3:4 Risk Assessment

All components of this Risk Assessment were revised using the best available data in the Purchase Region. GIS resources and public input were used to identify which hazards, of those listed below, affect the Purchase Region. The Purchase Area Development District (PADD) staff compiled this information to identify hazards and the Jackson Purchase Mitigation Council (JPMC) reviewed the definitions and discussed their occurrence in and impact on the region. This review identified all hazards to the region and consequently Calloway County.

For this revision, the Mitigation Planning Team (MPT) for Calloway County reviewed and revised the prioritization of Hazards from the 2012 plan using updated climatic/event data, 2016 revised flood zones, local events occurring since the previous plan, 2010 Census data and the 2015 American Community Survey. The resulting prioritization and risk assessments area contained in this chapter.

3:4.1 Identifying Hazards

FEMA recognizes many forms of natural hazards. Major natural hazards that may occur include:

- Geologic hazards
  - Tsunami
  - Volcano
  - Earthquake
  - Land Subsidence/Karst Topography
  - Landslide
- Weather generated hazards
  - Avalanche
  - Hurricane
  - Severe Thunderstorm
  - Hailstorm
  - Windstorm/Microburst
  - Severe Winter storm
  - Tornado
- Wildfire
- Flooding
  - Flashfloods
  - General Flooding
  - Coastal
  - Riverine
- Urban
- Climatological
  - Drought
  - Extreme Heat
- Failure of Man-made structures from the impact of natural forces
  - Dam Failure
  - Levee/flood Wall Failure

Natural Hazards Addressed by the Regional Plan

The regional planning process identified hazards that significantly impact the entire Purchase Region and eliminated from consideration those natural hazards that do not. Natural hazards where a historical record of damage to people and property exists, or the potential for such damage to occur, are addressed in the plan. This determination does not preclude from including more hazards in future updates. The Calloway County MPT agreed that the identification process was sufficiently thorough to serve all the signatory counties of the plan and need not be repeated for the Calloway County Chapter update. Table 3.1 summarizes why these hazards were identified.

Table 3.1 Hazards Identified and Reasons for Identification

Hazard	How Identified	Why Identified
Tornado	* Review of past disaster damage * Review of FEMA hazard maps * Public Input	* Several past occurrences * Hazard maps show all jurisdictions affected
Flood **Flash Flood** **River Erosion**	* Review of past disaster damage (FEMA & National Climatic Data Center) * Local Emergency Management * Public Input * Review of FIRM maps	* Affects the region frequently * Maps show many flood prone areas * Public identified several regions not mapped affected by flooding * Repetitive flooding has led to the deposit of enormous amounts of silt in Kentucky's Mississippi River ports
Thunderstorm Wind **Hail**	* Review of past disaster damage * Public Input * Review of past occurrences from National Climatic Data Center	* Many events in the past * Widespread: affects all jurisdictions * High wind zone
Earthquake	* Review of Ground Motion Maps * Review of the New Madrid and Wabash Seismic Zone Maps * Public Input	* Proximity to New Madrid/Wabash Seismic Zones * Historic accounts of 1812 disaster. * Potential for destructive impact in some jurisdictions
Winter Storm / Ice Storm	* Review of past disaster damage * Review of past occurrences from National Climatic Data Center * Public Input * Local DES/KYTC	* Several past occurrences * Variety of events including snow/ ice * Can affect all jurisdictions
Excessive Heat / Drought	* Review of past disaster damage * Public Input * Review of Palmer Drought Severity Index	* Losses have occurred in past * Large impact of agriculture on the region
Dam Failure	* Review of High Risk Dams in the region * Corps of Engineers Input	*Potential for flooding *Number of High Risk dams in region
Wildfire	* Review of State Mitigation Plan * Public Input	*Potential for loss at Wildland/urban interface, * Increased fuel supply due to ice storm damage

3:4.2 Hazard Profiles

The Calloway County MPT reviewed it's previously profiled hazards by using historical evidence gathered from the National Center for Environmental Information (NCEI), Kentucky State Climatology Center, Federal Emergency Management Agency's (FEMA) Hazard Mapping website, the Commonwealth of Kentucky Enhanced Mitigation Plan and the Kentucky Geological Survey. PADD staff gathered GIS information and historical data to provide to the MPT. There are some limitations to the best available GIS and historical data pertaining to hazards. The Calloway County MPT identified hazards affecting the county based on past experiences. Information collected throughout the planning process by means of public input was an invaluable resource to the plan. Because the purpose of this plan is to identify hazards that present a threat to the safety of life and property, only moderate and high risk hazards will be fully addressed.

Summary of Hazard Profiles

Several overall conclusions can be drawn from the information gathered in the Hazard Profiles. Based on historical frequency and past disaster damages, several hazards identified in the Regional Plan, stand out as more significant threats to Calloway County, while several others appear to be less significant.

According to frequency and damage figures, Tornado, Winter Storms, Thunderstorm Wind, and Flooding stand out as the most significant threats to Calloway County. Earthquake is a hazard rated by committee members as one of the biggest potential threats. There is no historical data on actual earthquake damages in Calloway County to analyze the threat, and considerable debate as to the severity of the resultant damage even for the "worst case scenario".

Dam Failure and Wildfire are perceived as possible threats to portions of the county, yet historic frequency and damage data do not suggest that these are among the most significant. There is no historical occurrence of damage or injury due to a dam failure in Calloway County. Dam failure is considered a hazard due to the location of Kentucky Dam and the impounded Kentucky Lake, along Calloway's eastern border. Wildfires, more specifically brushfires, have occurred, however the only damages documented for these events amount to approximately $1,100 in property damage. Hailstorms are a hazard that threatens the county, having caused some property and crop damage.

Table 3.2 is a summary of past Declared Disasters as provided by FEMA for the region. This table is limited to providing information only related to declared disasters on the county level and does not list each jurisdiction.

Table 3.2 Presidential Disaster Declarations that Affected PADD Counties

DR#	Declaration Date	Disaster Type	Total Declared Counties	Declared Counties	Counties Declared for Public Assistance and Individual Assistance	Counties Declared for Public Assistance Only	County	DH Approved Funding	IFG Approved
381	5/11/1973	Severe Storms, Flooding	5	Ballard, Carlisle, Fulton, Hickman, McCracken	Ballard, Carlisle, Fulton, Hickman, McCracken	0			
461	3/29/1975	Severe Storms, Flooding	17	Ballard, Calloway, Fulton, Graves, Hickman, Marshall, McCracken	Ballard, Calloway, Fulton, Graves, Hickman, Marshall, McCracken	0			
821	2/24/1989	Severe Storms, Flooding	67	Ballard, Carlisle, Graves, Hickman, Marshall, McCracken	Ballard, Carlisle, Graves, Hickman, Marshall, McCracken	0			
1089	1/13/1996	Blizzard	120	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall	0	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken,			
1163	3/4/1997	Flooding	101	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken	Ballard, Carlisle, Fulton, Hickman, Marshall, McCracken	Calloway	McCracken	$137,084.85	$78,709.00
1802	10/9/2008	Severe Wind Storm	36	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken	0	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken,			
3302	1/28/2009	Severe Wind Storm	114	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken	0	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken,			
1818	2/5/2009	Severe Winter Storm, Flooding	117	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken	0	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken,			
1976	5/4/2011	Severe Storms, Tornadoes, Flooding	22	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken		Calloway			

DR#	Declaration Date	Disaster Type	Total Declared Counties	Declared Counties	Counties Declared for Public Assistance and Individual Assistance	Counties Declared for Public Assistance Only	County	DH Approved Funding	IFG Approved
4057	3/6/2012	Severe Storms, Tornadoes, Straight-line Winds, Flooding	1	Ballard		Ballard			
4216	4/30/2015	Severe Winter Storms, Snowstorms, Flooding, Landslides, Mudslides	3	Ballard, Marshall, McCracken		Ballard, Marshall, McCracken			
4218	5/12/2015	Severe Winter Storms, Snowstorms, Flooding, Landslides, Mudslides	3	Calloway, Fulton, Marshall		Calloway, Fulton, Marshall			
4278	8/26/2016	Severe Storms, Tornadoes, Flooding, Landslides, Mudslides	2	Calloway, Marshall		Calloway, Marshall			

Source:https://www.fema.gov/disasters?field_state_tid_selective=49&field_disaster_type_term_tid=All&field_disaster_declaration_type_value=All&items_per_page=20&=GO

For this revision, the MPT for Calloway County reviewed and revised the prioritization of Hazards from their 2012 Plan using updated climatic/event data, 2016 revised flood zones, local events occurring since the previous plan, and 2010 census data. These provided a higher resolution for the resulting Hazard re-prioritization and revised risk assessments. All following discussions of risk and risk assessment are in the order of these revised priorities.

