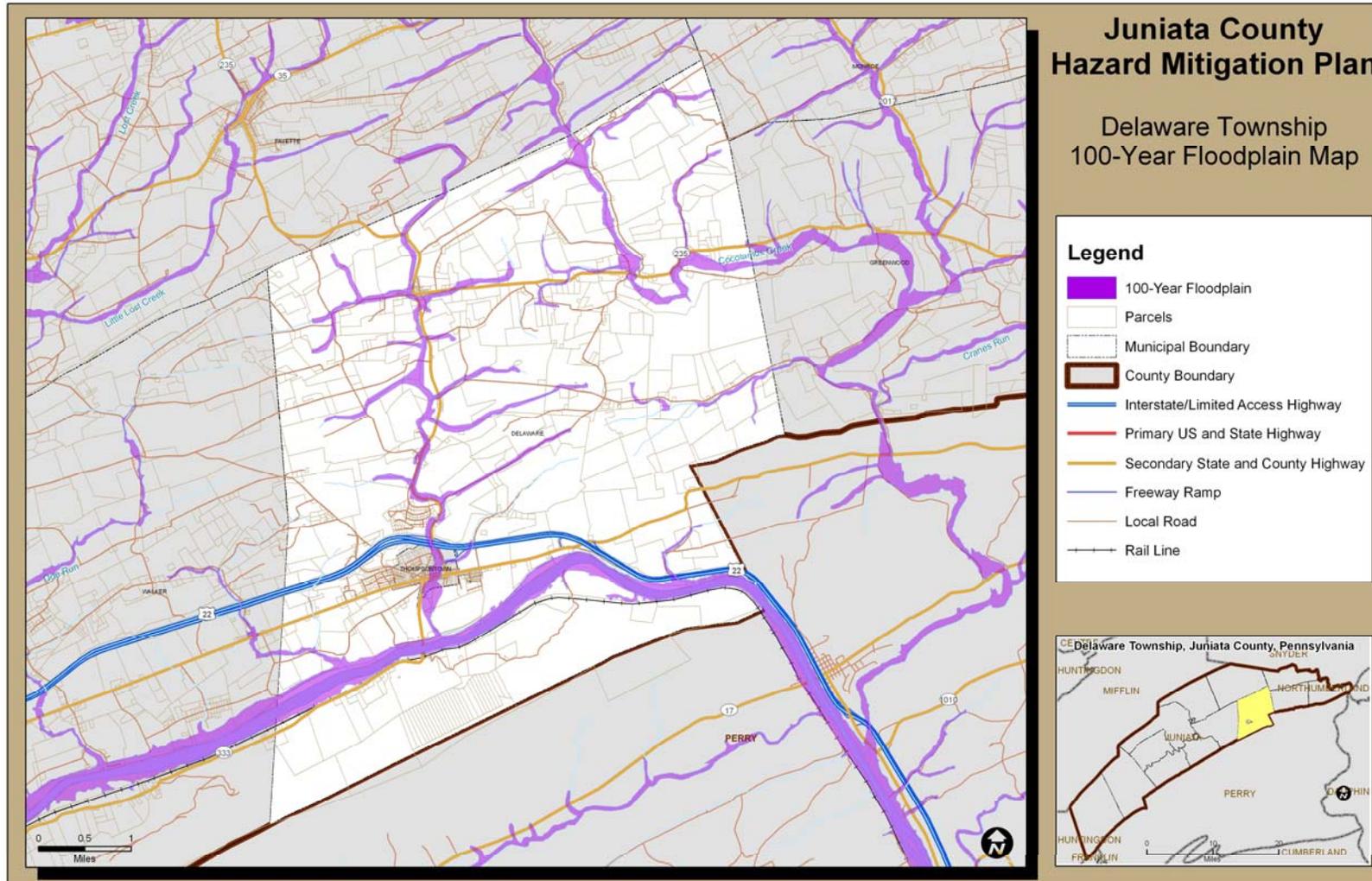


**Delaware Township**

The Township of Delaware is in the eastern portion of Juniata County. The Township is bordered by Fayette Township to the north; Monroe Township, Greenwood Township, Greenwood Township, Perry County to the east; and Tuscarora Township in Perry County to the south.

The Juniata River and the Delaware Creek present the greatest risk of flooding in Delaware Township. Major flooding has occurred in the Township in 1889, 1936, 1972, and 1975.

The map on the following page presents the 100-year floodplain risk for Delaware Township.

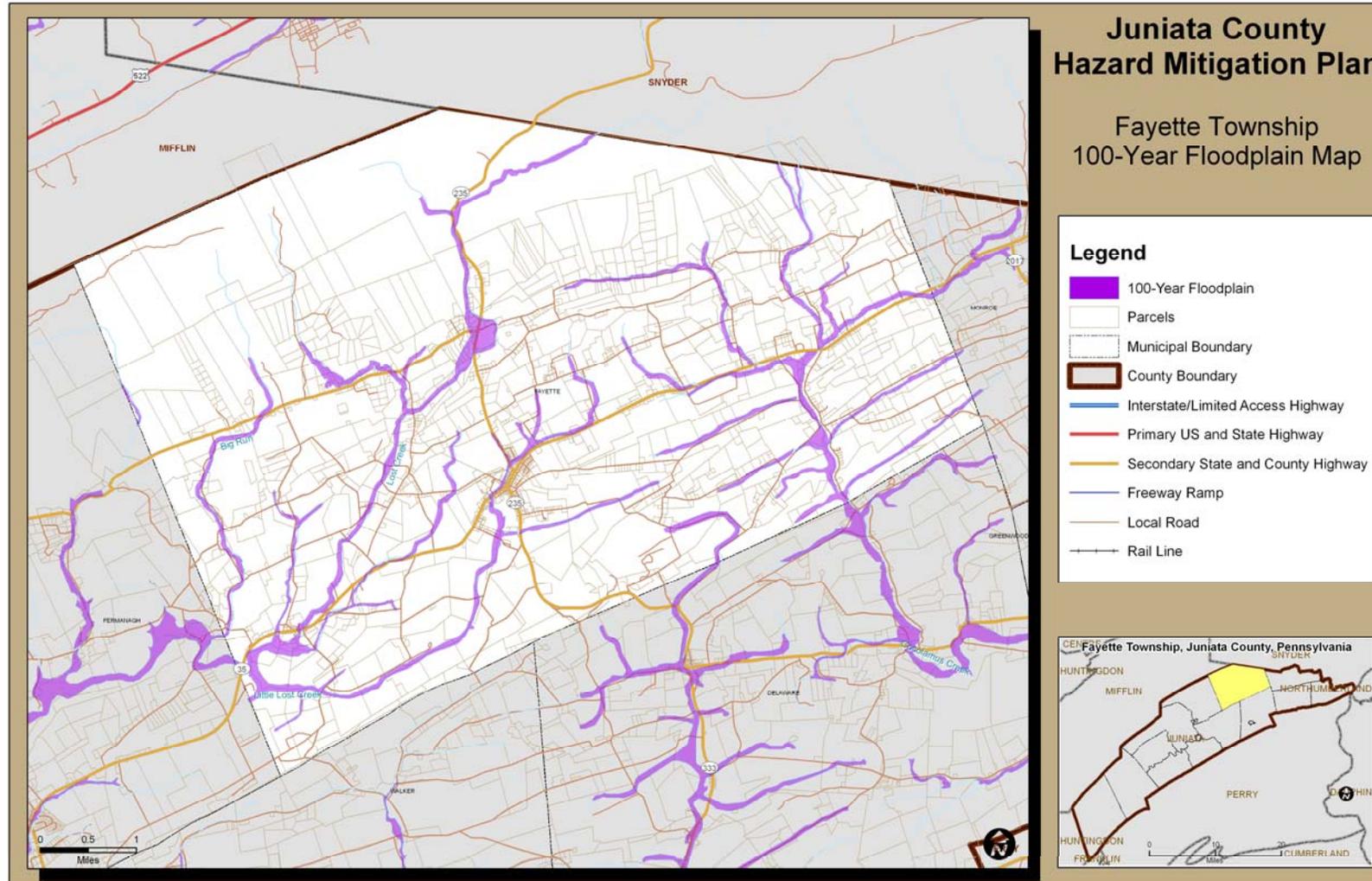


**Fayette Township**

The Township of Fayette is located in the northeastern portion of Juniata County. It is bordered by Fermanagh Township to the west; Walker Township and Delaware Township to the south; Monroe Township to the east; and Decatur Township in Mifflin County, and West Beaver Township and West Perry Township in Snyder County to the north.