Table 3.3 Calloway County Hazard Summary Table

PLAN VERSION	2017	2012
HIGH RISK HAZARDS	TORNADO THUNDERSTORM WIND FLOOD / FLASH FLOOD WINTER STORM/ICE STORM	TORNADO SEVERE THUNDERSTORM EARTHQUAKE SEVERE WINTER STORM
MODERATE RISK HAZARDS	EARTHQUAKE EXCESSIVE HEAT /DROUGHT HAIL	FLOODING HAILSTORM EXTREME HEAT/DROUGHT
LOW RISK HAZARDS	WILDFIRE DAM FAILURE	WILDFIRE DAM FAILURE

SOURCE: Calloway County MPT 2017
Note: Following this discussion the MPT added Ice Storm to the hazard priority for the county and terminology was updated based on updated NCEI descriptions.

Table 3.4 represents a summary of the events on record in the NCEI Storm Events Database occurring in Calloway County for the period January 1, 1950 through March 31, 2017. Data is available as early as 1950, but depending on reporting for some events, the first event on record may come at a much later time. The detailed, disaggregated listing of these events are included in Appendix 1.

Please see NCEI (formerly the National Climatic Data Center) contact page if you have questions at https://www.ncdc.noaa.gov/customer-support

Table 3.4 Summary of Hazard Previous Occurrences and Impacts January 1, 1950 – March 31, 2017

Event	Events	Death	Injury	Property Damage($)	Crop Damage($)
Tornado	36	1	35	$6.042M	$90K
Thunderstorm Wind	136	0	0	$5.435M	$1K
Winter Storm	15	0	0	$0	$0
Ice Storm	3	0	0	$17.2M	$0
Flood	17	0	5	$193K	$0
Flash Flood	38	0	0	$594K	$0
Hail	87	0	0	$116K	$20K
Excessive Heat	7	0	0	$0	$0
Drought	34	0	0	$0	$9.2M
Wildfire	1	0	0	$0	$0
Dam Failure	No History				
1 class A structure = no loss of life anticipated, only damage to dam owner's property					
2 class B structures = loss of life not probable, some economic loss & environmental damage					

Source: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

For the purpose of the update to the 2018 Jackson Purchase Hazard Mitigation (JPHM) Plan, the events from January 1, 2012 through the first quarter of 2017 (1/1/2017 – 3/31/2017) will be reviewed. This provides 5.25 years of recent data covering the current period for this cycle of the JPHM Plan update. For a complete listing of all events, please refer to the Appendix 1.

Tornado

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. It is most often generated by a thunderstorm when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly and upper level winds, especially the jet stream runs at an angle relative to the prevailing surface winds. These conditions occur with regularity over the Purchase Region in the spring, but as evidenced recently, can occur at any time of the year. Tornadoes are often accompanied by large hail and damage is most often the result of the high wind velocity and wind-blown debris. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction. They have the power to uproot trees, structures, and turn harmless objects into deadly flying debris.

Most tornadoes aren't very wide and touch down only briefly. However, a highly destructive tornado may carve a path over a mile wide and several miles long. Tornadoes typically cause the most damage to lightly or poorly built structures, such as residential homes. An average of 800-1000 tornadoes are reported nationwide and they are more likely to occur during the spring and early summer months. Tornadoes can occur at any time of the day, but are more likely to form in the late afternoon or early evening.

In 2007 the Enhanced Fujita (EF) Scale (Table 3.5) was introduced to better reflect wind speed and the amount of damage produced by tornadoes. It replaced the Fujita-Pearson Scale that defined every tornado on record in the United States since 1950. EF rankings are assigned after a tornado event has occurred and the National Weather Service has inspected the damage.

Table 3.5 The Enhanced Fujita Tornado Measurement Scale

Scale	Estimated Wind Speed	Typical Damage
EF0	65-85 mph	Light Damage - Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; signboards damaged.
EF1	86 – 110 mph	Moderate Damage - Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
EF2	111 – 135 mph	Considerable Damage - Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light object missiles generated; cars lifted off ground and thrown.
EF3	136 – 165 mph	Severe Damage - Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
EF4	166 – 200 mph	Devastating Damage - Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
EF5	>200 mph	Incredible Damage - Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

Table 3.6 Tornado Events and Impacts in Calloway County January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
HAZEL	01/22/2012	23:03	CST-6	EF1	0	0	50.00K	0.00K
LYNN GROVE	01/29/2013	23:36	CST-6	EF0	0	0	25.00K	0.00K
WADESBORO	12/21/2013	17:31	CST-6	EF0	0	0	2.00K	0.00K
MIDWAY	03/12/2016	21:22	CST-6	EF0	0	0	30.00K	0.00K
COLDWATER	07/03/2016	17:40	CST-6	EF0	0	0	0.00K	0.00K
TAYLORS STORE	02/28/2017	22:42	CST-6	EF0	0	0	35.00K	0.00K
MURRAY	03/09/2017	21:13	CST-6	EF1	0	0	75.00K	0.00K
				TOTALS	**0**	**0**	**217.00K**	**0.00K**

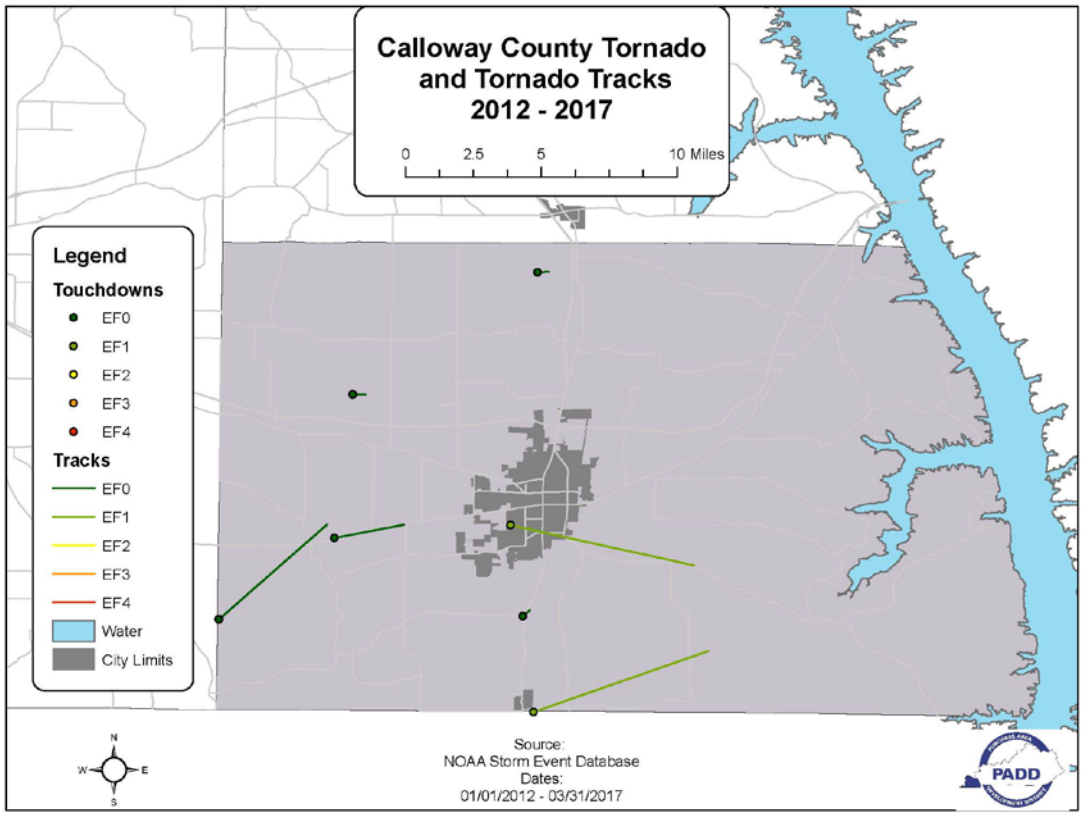
Source: National Oceanic and Atmospheric Administration, National Centers for Environmental Information, Storm Events Database: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

The following descriptions are typical of tornado events experienced in Calloway County.