Major flooding in Fayette Township is localized along Lost Creek and Little Lost Creek.

The map on the following page presents the 100-year floodplain risk for Fayette Township.

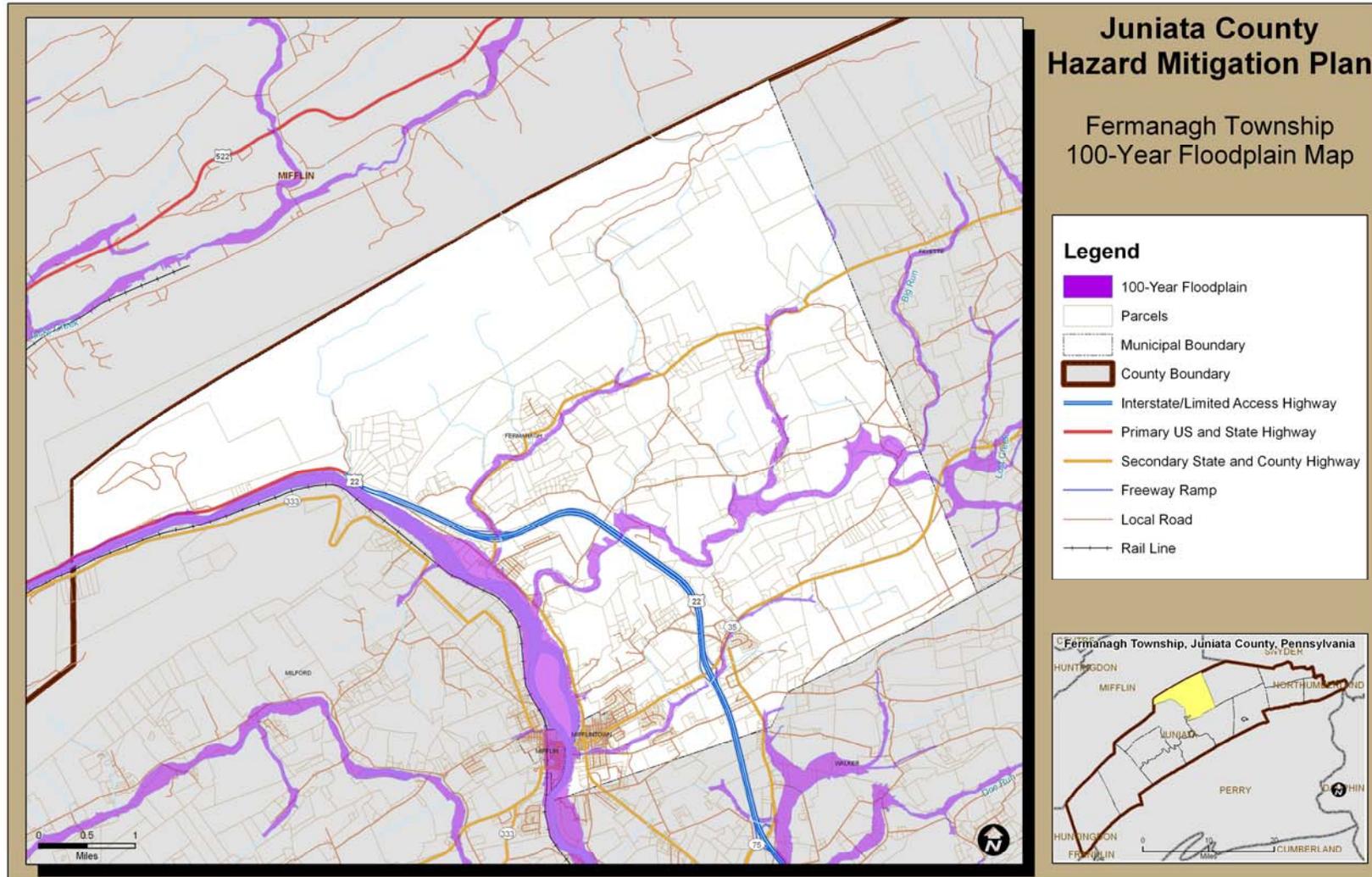


### **Fermanagh Township**

The Township of Fermanagh is located in the North Central section of Juniata County. It is bordered by Fayette Township to the east, Walker Township to the south, the Borough of Mifflin and Milford Township to the west, and Mifflin County to the north. The Township covers a total area of 31.8 square miles.

The western boundary of the Township is formed by the Juniata River. Other streams flowing west into the Juniata River include Horning Run, Lost Creek, and Schweyer Run. However, the principal source of flooding in the Township is the Juniata River. The worst flooding event recorded at the Juniata River occurred in 1889 when the river was measured at 35.9 feet just downstream from Newport, PA. This flood had a recurrence interval of 350-400 years. Flooding history for other streams in the Township is not documented by the FEMA flood insurance study.

The map on the following page presents the 100-year floodplain risk for Fermanagh Township.

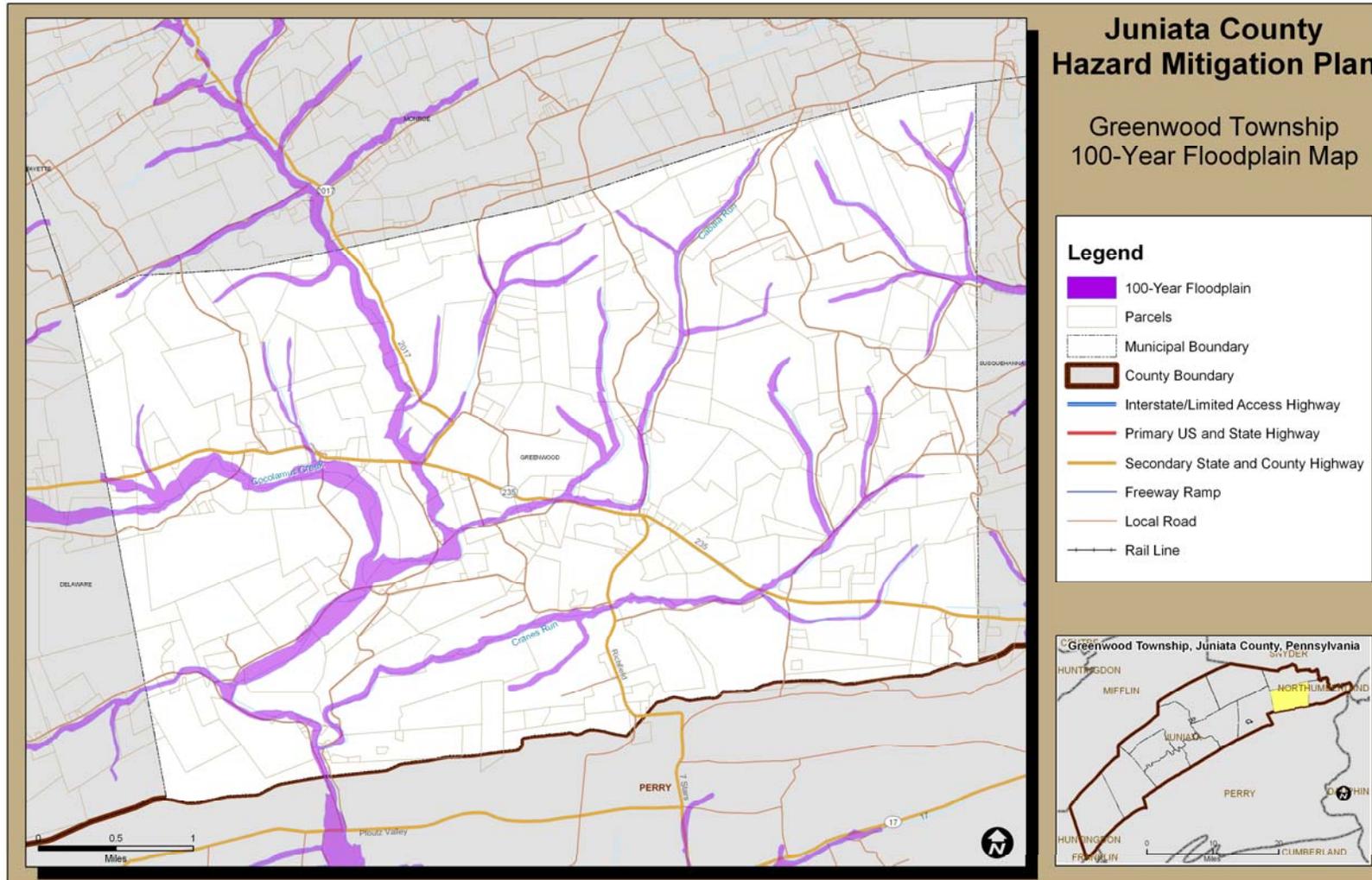


**Greenwood Township**

The Township of Greenwood is located in the eastern portion of Juniata County. It is bordered by Monroe Township to the north; Susquehanna Township to the east; Delaware Township to the west; and Liverpool Township and Greenwood Township in Perry County to the south.

The greatest threat of flooding in Greenwood Township comes from the Cocolamus Creek. Major flooding has been localized along the Cocolamus Creek.

The map on the following page presents the 100-year floodplain risk for Greenwood Township.

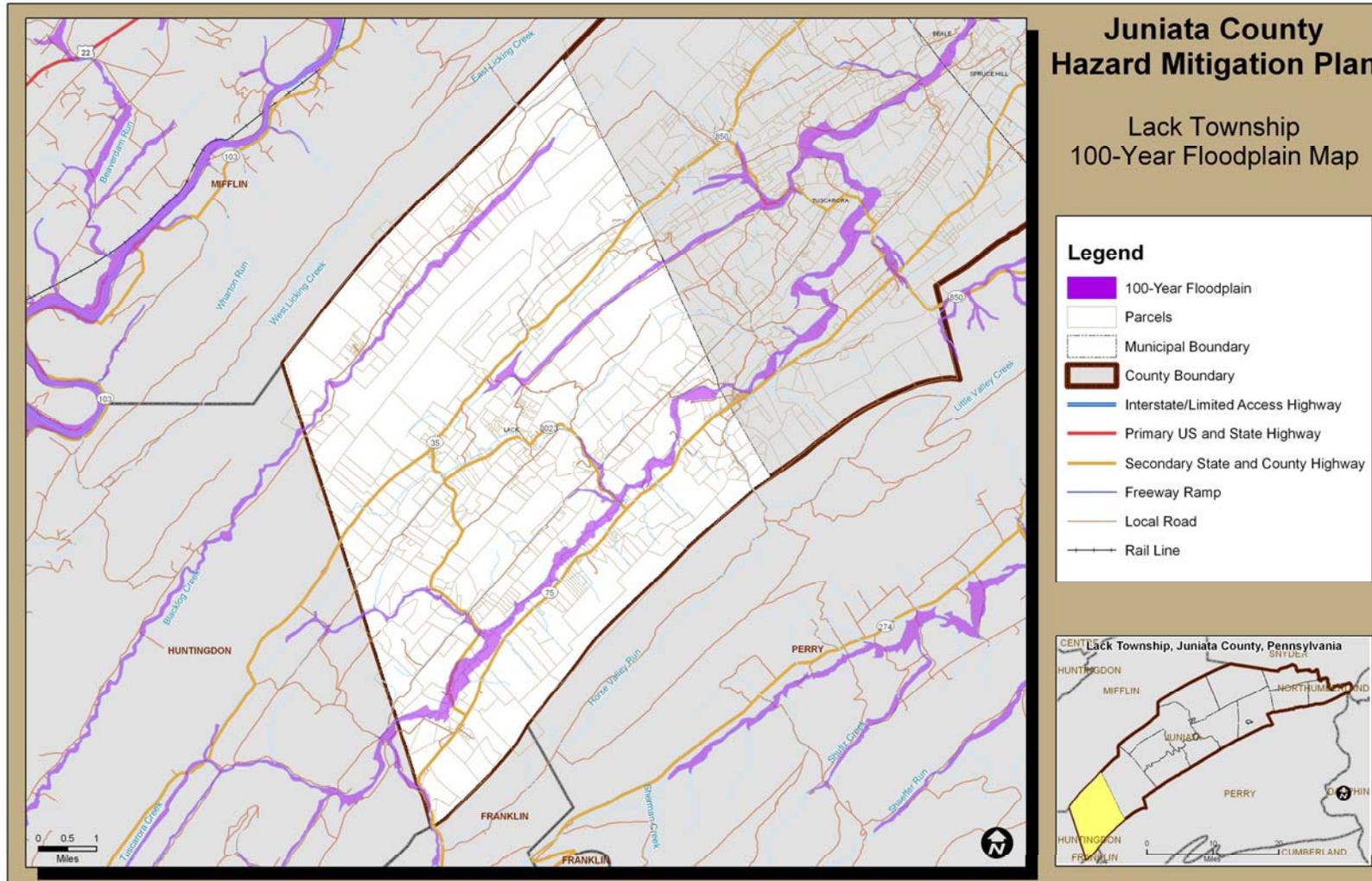


**Lack Township**

Lack Township is located along the western edge of Juniata County. It is bordered by Tuscarora Township to the east; Bratton Township and Wayne Township in Mifflin County to the north; Shirley Township and Tell Township in Huntingdon County to the west; and Fannett Township in Franklin County and Toboyne Township in Perry County to the south.

The Tuscarora Creek is the principal source of flooding in Lack Township.

The map on the following page presents the 100-year floodplain risk for Lack Township.