- On January 22, 2012 A potent upper-level trough moved east into eastern Kansas and Oklahoma, before assuming a negative tilt and accelerating east-northeast across the Mid-Mississippi and Lower Ohio Valleys. The associated surface low tracked northeast from Kansas across northern Missouri to southern Wisconsin. Ahead of the low and trough, a south-southwesterly low-level jet in excess of 50 knots expanded east across the Mid-Mississippi Valley. An expansive quasi-linear convective system formed along the lead cold front trailing southward from the surface low. Despite rather meager instability, very strong low and mid-level wind fields resulted in organized storm structures with pockets of damaging wind, isolated large hail, and a couple of tornadoes.
  Peak winds were estimated near 95 mph. Hundreds of trees were uprooted or snapped. Windows were blown out of a house, and shingles were damaged. Shutters were ripped off the house. Three barns were destroyed. Two garages were levelled. A section of roof was peeled off another garage. The porch roof of a business in Hazel was destroyed. A large tree fell across a truck. Reported damages were estimated at $50,000.
- On March 9, 2017 an outbreak of severe thunderstorms occurred over the Tennessee border counties. Thunderstorms rapidly developed across western Kentucky ahead of a line of thunderstorms over the Missouri Bootheel region. These initial storms formed along a southwesterly low-level jet and its associated moisture plume. Large hail was the primary severe weather hazard in this leading activity,

which was elevated above the surface. Later in the evening, a surface-based bowing line of thunderstorms exited southeast Missouri and then crossed southwest Kentucky. This bowing line was associated with an embedded supercell that spawned a few tornadoes. The storms developed along and just ahead of a cold front as it pressed southward into the Lower Ohio Valley and extreme southeast Missouri. Peak winds were estimated near 95 mph. The path began in the southwest part of Murray and followed Highway 121 to about four miles southeast of Murray. Dugout roofs at the city high school ballfield in Murray were blown across the street into a home and car. Numerous very large trees were snapped and uprooted. About three miles outside the city limits of Murray, barns and outbuildings were heavily damaged. Most of the path was high-end EF-0 strength. Near the end of the path, the tornado intensified to EF-1. This is the area where a large section of roof and some trusses were blown off a well-built metal barn, and plastic projectiles were hurled through a garage wall. A building was destroyed by uprooted trees that fell on top of it. This storm caused an estimated $75,000 in property damages.

Figure 3.1 Vulnerability to Tornados through Identification of Tornado Tracks, January 1, 2012 – March 31, 2017



SUMMARY AND CONCLUSIONS OF TORNADO PROFILE

From January 1, 2012 through March 31st, 2017, there have been seven occurrences of tornadoes in Calloway County reported by the NCEI. These occurrences totaled over $217,000 in reported personal property and crop damage.

Information from Table 3.6 and Figure 3.1 related to Tornadoes can be used to define the frequency of tornado events and the impact of these events. Data on tornado event magnitude is provided in the form of the Fujita Scale as shown on the map.

Calloway County experienced seven reported events over a 5.25 year period, which divides out to 1.33 reported Tornado Events per year, or a 100% probability of a tornado event in any given year. The cost of a Tornado Event could be calculated as:

- $217,000 divided by 7 events = $31,000 per event.
- $31,000 times 1.33 events/year = $41,230 per year.

Of critical concern to the Calloway County MPT, and the main contributing factor in their consideration of risks and vulnerability, is the human cost of Tornado Events.

Thunderstorm Wind

A thunderstorm is formed from a combination of moisture, rapidly rising, warm air, or a force capable of lifting air, such as the meeting of a warm and cold front, a sea breeze, or a mountain. Thunderstorms can produce tornadoes, large hail and heavy rain which can cause flash flooding. The National Weather Service considers a thunderstorm as severe if it develops ¾ inch hail or 58 mph winds. Straight line winds during thunderstorms can exceed 100 miles per hour and are responsible for wind damage associated with thunderstorms. One type of straight-line wind, the downburst, can cause damage equivalent to a strong tornado and can be extremely dangerous to aviation.

Thunderstorms affect relatively small area when compared with winter storms, as the average storm is 15 miles in diameter and lasts an average of 30 minutes. All thunderstorms are dangerous and capable of threatening life and property in localized areas. Every thunderstorm produces lightning, which results from the buildup and discharge of electrical energy between positively and negatively charged areas.

Thunderstorms are quite frequent in Calloway County. They have produced damage and injuries, but no recorded fatalities over the update period. Numerous severe thunderstorms have been recorded that produce high winds, lightning, and hail in the county. Many of these thunderstorms have caused property or crop damage. These storms although relatively short in duration when compared to other weather events are often long lived enough to track across the entire county before dissipating their energy or exiting the region.

Table 3.7 Thunderstorm Wind Events and Impacts in Calloway County January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
MURRAY	01/22/2012	23:14	CST-6	52 kts. MG	0	0	0.00K	0.00K
MURRAY ARPT	05/20/2012	17:50	CST-6	61 kts. EG	0	0	5.00K	1.00K
BACKUSBURG	07/06/2012	15:45	CST-6	61 kts. EG	0	0	30.00K	0.00K
MIDWAY	07/18/2012	17:45	CST-6	56 kts. EG	0	0	5.00K	0.00K
MURRAY	09/06/2012	18:40	CST-6	52 kts. EG	0	0	15.00K	0.00K
MURRAY	01/29/2013	23:57	CST-6	56 kts. EG	0	0	4.00K	0.00K
BACKUSBURG	04/18/2013	19:50	CST-6	52 kts. EG	0	0	5.00K	0.00K
LYNN GROVE	05/30/2013	19:30	CST-6	52 kts. EG	0	0	18.00K	0.00K
KIRKSEY	07/18/2013	11:50	CST-6	83 kts. EG	0	0	100.00K	0.00K
FAXON	08/08/2013	12:25	CST-6	52 kts. EG	0	0	20.00K	0.00K
FAXON	10/31/2013	20:35	CST-6	70 kts. EG	0	0	250.00K	0.00K
DEXTER	11/17/2013	16:24	CST-6	52 kts. EG	0	0	3.00K	0.00K
COLDWATER	12/21/2013	17:27	CST-6	61 kts. EG	0	0	30.00K	0.00K
ALMO	12/21/2013	17:31	CST-6	65 kts. EG	0	0	50.00K	0.00K
COLDWATER	06/07/2014	14:44	CST-6	83 kts. EG	0	0	100.00K	0.00K
MURRAY	06/07/2014	14:58	CST-6	83 kts. EG	0	0	100.00K	0.00K
MURRAY	06/08/2015	13:05	CST-6	56 kts. EG	0	0	10.00K	0.00K
POTTERTOWN	07/28/2015	19:00	CST-6	56 kts. EG	0	0	3.00K	0.00K
ALMO	12/23/2015	16:22	CST-6	61 kts. EG	0	0	30.00K	0.00K
HARRIS GROVE	03/31/2016	11:55	CST-6	78 kts. EG	0	0	40.00K	0.00K
MURRAY	04/06/2016	15:20	CST-6	56 kts. EG	0	0	35.00K	0.00K
TAYLORS STORE	05/01/2016	12:35	CST-6	61 kts. EG	0	0	10.00K	0.00K
ALMO	05/26/2016	14:15	CST-6	52 kts. EG	0	0	2.00K	0.00K

Location	Date	Time	Time Zone	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
ALMO	06/13/2016	17:30	CST-6	52 kts. EG	0	0	15.00K	0.00K
MURRAY	06/15/2016	13:05	CST-6	56 kts. EG	0	0	3.00K	0.00K
MURRAY	06/25/2016	13:52	CST-6	52 kts. EG	0	0	8.00K	0.00K
COPELAND	07/03/2016	17:50	CST-6	45 kts. MG	0	0	7.00K	0.00K
LYNN GROVE	07/06/2016	13:10	CST-6	61 kts. EG	0	0	5.00K	0.00K
ALMO	07/08/2016	17:50	CST-6	56 kts. EG	0	0	20.00K	0.00K
MURRAY	07/20/2016	13:45	CST-6	61 kts. EG	0	0	18.00K	0.00K
MURRAY	07/22/2016	11:40	CST-6	52 kts. EG	0	0	8.00K	0.00K
MURRAY	02/28/2017	22:55	CST-6	61 kts. EG	0	0	15.00K	0.00K
LYNN GROVE	03/01/2017	05:32	CST-6	65 kts. EG	0	0	0.00K	0.00K
LYNN GROVE	03/09/2017	21:05	CST-6	65 kts. EG	0	0	70.00K	0.00K
TOTALS					**0**	**0**	**1.034M**	**1.00K**

Wind Magnitude Definitions:
Measured Gust:'MG', Estimated Gust:'EG', Measured Sustained:'MS', Estimated Sustained:'ES' Source: Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

The following descriptions are typical of thunderstorm wind experienced in Calloway County:

- On June 7, 2014 a macroburst containing winds estimated near 95 mph entered western Calloway County from Graves County. The three-mile wide damage area was roughly parallel to Highway 80. A camper was flipped over. Many homes and a tobacco barn sustained minor roof damage. Hundreds of trees were uprooted, including several along Highway 121 near Coldwater. Widespread power outages lasted for 6 to 12 hours on average. The underpinning of a mobile home was damaged. Much of the damage was along and just south of a line from Kirksey to Almo, including the airport area. The damage area continued east-southeast across the city of Murray. There was an estimated $100,000 in damages.

- On March 9, 2017 an outbreak of severe thunderstorms occurred over the Tennessee border counties. Thunderstorms rapidly developed across western Kentucky ahead of a line of thunderstorms over the Missouri Bootheel region. These initial storms formed along a southwesterly low-level jet and its associated moisture plume. Large hail was the primary severe weather hazard in this leading activity, which was elevated above the surface. Later in the evening, a surface-based bowing line of thunderstorms exited southeast Missouri and then crossed southwest Kentucky. This bowing line was associated with an embedded supercell that spawned a few tornadoes. The storms developed along and just ahead of a cold front as it pressed southward into the Lower Ohio Valley and extreme southeast Missouri. Power poles were snapped, power lines were down, and several trees were uprooted. This storm had an estimated $70,000 in reported damages.