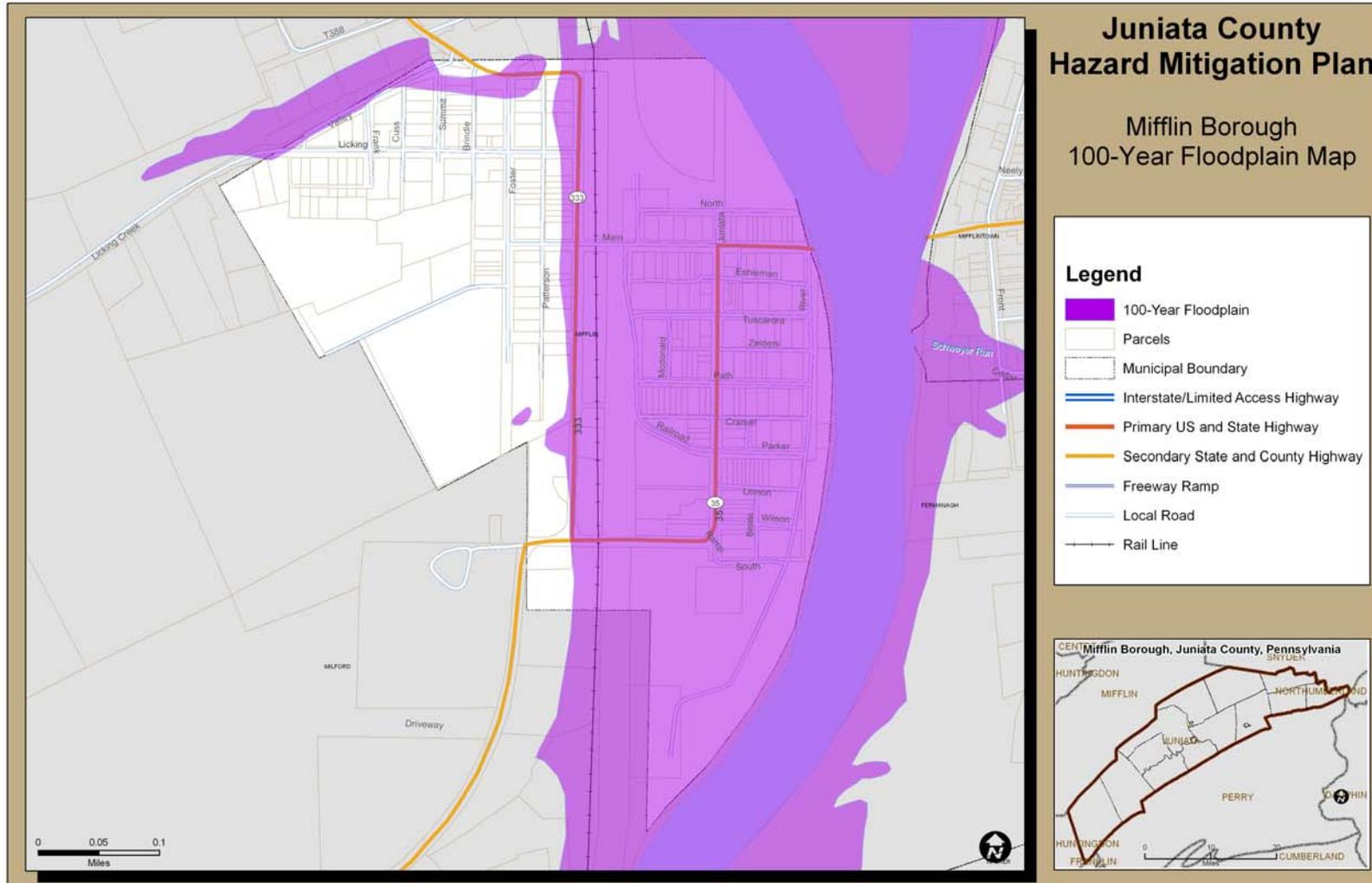
### **Mifflin Borough**

The Borough of Mifflin is located in the south-central section of Juniata County. The borough is bordered on the north, south, and west by Milford Township and the Borough of Mifflintown to the East. Mifflin Borough is located along the Juniata River, which forms the eastern border with the Borough of Mifflintown.

The Juniata River is the main water body in the Borough. A mixture of commercial, industrial, and residential land lies within the 100 year floodplain. The worst flooding event recorded at the Juniata River occurred in 1889 when the river was measured at 35.9 feet just downstream from Newport, PA. This flood had a recurrence interval of 350-400 years.

Also, during the Agnes flood in 1972, approximately 50 percent of the Borough was inundated by floodwaters.

The map on the following page presents the 100-year floodplain risk for Mifflin Borough.



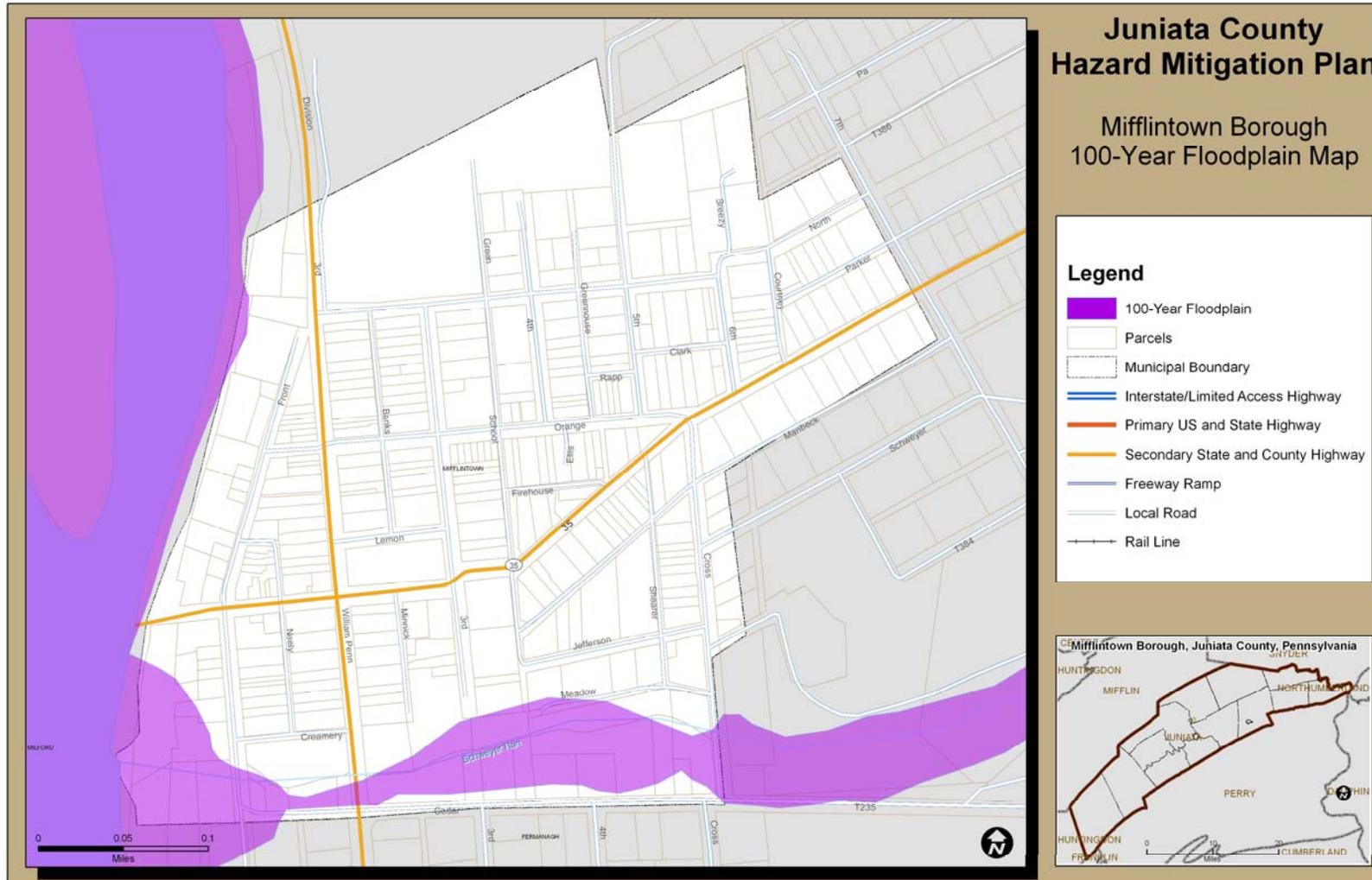
**Mifflintown Borough**

The Borough of Mifflintown is the county seat and is situated in the center of Juniata County. Fermanagh Township borders the Borough on the north, east, and south. The Juniata River forms the eastern border with Mifflin Borough.

Low lying areas of Mifflintown Borough are subjected to flooding from the Juniata River and Moist Run. Damage can be extensive along Front Street and East Main Street.

A severe flood was recorded in June 1972 where water reached 448.5 feet. Another severe flood in 1936 destroyed a bridge on State Route 35 across the Juniata River between the Mifflin Borough and Mifflintown Borough.

The map on the following page presents the 100-year floodplain risk for Mifflintown Borough.



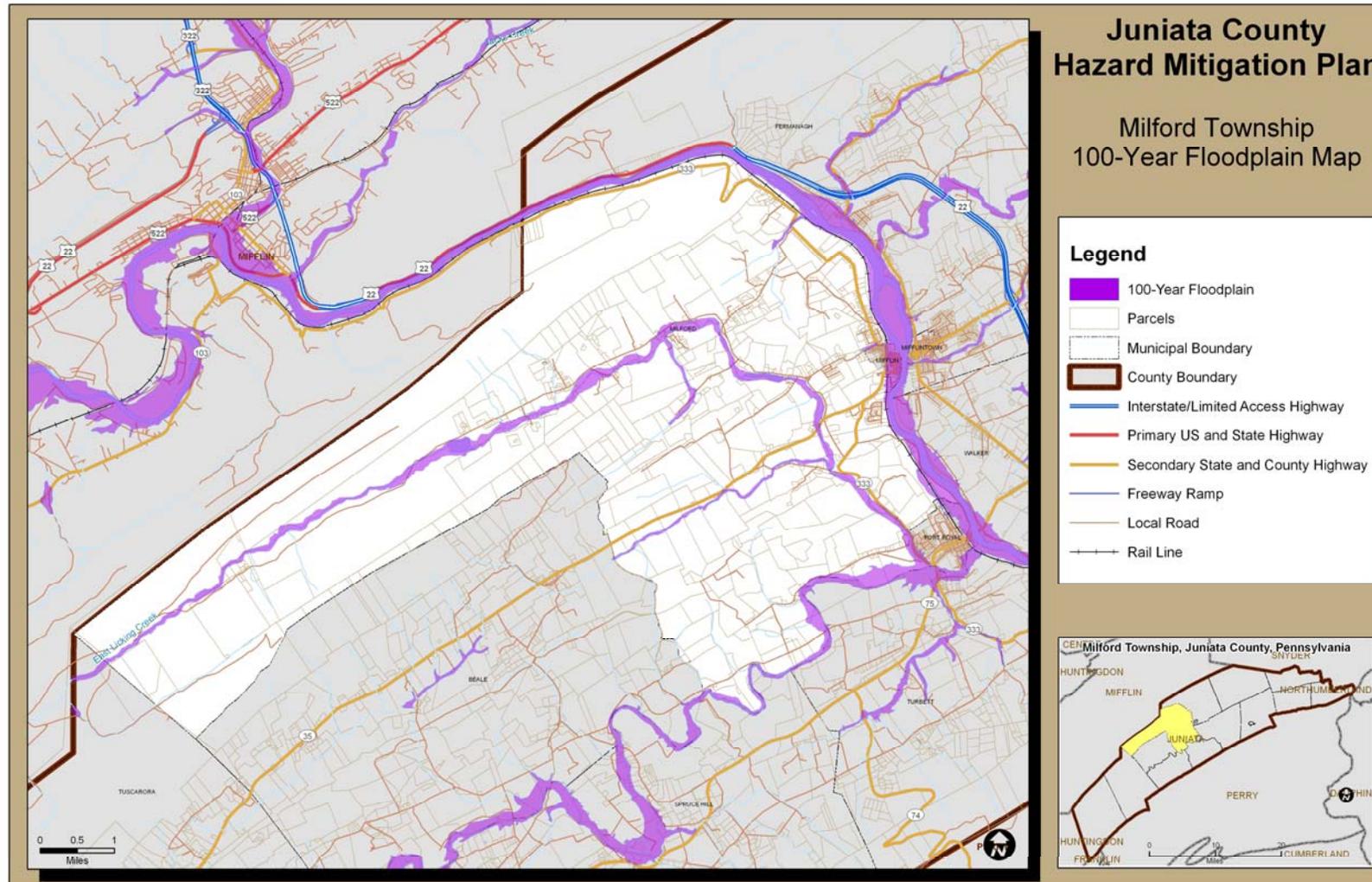
**Milford Township**

The Township of Milford is located in the central portion of Juniata County. The Township is bordered by Fermanagh Township, Mifflin Borough, and Walker Township to the east; Port Royal Borough and Turbett Township, and Spruce Hill Township to the south; Beale Township and Tuscarora Township to the west; and Granville Township in Mifflin County to the north.

East Licking Creek drains a majority of the township and empties into the Tuscarora Creek. The Tuscarora Creek empties into the Juniata River.

The principal sources of flooding in the Township are the Juniata River, the Tuscarora Creek, and the East Licking Creek. Major flooding occurred in 1889, 1936, 1972, and 1975.

The map on the following page presents the 100-year floodplain risk for Milford Township.

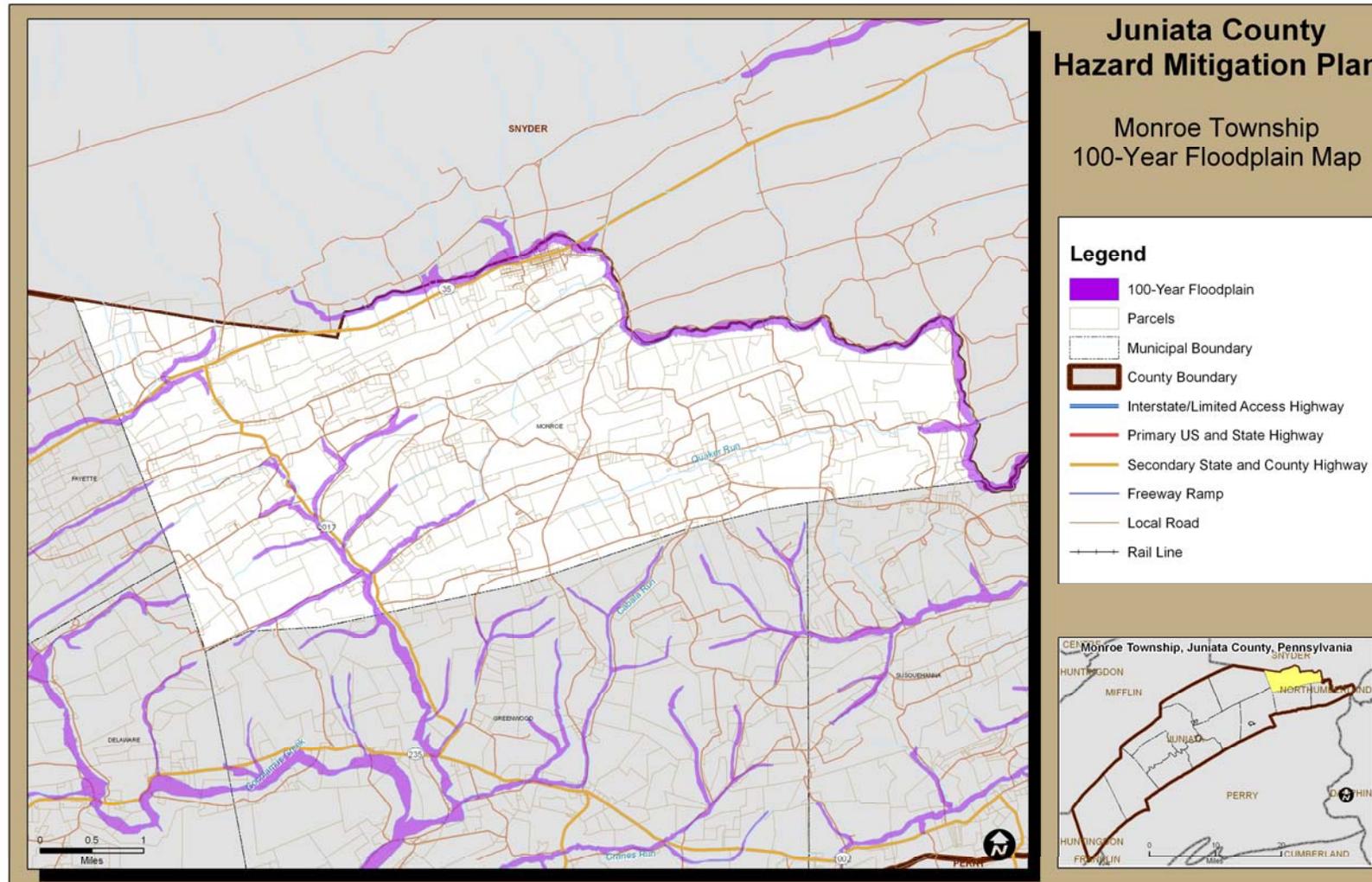


**Monroe Township**

The Township of Monroe is located in the northeastern portion of Juniata County. It is bordered by Fayette Township and Delaware Township to the west; Greenwood Township and Susquehanna Township to the south; Perry Township in Snyder County to the east; and West Perry Township in Snyder County to the north.