SUMMARY AND CONCLUSIONS OF THUNDERSTORM WIND PROFILE

From January 1, 2012 through March 31, 2017, there have been 34 occurrences of Thunderstorm Wind Events in Calloway County reported by the NCEI. There were no fatalities and no injuries reported from these events. These occurrences totaled over $1,034,000 in reported personal property damage.

Calloway County experienced 34 reported events over the 5.25 year update period, which divides out to 6.48 reported events per year. This is more than a 100% probability that such an event will occur in any given year. Based on recorded events and damages reported in Calloway County, the cost of a Thunderstorm Wind Event could be calculated as:

- $1,034,000 divided by 34 events = $30,411 per event.
- $30,411 times 6.48 events/year = $197,063 per year.

Of critical concern to the Calloway County MPT and the main contributing factor in their consideration of risks and vulnerability, is the potential risk of human cost of Thunderstorm Wind Events.

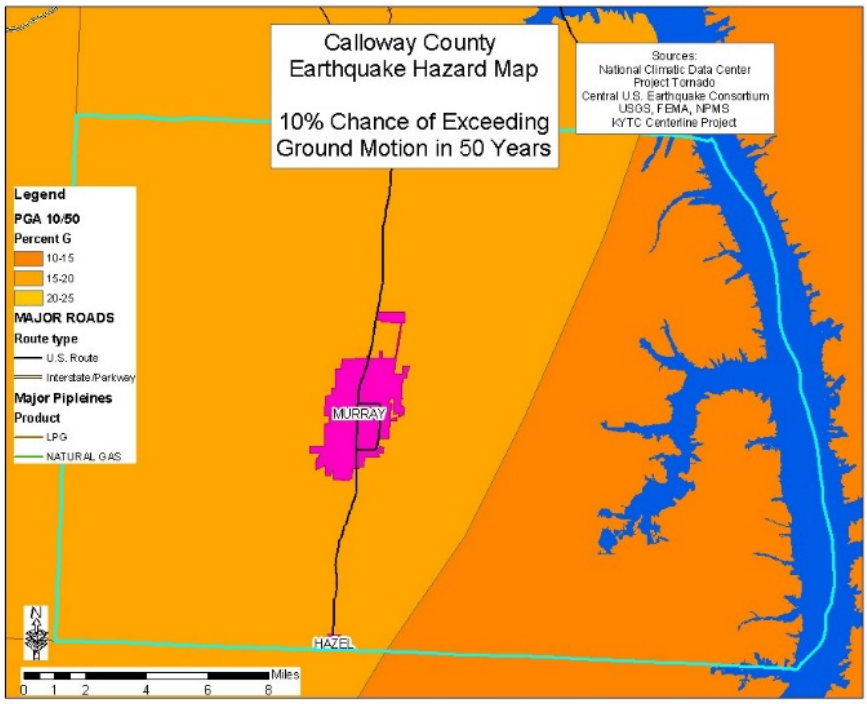
Earthquake

An earthquake is a geologic event that involves movement or shaking of the earth's crust. Earthquakes are usually caused by the release of stresses accumulated as a result of the rupture of rocks along borders of the earth's ten tectonic plates. Earthquakes can affect hundreds of thousands of square miles, causing damage to property, resulting in loss of life and injury, and disrupting the social and economic functioning of the affected area.

An assessment to the earthquake threat to the entire Purchase Region is provided in the regional plan. Two thirds of Calloway County lies in an area that has a 10 per cent probability of an earthquake in the new Madrid Seismic Zone producing ground motions that exceed 15 % to 20% of "G" during the next 50 years (See Figure 3.2). That would equate to a VI on the Modified Mecalli Scale, or a 5.4 on the Richter. (Trees sway, suspended objects swing, and objects fall off shelves). The remainder of the county would experience ground motions 10-15% of G under the same conditions.

That does not mean it will happen in fifty years, as one could look at the data and just as correctly assume that there is a 90% probability that the region will not experience this level of ground motion during a given 50 year period. It should be noted that 20% of G is an acceleration of 73 inches/second/second.

Figure 3.2
Earthquake Ground Motion Map

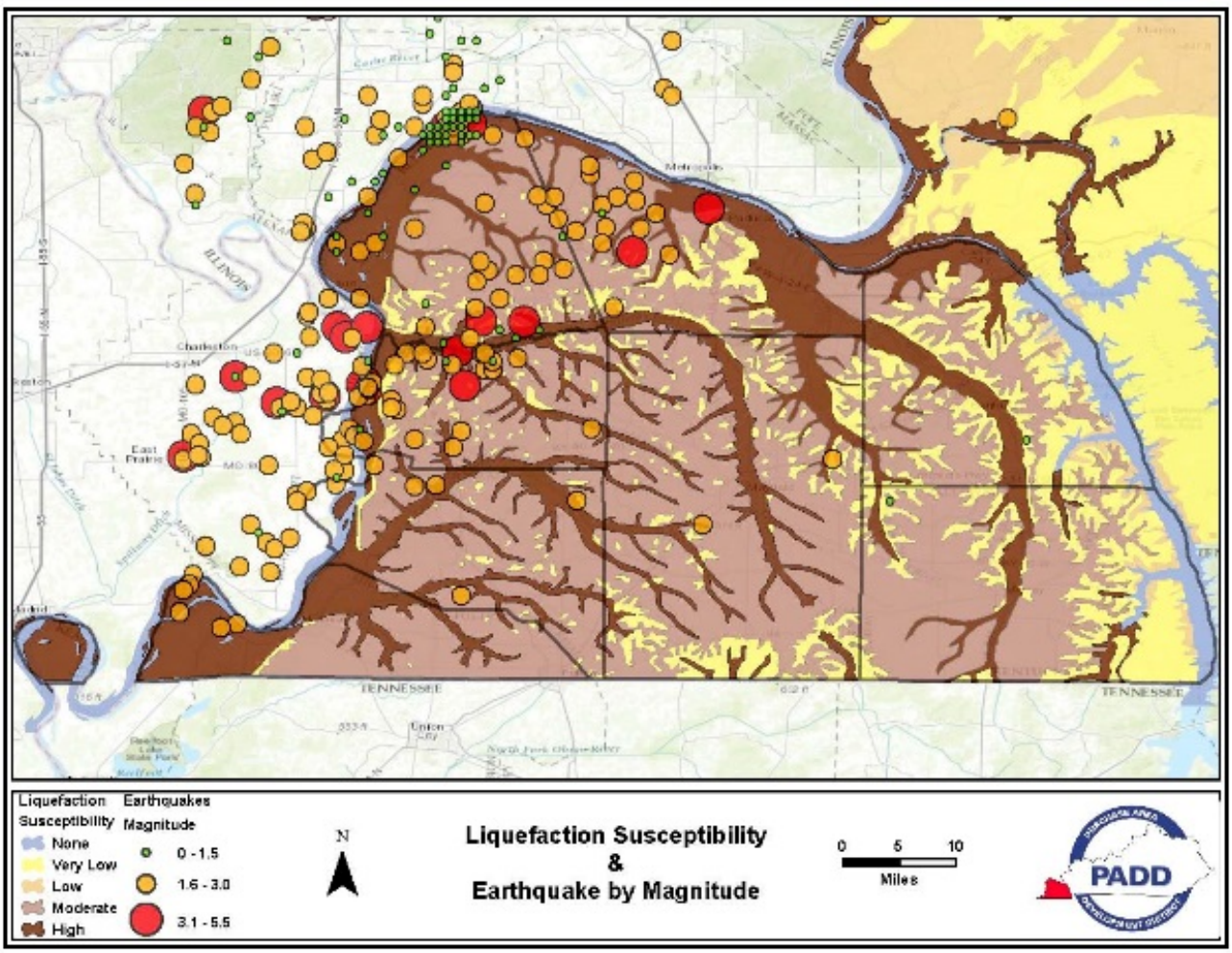


At issue for all the Purchase Region and virtually all of Calloway County would be the effect of a large magnitude quake on the soils underlying the region. The ground shaking estimate accounts for both the likely ranges of recurrence intervals and locations. Due to the relatively low rate of seismicity, ground cover, deep soil, etc, most faults within the region aren't even mapped. Even the precise location of faults within the New Madrid Seismic Zone are subject to debate. No one knows what causes New Madrid earthquakes. However, there are ideas that are being researched. Although there is great uncertainty regarding the cause of earthquakes, scientists generally do agree on what

happens when they do occur – that is, the likely levels of ground shaking associated with the waves earthquakes emit. These levels are reflected in the National Seismic Hazard Maps, which represent the products of a long consensus building process. These maps also account for the uncertainties in our understanding.

Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends on the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site and regional geology. Earthquakes may also cause liquefaction. Liquefaction occurs when the ground soil loses the ability to resist shear and flows, much like quick sand. When liquefaction occurs, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

Figure 3.3 Generalized Liquefaction Susceptibility & Earthquake Magnitude of the Purchase Region



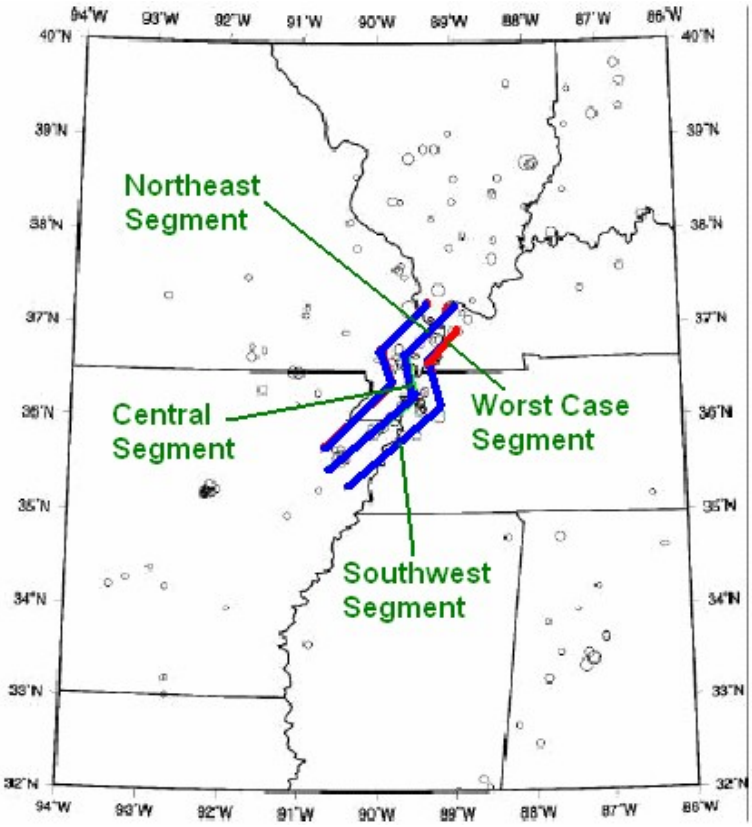
Source: USGS Map was derived from the USGS Earthquake Catalog, Available at: https://earthquake.usgs.gov/earthquakes/search/

Included in Appendix 2 to the regional plan and the Calloway County Chapter are excerpts from Mid-America Earthquake Center Report 08-02 *Impact of Earthquakes on the Central USA*. This report is the result of a FEMA funded Project completed under the management of the U.S. Army Corps of Engineers.

> The NMSZ scenario for the State of Kentucky consists of a magnitude 7.7 (Mw7.7) earthquake along the northeast extension of the presumed eastern fault line in the New Madrid fault system. The ground motions used to represent this seismic event were developed by the U.S. Geological Survey (USGS) for the middle fault in the proposed New Madrid Seismic Zone (NMSZ). Each fault line is presumed to consist of three fault segments; northeastern, central, and southwestern. This scenario, the worst case event for Kentucky, employs an event in the northeast segment of the eastern fault. The location of this scenario event is illustrated in Figure 3.4. For more information on the ground motion used in this scenario please reference Appendix 2
>
> This earthquake impact assessment includes all 120 counties in the State of Kentucky. Kentucky is approximately 40,400 square miles and is bordered by Indiana and Ohio to the north, Tennessee to the south, West Virginia and Virginia to the east and Illinois and Missouri to the west. For the purposes of this analysis, 25 critical counties have been identified in the western portion of the state where shaking is anticipated to be most intense. These 25 counties are the focus of much of the damage assessment included within this document". Purchase counties included as critical counties are Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, McCracken, and Marshall.
>
> Within the State of Kentucky, nearly 29,000 buildings experience complete damage, which are included in the nearly 53,000 at least moderately damaged buildings. While this is roughly 2% of all Kentucky buildings, many of these collapsed structures are concentrated in the western counties. As with previous state scenarios, residential buildings experience the greatest amount of damage. Nearly 98% of all building collapses occur to residential structures. In addition, about 94% of all at least moderate damage occurs in the 25 critical counties for Kentucky.

More detailed data from the scenario's results are included in the Appendix 2.

Figure 3.4 **Scenario Fault Location for the State of Kentucky**



SUMMARY AND CONCLUSIONS OF EARTHQUAKE HAZARD PROFILE

Low magnitude earthquakes occur constantly in the New Madrid Seismic Zone. Depending on the depth and magnitude, some of the stronger tremblors, 3 and above, are felt throughout the entire region. Damages amount to the rare instance of a picture being knocked off a wall or items shaken from shelves.

The potential for an earthquake of catastrophic proportions is not open to debate. Historic and geologic evidence are proof. However, the probability of such an event in any given time frame is open to interpretation and the effects are still a matter of discussion. The excerpts from Report 08-02 include the results of HAZUS simulations for a New Madrid 7.7 generated by the team at the Mid-America Earthquake Center, clearly support the High Risk ranking of this hazard, and provide detailed potential damage and casualty figures.

Winter Storms/Ice Storm

Winter Storms can produce an array of hazardous weather conditions that include heavy snow, freezing rain, sleet, high winds, and extreme cold. Ice Storms occur when freezing rain accumulates on surfaces and the ground. When a quarter-inch or more of ice builds up, severe impacts can result. Winter storms are fueled by strong temperature gradients and an active upper-level cold jet stream. An Ice Storm can develop when warmer air above the freezing mark above the ground moves over subfreezing air near the ground. Snow aloft falls through the warmer air and melts into rain, then the rain droplets fall into the subfreezing air and freeze upon contact creating a glaze of ice. Winter and Ice storms can paralyze a community by shutting down normal everyday operations. Accumulating snow and ice can result in downed trees and power lines and may block transportation routes or make them hazardous. Heavy snow can lead to the collapse of weak roofs or unstable structures. Often, the loss of electricity results in the loss of heat in some homes and buildings. This presents a threat to human life, especially the elderly population.

The level of impact Winter Storms have is greatly determined by a community's ability to manage and control the affect; for example, the rapid mobilization of snow removal equipment. Because winter storms are sporadic, many communities cannot afford the expensive equipment and maintenance of snow removal. This increases the potential damage a Winter Storm may cause. Depending on the severity of the storm, its impact can persist for days. If more than a half-inch of accumulation occurs and damage is widespread, it can take a while to remove trees and repair power lines. This can result in a loss of electricity and heat for several days. During the planning period there have been seven Winter Storms and one Ice Storm recorded in Calloway County.

Table 3.8 Winter Storm / Ice Storm Events and Impacts in Calloway County, January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Event Type	Deaths	Injuries	Property Damage	Crop Damage
CALLOWAY (ZONE)	12/05/2013	23:00	CST-6	Winter Storm	0	0	0.00K	0.00K
CALLOWAY (ZONE)	12/08/2013	00:00	CST-6	Ice Storm	0	0	0.00K	0.00K
CALLOWAY (ZONE)	02/04/2014	12:00	CST-6	Winter Storm	0	0	0.00K	0.00K
CALLOWAY (ZONE)	03/02/2014	14:00	CST-6	Winter Storm	0	0	0.00K	0.00K
CALLOWAY (ZONE)	02/16/2015	00:00	CST-6	Winter Storm	0	0	0.00K	0.00K
CALLOWAY (ZONE)	02/20/2015	14:00	CST-6	Winter Storm	0	0	0.00K	0.00K
CALLOWAY (ZONE)	03/04/2015	15:00	CST-6	Winter Storm	0	0	0.00K	0.00K
CALLOWAY (ZONE)	01/21/2016	22:00	CST-6	Winter Storm	0	0	0.00K	0.00K
TOTALS					**0**	**0**	**0.00K**	**0.00K**

Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

The following event is typical of the type of winter storms experienced in Calloway County:

- On December 8, 2013 A disturbance in the upper levels of the atmosphere lifted northeast across the Lower Ohio Valley. This disturbance ushered in warmer air aloft. Rain fell into a shallow layer of sub-freezing air near the surface, resulting in freezing rain. Where the layer of sub-freezing air was deeper, the precipitation fell as sleet. In the Tennessee border area from Murray eastward to Hopkinsville and Elkton, around one-quarter inch of ice coated all surfaces. Trees and power lines were ice-covered. Roads were ice-covered and hazardous. Scattered power outages were reported in the Murray area. Across the remainder of western Kentucky away from the Murray to Hopkinsville corridor, ice accumulations were mainly one-tenth inch or less.
- On February 4, 2014 one-quarter to one-half inch of ice coated trees and power lines across western Kentucky. The highest accumulations of ice were from the Murray area, northeast across Kentucky Lake, to Madisonville and Calhoun. The freezing rain started as a period of heavy snow and sleet in some areas, mainly from Paducah to Madisonville and points north. Up to an inch of snow and sleet accumulated in the Henderson and Owensboro areas. Scattered power outages were reported across western Kentucky. In the Pennyrile Region, east of Kentucky Lake, a utility company reported 2,000 customers without power. Roads started off very slick with numerous accidents, but they became mainly wet as temperatures rose into the lower 30's. In Calloway County, three accidents were reported in 20 minutes. The bridge carrying U.S. Highway 45 across the Ohio River between Paducah and Brookport was closed due to ice on the metal bridge deck. In Marshall County, downed power lines blocked the intersection of Highways 641 and 58. Widespread heavy perception north of the warm front resulted in significant icing across western Kentucky, along with some minor accumulations of sleet and snow.