Major flooding in Monroe Township is localized along the West Branch Mahantango Creek and Stony Run.

The map on the following page presents the 100-year floodplain risk for Monroe Township.



### **Port Royal Borough**

The Borough of Port Royal is located in south-central Juniata County and is bordered by Milford Township to the west and north, Walker Township to the east and north, and Turbett Township to the south. The Tuscarora Creek and the Juniata River run through Port Royal Borough.

The Juniata River is the principal source of flooding in Port Royal Borough. The worst flooding occurred in 1889 when the river was measured at more than 35 feet just downstream of the Borough. Other major flooding events occurred in 1936 and 1972.

While flooding of the other water bodies in the Borough does occur, the Tuscarora Creek and East Lick Creek are often flooded due to backwater from the Juniata River.

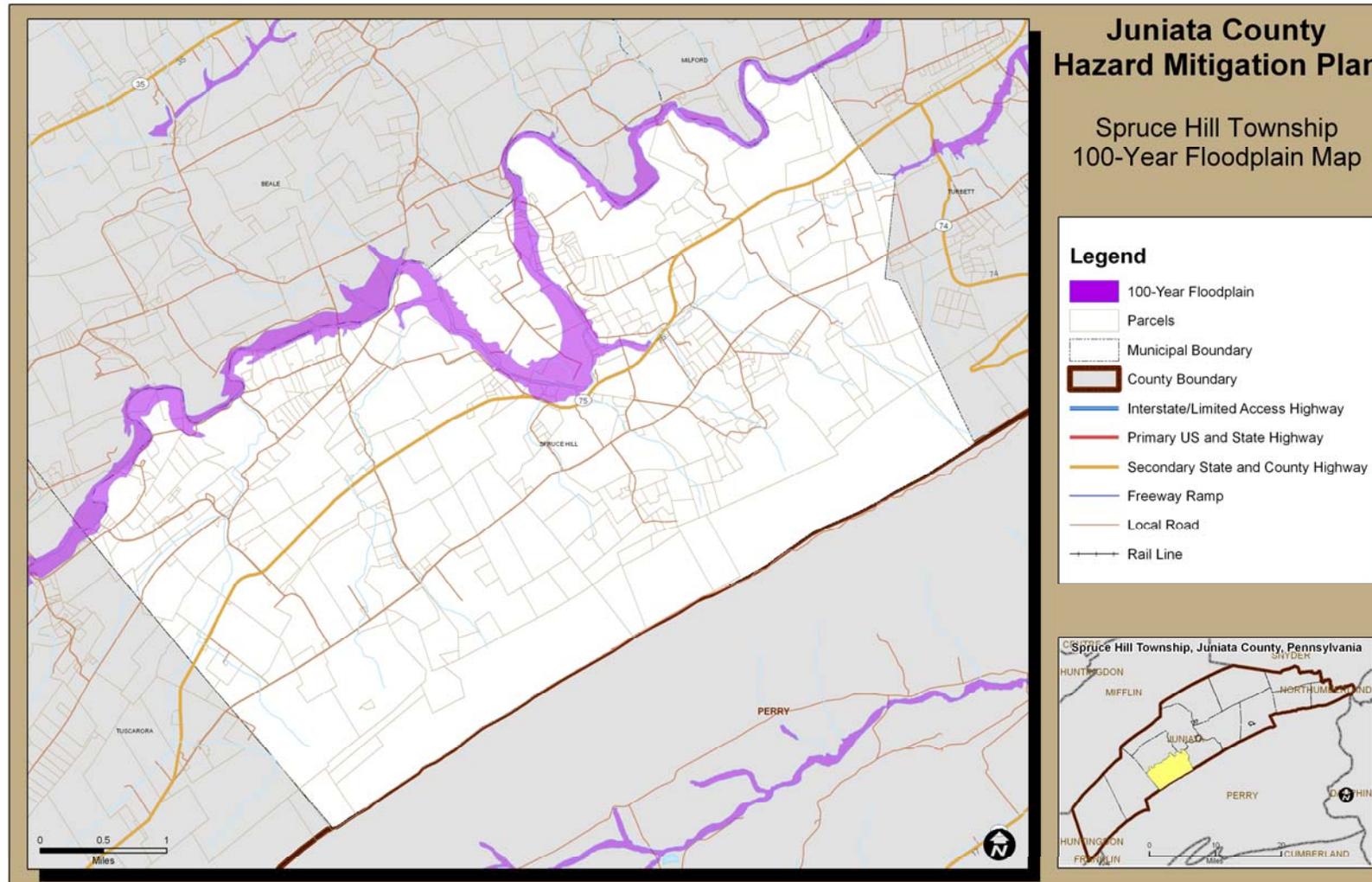
The map on the following page presents the 100-year floodplain risk for Port Royal Borough.



### **Spruce Hill Township**

Spruce Hill Township is located in the central portion of Juniata County. It is bordered by Tuscarora Township to the west; Beale Township and Milford Township to the north; Turbett Township to the east; and Saville Township and Northeast Madison Township in Perry County to the south.

While Spruce Hill Township was not included in the FEMA Flood Insurance Study, the map on the following page presents the 100-year floodplain risk for Spruce Hill Township. The greatest flooding threat to the Township exists along the northern border and the central portion of the Township along the Tuscarora Creek.

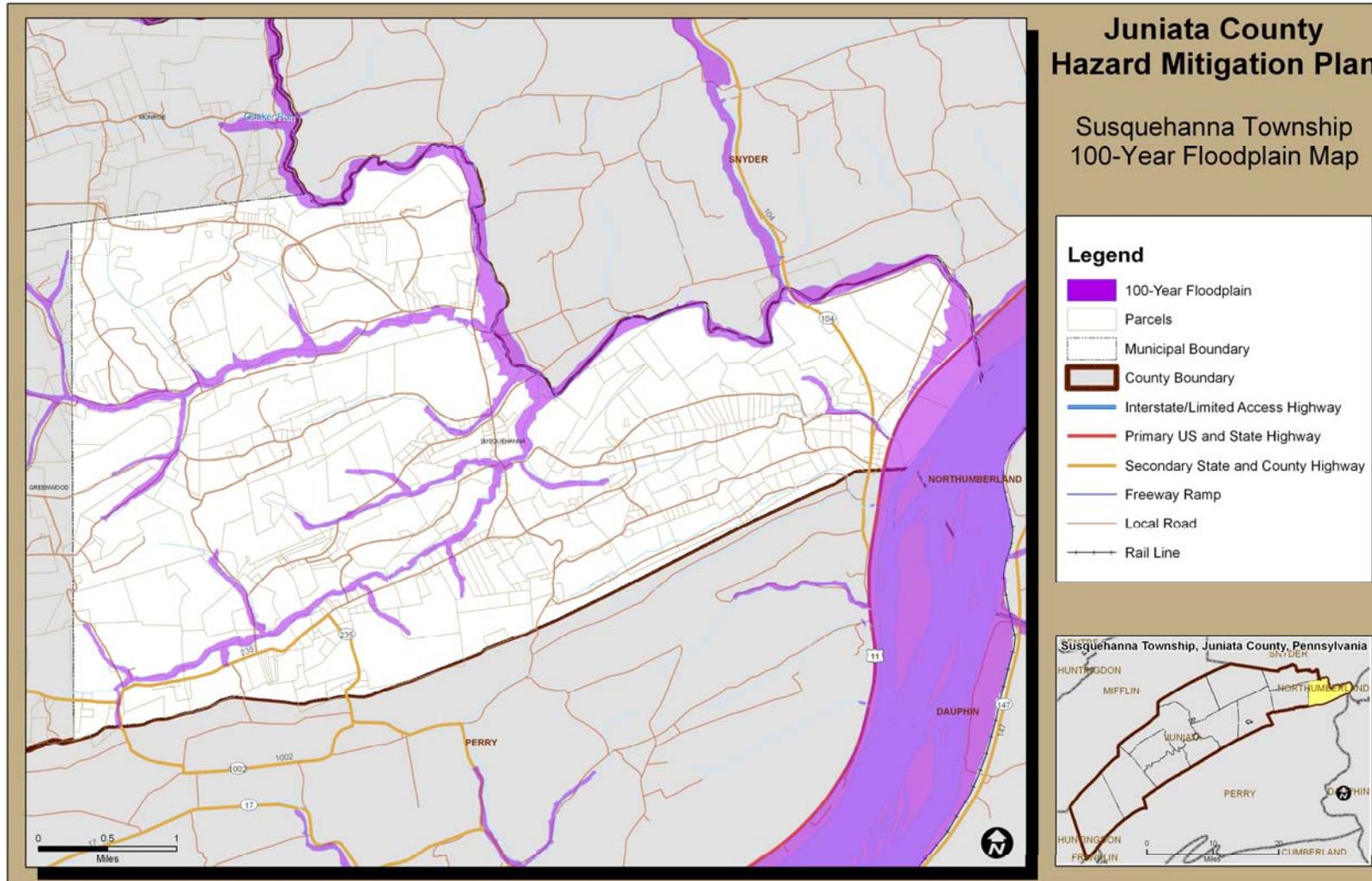


**Susquehanna Township**

Susquehanna Township is located in the eastern portion of Juniata County. It is bordered by Greenwood Township to the west; Monroe Township to the north; Perry Township and Chapman Township in Snyder County, and Lower Mahanoy Township in Northumberland County to the east; and Liverpool Township in Perry County to the south.

Flooding in Susquehanna Township is often localized to small tributaries that flow into the Susquehanna River. Flooding events have been recorded in the Township in 1936, 1946, 1964, and 1972.

The map on the following page presents the 100-year floodplain risk for Susquehanna Township.



### **Thompsontown Borough**

The Borough of Thompsontown is located in the eastern portion of Juniata County. It is encompassed by Delaware Township.

The Delaware Creek drains the Borough of Thompsontown and flows into the Juniata River approximately 3,000 feet downstream from the boundary of the Borough. The Delaware Creek is the principal source of flooding in Thompsontown Borough. The Borough was affected by floods in 1972 and 1975.

The map on the following page presents the 100-year floodplain risk for Thompsontown Borough.



### **Turbett Township**

Turbett Township is located in the south-central portion of Juniata County. It is bordered by Spring Hill Township to the west, Milford Township and Port Royal Borough to the north, Walker Township to the east, and Tuscarora Township in Perry County to the south. The Juniata River and the Tuscarora Creek run along the Township's northern boundary.

The principal source of flooding in Turbett Township is the Juniata River. The worst flood disaster occurred in 1889 when the River reached more than 35 feet just downstream in Newport, Perry County. Other major floods occurred in 1936 and 1972.

The Tuscarora Creek also presents a flooding risk, however, it is not as great a risk as the Juniata River.

The map on the following page presents the 100-year floodplain risk for Turbett Township.

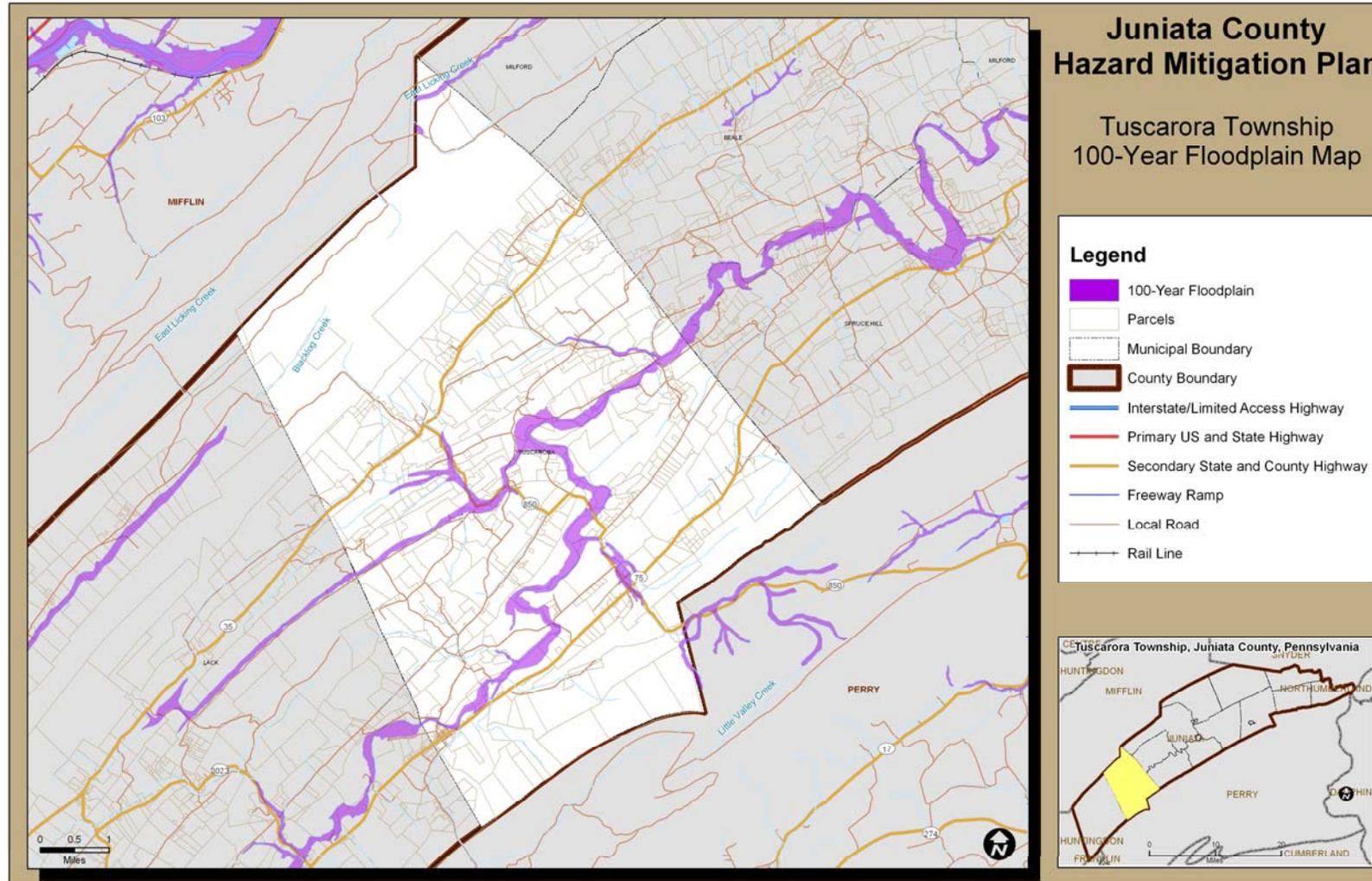


**Tuscarora Township**

Tuscarora Township is located in southwestern Juniata County. It is bordered by Lack Township to the west; Milford Township, Beale Township, and Spruce Hill Township to the east; Bratton Township in Mifflin County to the north; and Tobbyne Township and Jackson Township in Perry County to the south.