SUMMARY AND CONCLUSIONS OF WINTER STORMS / ICE STORM PROFILE

From January 1, 2012 through March 31, 2017, there have been eight occurrences of Winter Storms (7)/ Ice Storms (1) in Calloway County reported by the NCEI. There were no recorded monetary damages reported with these occurrences. Likewise there were no injuries or fatalities recorded however the 2009 ice storm contributed to one death in Calloway County.

The eight reported Events over the 5.25 year plan update period, divides out to 1.52 reported Events per year, or a more than 100% probability that such an event will occur in any given year. The annual cost of an Event could not be calculated based on recorded events for the planning update period.

Flash Flood / Flood

As can be seen Table 3.9, Flash Flooding is the most common (13/17) form of flooding in Calloway County. The cause, being too much rain water, delivered in too short of time. However, rather than steep slopes and narrow valleys channeling and concentrating the runoff from heavy rains, the runoff is too great in volume for the County's characteristic low lying, meandering streams, to carry away. This slow drainage is often exacerbated by stream blockages of tree limbs and trunks, which form effective check dams and barrages.

River basin flooding is common among Kentucky's major streams and bodies of water during the winter and early spring months. The major bodies of water in Calloway County are: the Tennessee River/Kentucky Lake and the Clarks River. The Tennessee River delivered catastrophic flooding to the area in the past, most memorably in 1937, but has since been contained, if not controlled Kentucky Dam.

Periodic flooding of land adjacent to rivers, streams and shorelines is natural and can be expected to take place at fairly regular intervals. The recurrence interval of a flood is defined as the average time interval, in years, expected between a flood event of a particular magnitude and an equal or larger flood. As determined by the FEMA, a 100-year flood is a flood event of a magnitude expected to be equaled or exceeded once on the average during any 100-year period. It is not the flood that will occur once every 100 years. Rather, it is the flood elevation that has a 1- percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood, is also used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance.

Table 3.9 Flash Flood / Flood Events and Impacts in Calloway County January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Event Type	Deaths	Injuries	Property Damage	Crop Damage
HAZEL	03/08/2012	19:30	CST-6	Flash Flood	0	0	0.00K	0.00K
HARRIS GROVE	01/11/2013	01:00	CST-6	Flash Flood	0	0	20.00K	0.00K
MURRAY	01/13/2013	08:42	CST-6	Flash Flood	0	0	0.00K	0.00K
MIDWAY	04/27/2013	07:00	CST-6	Flood	0	0	0.00K	0.00K
ALMO	04/27/2013	17:31	CST-6	Flash Flood	0	0	0.00K	0.00K
POTTERTOWN	07/06/2013	20:15	CST-6	Flash Flood	0	0	10.00K	0.00K
NEW CONCORD	08/10/2013	06:30	CST-6	Flash Flood	0	0	0.00K	0.00K
STELLA	12/21/2013	17:31	CST-6	Flash Flood	0	0	40.00K	0.00K
MIDWAY	03/29/2014	09:35	CST-6	Flood	0	0	0.00K	0.00K
COPELAND	04/28/2014	05:30	CST-6	Flash Flood	0	0	0.00K	0.00K
CROSSLAND	05/14/2014	15:23	CST-6	Flash Flood	0	0	0.00K	0.00K
ALMO	12/23/2015	16:22	CST-6	Flash Flood	0	0	25.00K	0.00K
NEW CONCORD	12/28/2015	13:40	CST-6	Flash Flood	0	0	0.00K	0.00K
ALMO	03/10/2016	07:00	CST-6	Flood	0	0	0.00K	0.00K
MURRAY	07/03/2016	21:35	CST-6	Flash Flood	0	0	30.00K	0.00K
ALMO	07/07/2016	04:21	CST-6	Flash Flood	0	0	10.00K	0.00K
HAZEL	07/29/2016	18:45	CST-6	Flood	0	0	3.00K	0.00K
				TOTALS	0	0	138.00K	0.00K

Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information Storm Events Database: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

The following events are typical of the type of flooding experienced in Calloway County.

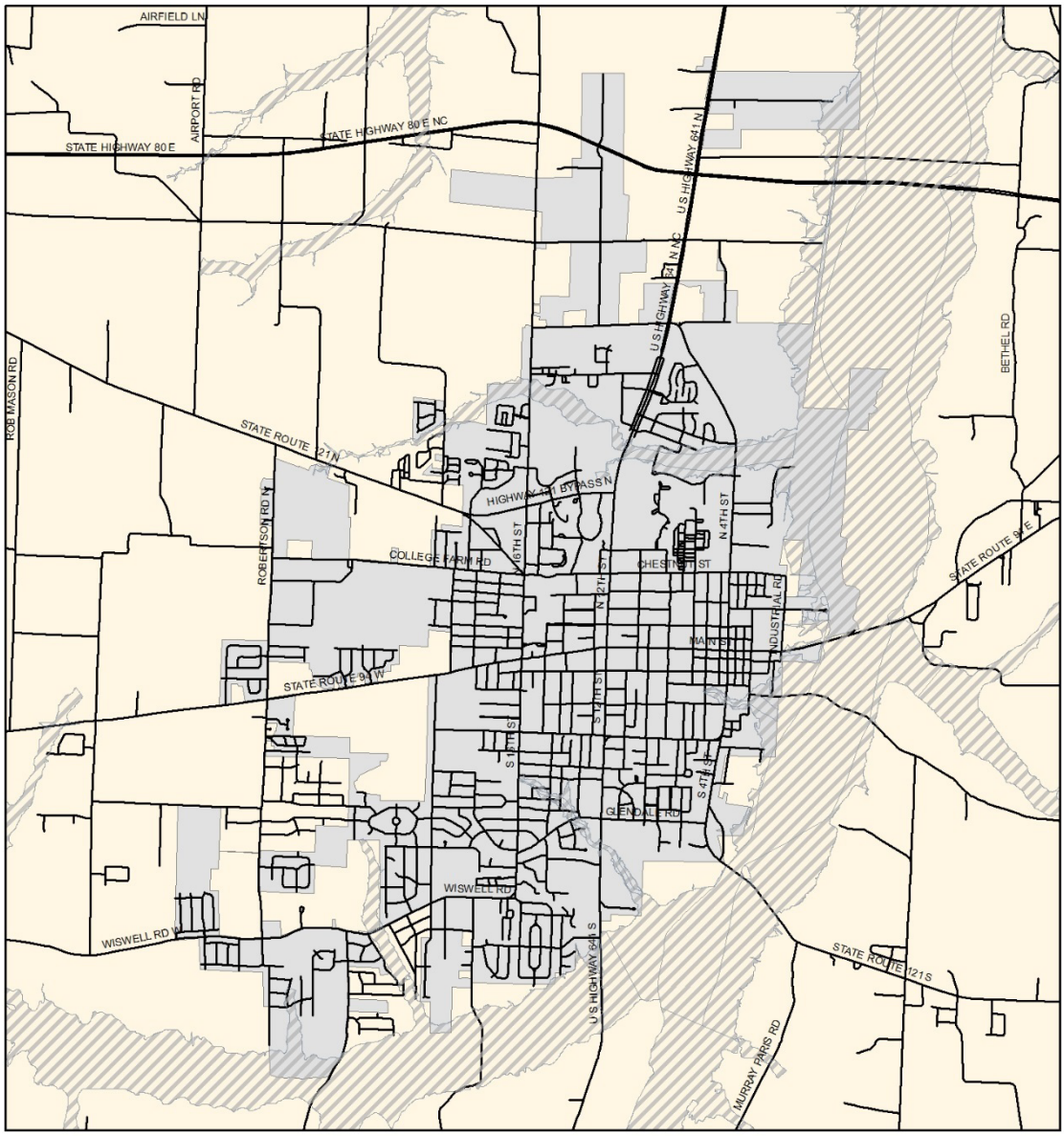
- On December 21, 2013 a slow-moving cold front passed across the region between the 20th and 22nd. Several upper level disturbances moved north-northeast along the front, touching off numerous showers and thunderstorms. The ground was already moist from snowmelt in the wake of the early December winter storm. On the 21st, a strong negatively tilted shortwave at 500 mb ejected northeast from the southern Plains, providing strong forcing for ascent. Widespread heavy rain and thunderstorms surged northeast in association with the strengthening surface low that tracked across western Kentucky. Storm total rainfall amounts ranged from 3 to 6 inches in most areas, with the highest amounts west of Kentucky Lake. Isolated higher rainfall amounts up to 9 inches occurred in Ballard County, near the confluence of the Mississippi and Ohio Rivers. Ditches and creeks quickly spilled out onto roadways and into nearby fields. There were numerous road closures and water rescues as waters continued to rise. The main street through the center of Murray was nearly impassable in spots. Cars were stalling out in the roadway. Floodwaters from a city creek were backing into homes. Highway 80 north of Murray was impassable in spots. A water rescue was conducted on a residential street on the south side of Murray. Five people were stranded on top of a jeep. A heavily travelled access road was closed in a business strip of Murray along the Highway 121 bypass. A mile west of Hazel, a car was swept off the road. The occupants were rescued. Several roadways around Lynn Grove had areas of standing water. An estimated $40,000 in property damages was reported as a result of this event.