Major flooding is localized along Laurel Run and Tuscarora Creek.

The map on the following page presents the 100-year floodplain risk for Tuscarora Township.

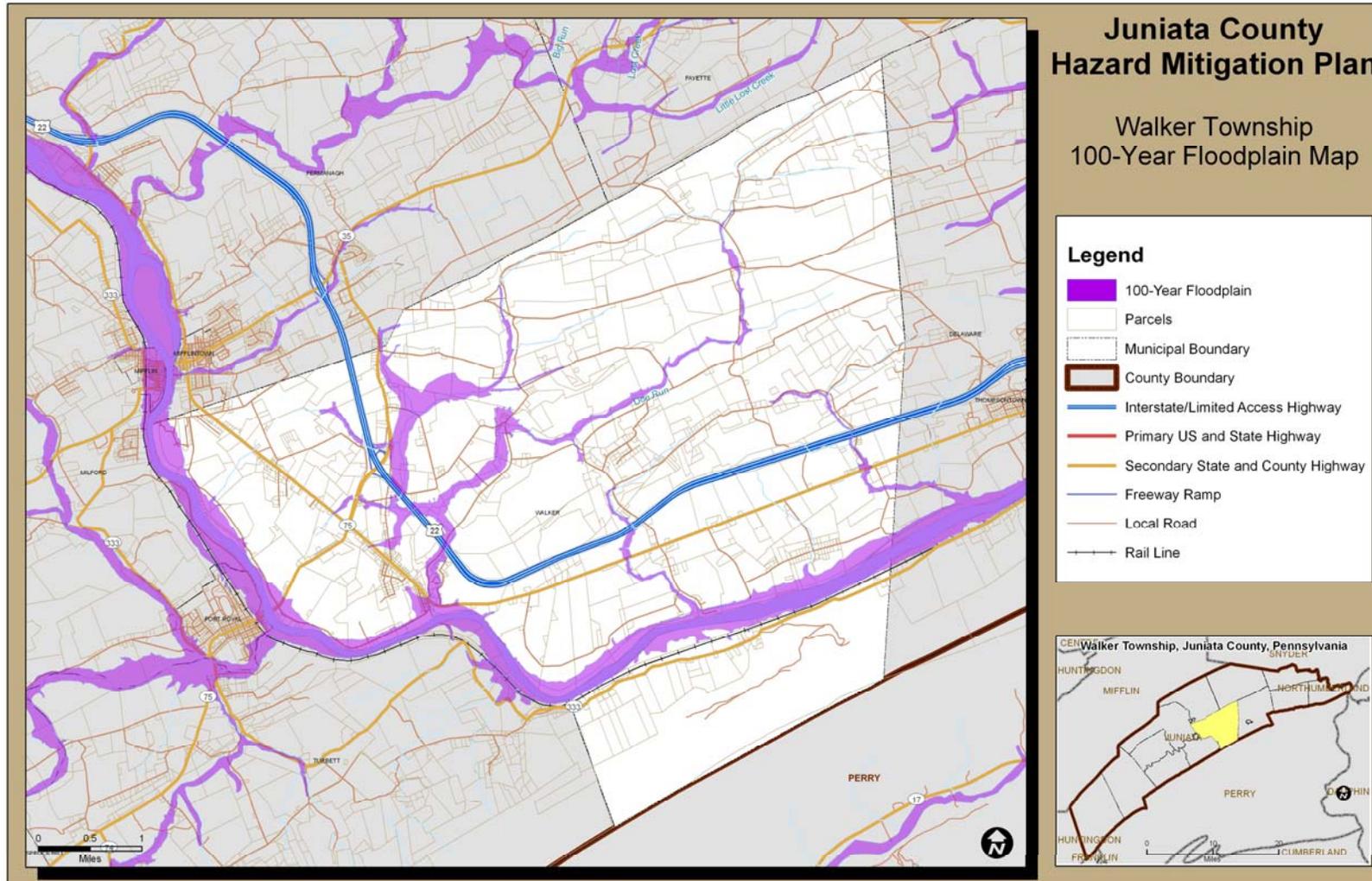


### **Walker Township**

Walker Township is located in the south-central portion of Juniata County. It is bordered by Fermanagh Township, Mifflintown Borough, and Fayette Township to the north; Delaware Township to the east; Tuscarora Township in Perry County to the south; and Turbett Township, Port Royal Borough, and Milford Township to the west. The Juniata River forms a large portion of the western and southern boundaries of the Township.

Other major streams in the Township are Doe Run, Locust Run, and Cedar Spring Run. However, the principal source of flooding in Walker Township is the Juniata River. The worst flooding event occurred in 1889 when the River reached more than 35 feet just downstream in Newport, Perry County. The flooding history of other streams in the Township was not recorded in the FEMA Flood Insurance Study.

The map on the following page presents the 100-year floodplain risk for Walker Township.



### **Probability**

The probability of a flooding event occurring in Juniata County is high, as this hazard is an annual event. Flooding is a frequent problem throughout Pennsylvania. While Juniata County experiences some degree of flooding at various times throughout the year, the threat of flooding is compounded in the late winter and early spring months, as melting snow can cause streams, rivers, and tributaries to overflow, blocking bridges and storm water culverts.

### **Maximum Threat**

Potential flooding impacts range from very low to catastrophic depending on the type and location of flooding. The maximum threat of flooding in Juniata County is estimated by looking at the location of the floodplain and the repetitive loss properties in the County.

FEMA defines a repetitive loss property as any insurable building that has experience two losses in a 10-year period where each loss is \$1,000 or more. A repetitive loss property may or may not be currently insured by the National Flood Insurance Program (NFIP). Fermanagh Township has seven repetitive loss properties, the most repetitive loss properties among all the municipalities in Juniata County. All of the properties are single family residences. The combined value of the Fermanagh repetitive loss properties is more than \$488,000. Susquehanna Township has two repetitive loss non-residential properties with a combined value of more than \$407,000. Similarly, Turbett Township has three repetitive loss properties, two are single family residents and one is a multi-family structure, with a combined value of more than \$363,000.

The potential for loss of life and injuries to occur in these areas is high. Additionally, the long-term impacts of severe flooding could have on health and safety of the citizens is high. Depending on the scope and magnitude of the flooding, the likelihood of long-term economic disruption is possible. Flooding may have a moderate impact on property, facilities, and infrastructure with varying levels of damage to structures in the affected area. Mobile homes are especially threatened by high water levels. Basic services may experience moderate impacts, as disruptions for short periods of time could occur. Government operations are expected to continue without disruption. The environmental impacts should be minimal, unless hazardous materials are released as a result of the flooding.

### **Secondary Effects**

Power failures are the most common secondary effect associated with flooding. Coupled with a shortage of critical services and supplies, power failures can cause public health emergencies and present a danger to the special needs population. Disruption to the flow of traffic may cause accidents, and high flood waters can play a role in hazardous material spills. Dam failures are also more likely to occur with flooding. Industrial, commercial, and public infrastructure facilities can become inundated with flood waters that also threaten the continuity of government.

Severe flooding can have long-term secondary effects on the population, economy, and the infrastructure of Juniata County. Escalating costs of damages to private structures and the frequency of flooding can cause permanent population displacement. Small businesses that contribute to the local economy may close if they are unable to recover from the disaster. Disruption to commerce and/or transportation modes can have an adverse effect on municipal economies in affected areas. Critical infrastructure, such as sewage and water treatment facilities, can be irreparably damaged.