- On July 29, 2016, complexes of thunderstorms formed south of a stationary front that was located over the Lower Ohio Valley. One complex of storms produced widespread flash flooding of roads in Todd County in the morning. Another storm complex flooded roads in Calloway County in the evening. Numerous roads were flooded, especially in areas west of Murray. Four miles west of Hazel, a car was stranded in high water. A trained spotter in Murray reported 2.6 inches of rain in three hours.

Figure 3.5 and 3.6 show the Flood Hazard Areas in Calloway County.

Figure 3.5 Calloway County 100 Year Floodplain

Figure 3.6 City of Murray 100 / 500 year Floodplain



Murray Flood Hazard Area

Legend

- Revised 100 Year Flood Zone
- Rivers
- City Limits
- Roads

0 0.25 0.5 1 Miles

N W E S

PADD

Source:
FEMA Revised Flood Data

Table 3.10 National Flood Insurance Program Participation by Jurisdiction

Jurisdiction	Floodplain Management Ordinance	SFHA in Jurisdictional Limits	Comments	City Class
Ballard County	X	X		
City of Barlow			No mapped SFHA	6
City of Kevil			No mapped SFHA	6
City of La Center		X	SFHA mapped in 2009, NFIP under consideration	5
City of Wickliffe	X	X		5
Calloway County	**X**	**X**		
City of Murray	**X**	**X**		**3**
City of Hazel			**No mapped SFHA**	**6**
Carlisle County	X	X		
City of Bardwell	X	X		5
City of Arlington	X	X		6
Fulton County	X	X		
City of Fulton	X	X		4
City of Hickman	X	X		4
Graves County	X	X		
City of Mayfield	X	X		3
City of Wingo		X		6
Hickman County		X	Mapped SFHA, non-participant	
City of Clinton	X	X		5
City of Columbus			No mapped SFHA	5
Marshall County	X	X		
City of Benton	X	X		4
City of Calvert City	X	X		4
City of Hardin	X	X		5
McCracken County	X	X		
City of Paducah	X	X		2

Information from the FEMA Community Status Book as of 6-13-17

SUMMARY AND CONCLUSIONS OF FLOODING PROFILE

Information from the above tables and maps related to flooding can be used to define the frequency of Flood Events and the impact of these events. Data on flood event magnitude was not available.

The frequency of occurrence that can be derived from this data is 17 Flood Events in 5.25 years, which divides out to 3.23 reported flooding events per year, or a better than 100% probability of a Flood Event in any given year. The cost of a Flood Event could be calculated as:

- $188,000 divided by 17 events = $11,058 per event.
- $11,058 times 3.23 events/year = $35,717 per year.

Hail

Hail is one of four types of precipitation that falls from the sky. It's also the most dangerous, damaging type, occurring during severe storms. If hail measuring larger than ¾ inches in diameter falls during a thunderstorm, it is classified as severe weather. Sometimes damaging winds accompany this type of storm as well. According to the National Oceanic and Atmospheric Administration, hail causes over one billion dollars of damage in the United States each year.

Generally, hail must be 1 ¼ inches in diameter (Half-Dollar size) before it causes damage to heavy composite shingles or wood shake shingles. Lightweight composite shingles may show damage after being struck by 1-inch diameter (Quarter size) hail. Only deteriorated composite shingles will show hail damage due to hail less than 1 inch in diameter, and the hail generally must be more than ¾ inch in diameter (Dime size).

TORRO Hailstorm Intensity Scale

The Torro Hailstorm Intensity Scale was introduced by Jonathan Webb of Oxford, England, in 1986 as a means of categorizing hailstorms. The scale extends from H0 to H10 (See Table 3.11) with its increments of intensity or damage potential related to hail size, texture, numbers, fall speed, speed of storm translation, and strength of the accompanying wind.

An indication of equivalent hail kinetic energy ranges (in joules per square meter) has now been added to the first six increments on the scale, and this may be derived from radar reflectivity or from hail pads. The International Hailstorm Intensity Scale recognizes that hail size alone is insufficient to accurately categorize the intensity and damage potential of a hailstorm, especially towards the lower end of the scale. For example, without additional information, an event in which hail of up to walnut size is reported (hail size code 3: hail diameter of 21-30 mm) would be graded as a hailstorm with a minimum intensity of H2-3. Additional information, such as the ground wind speed or the nature of the damage the hail caused, would help to clarify the intensity of the event. For example, a fall of walnut-sized hail with little or no wind may scar fruit and sever the stems of crops but would not break vertical glass and so would be ranked H2-3. However, if accompanied by strong winds, the same hail may smash many windows in a house and dent the bodywork of a car, and so be graded an intensity as high as H5.

However, evidence indicates that maximum hailstone size is the most important parameter relating to structural damage, especially towards the more severe end of the scale. It must be noted that hailstone shapes are also an important feature, especially as the "effective" diameter of non-spheroidal specimens should ideally be an average of the co-ordinates. Spiked or jagged hail can also increase some aspects of damage.

Table 3.11

H	Intensity Category	Typical Hail Diameter (mm)*	Probable Kinetic Energy, J-m^2	Typical Damage Impacts
H0	Hard Hail	5	0-20	No damage
H1	Potentially Damaging	5-15	>20	Slight general damage to plants, crops
H2	Significant	10-20	>100	Significant damage to fruit, crops, vegetation
H3	Severe	20-30	>300	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	25-40	>500	Widespread glass damage, vehicle bodywork damage
H5	Destructive	30-50	>800	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	40-60		Bodywork of grounded aircraft dented, brick walls pitted
H7	Destructive	50-75		Severe roof damage, risk of serious injuries
H8	Destructive	60-90		(Severest recorded in the British Isles) Severe damage to aircraft bodywork
H9	Super Hailstorms	75-100		Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	>100		Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Size codes are presented in TABLE 3.12 The Size Code is the maximum reported size code accepted as consistent with other reports and evidence.

Table 3.12

Size code	Maximum Diameter mm	Description
0	5-9	Pea
1	10-15	Mothball
2	16-20	Marble, grape
3	21-30	Walnut
4	31-40	Pigeon's egg > squash ball
5	41-50	Golf ball > Pullet's egg
6	51-60	Hen's egg
7	61-75	Tennis ball > cricket ball
8	76-90	Large orange > Soft ball
9	91-100	Grapefruit
10	>100	Melon

From January 1, 2012 through March 31, 2017, there have been 25 occurrences of Hail events in Calloway County reported by the NCEI. There were no injuries or property damages associated with these events for the plan update period.

Table 3.13 Hail Events and Impacts in Calloway County January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
LYNN GROVE	01/22/2012	23:04	CST-6	0.88 in.	0	0	0.00K	0.00K
MURRAY	01/22/2012	23:05	CST-6	2.00 in.	0	0	0.00K	0.00K
DEXTER	02/29/2012	09:10	CST-6	1.00 in.	0	0	0.00K	0.00K
MURRAY	03/02/2012	14:57	CST-6	0.88 in.	0	0	0.00K	0.00K
MURRAY	03/15/2012	13:20	CST-6	1.00 in.	0	0	0.00K	0.00K
HAMLIN	03/15/2012	13:35	CST-6	1.00 in.	0	0	0.00K	0.00K
LYNN GROVE	05/05/2012	22:57	CST-6	0.88 in.	0	0	0.00K	0.00K
MURRAY ARPT	05/20/2012	17:50	CST-6	0.75 in.	0	0	0.00K	0.00K
HAZEL	07/18/2012	17:47	CST-6	1.75 in.	0	0	0.00K	0.00K
MURRAY	08/16/2012	19:30	CST-6	0.75 in.	0	0	0.00K	0.00K
MURRAY	01/29/2013	23:55	CST-6	0.75 in.	0	0	0.00K	0.00K
MURRAY	05/30/2013	19:36	CST-6	0.88 in.	0	0	0.00K	0.00K
HAZEL	05/01/2016	12:50	CST-6	1.00 in.	0	0	0.00K	0.00K
MURRAY	05/26/2016	14:13	CST-6	0.75 in.	0	0	0.00K	0.00K
MURRAY	06/15/2016	13:19	CST-6	0.75 in.	0	0	0.00K	0.00K
MURRAY	06/25/2016	13:55	CST-6	0.75 in.	0	0	0.00K	0.00K
ALMO	07/08/2016	18:10	CST-6	0.88 in.	0	0	0.00K	0.00K
MURRAY	02/28/2017	22:45	CST-6	0.75 in.	0	0	0.00K	0.00K
MURRAY	03/09/2017	19:40	CST-6	1.00 in.	0	0	0.00K	0.00K
ALMO	03/09/2017	19:55	CST-6	1.00 in.	0	0	0.00K	0.00K
MURRAY	03/09/2017	20:37	CST-6	.075 in.	0	0	0.00K	0.00K

Location	Date	Time	Time Zone	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
MURRAY	03/20/2017	16:18	CST-6	.075 in.	0	0	0.00K	0.00K
COLDWATER	03/27/2017	12:18	CST-6	1.75 in.	0	0	0.00K	0.00K
MURRAY	03/27/2017	12:30	CST-6	1.00 in.	0	0	0.00K	0.00K
NEW CONCORD	03/27/2017	12:50	CST-6	1.75 in.	0	0	0.00K	0.00K
Totals					**0**	**0**	**0.00K**	**0.00K**

Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

The following descriptions are typical of Hail events experienced in Calloway County.

- On January 22, 2012, a potent upper-level trough moved east into eastern Kansas and Oklahoma, before assuming a negative tilt and accelerating east-northeast across the Mid-Mississippi and Lower Ohio Valleys. The associated surface low tracked northeast from Kansas across northern Missouri to southern Wisconsin. Ahead of the low and trough, a south-southwesterly low-level jet in excess of 50 knots expanded east across the Mid-Mississippi Valley. An expansive quasi-linear convective system formed along the lead cold front trailing southward from the surface low. Despite rather meager instability, very strong low and mid-level wind fields resulted in organized storm structures with pockets of damaging wind, isolated large hail, and a couple of tornadoes. A swath of large hail occurred just southwest of Murray. Hail was up to the size of hen eggs a couple miles southwest of the city.

- On July 8, 2016, during the late afternoon and evening hours, a complex of thunderstorms produced damaging winds and isolated flash flooding across southwestern Kentucky. These storms produced sporadic wind damage all the way from the Mississippi River to Elkton, Kentucky. This was the third straight day of widespread thunderstorms, so heavy rainfall resulted in isolated flooding in those areas already hit hard by recent heavy rain. A mid-level shortwave trough moved through the Great Lakes region during the day. The lower Ohio Valley was on the southwest fringe of the stronger mid-level flow, with winds around 35 knots. At 700 mb, a weak disturbance over southwest Missouri and northwest Arkansas helped focus organized convection ahead of it. A weak surface front resided just north of the storms across portions of Missouri and Illinois. Strong instability along with steep mid-level lapse rates contributed to strong updrafts. Perceptible water values were also quite high, around 2 inches.

SUMMARY AND CONCLUSIONS OF HAIL PROFILE

Calloway County has experienced 25 reported Hail Events during the 5.25 year plan update period, which divides out to 4.76 events per year or a probability of over 100% for an event with Hail occurrence in any given year. Due to no reported damages in Calloway County, the cost of a Hail Event could not be calculated.

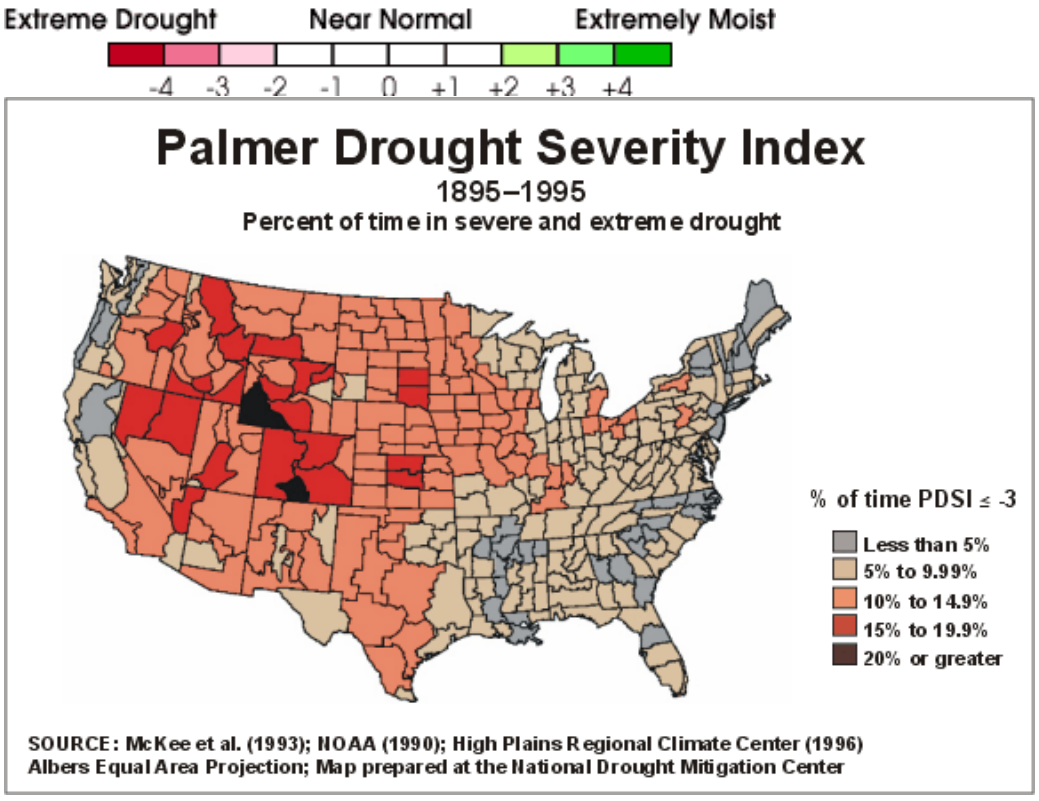
Excessive Heat / Drought

Excessive heat is defined as temperatures that hover 10 degrees or more above the average high temperatures for the region and last for several weeks. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. Excessively dry and hot conditions can provoke dust storms and low visibility.

Droughts occur when a long period passes without substantial rainfall. Drought conditions can cause significant crop damage, but there is little property damage from excessive heat. Due to the historical occurrences of drought and excessive heat in the Purchase Region, these hazards present a threat not only to the agriculture of the region, but to the aged, and chronically ill population.

The Palmer Drought Severity Index (PDSI) is used to show the relative dryness or wetness in an area and indicates prolonged and abnormal moisture deficiency or excess. The PDSI is used for evaluating the scope, severity and frequency of prolonged periods of abnormally wet or dry weather (Figure 3.7). The PDSI scale follows below.

Figure 3.7 Palmer Drought Severity Index



During the planning period for this update there have been a combined total of 16 events recorded in Calloway County. Of those 16 events, three have been Excessive Heat and 13 Drought. There were no injuries / fatalities or damages (property or crop) recorded during these events.

Table 3.14 Excessive Heat / Drought Events and Impacts in Calloway County January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Event Type	Deaths	Injuries	Property Damage	Crop Damage
CALLOWAY (ZONE)	05/12/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	06/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	07/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	07/01/2012	10:00	CST-6	Excessive Heat	0	0	0.00K	0.00K
CALLOWAY (ZONE)	07/18/2012	10:00	CST-6	Excessive Heat	0	0	0.00K	0.00K
CALLOWAY (ZONE)	08/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	09/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	10/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	11/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	12/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	01/01/2013	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	07/25/2014	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	08/01/2014	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	01/10/2015	00:00	CST-6	Drought	0	0	0.00K	0.00K
CALLOWAY (ZONE)	07/27/2015	12:00	CST-6	Excessive Heat	0	0	0.00K	0.00K
CALLOWAY (ZONE)	11/01/2016	00:00	CST-6	Drought	0	0	0.00K	0.00K
Totals:					**0**	**0**	**0.00K**	**0.00K**

Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

The excessive heat and drought events from July 1, 2012 are recorded below as an example of the heat type event that occurs in Calloway County and throughout the Purchase Region.

- July 1, 2012 Excessive Heat Event

The historic heat wave that began in late June continued into July. This heat was comparable to the intense heat experienced in the 1930's. The high temperature reached or exceeded 100 degrees on 9 out of 10 days going back to June 28 and ending on July 7. At Paducah, the high of 107 degrees on the 6th was one degree shy of the all-time highest temperature recorded there. The all-time record at Paducah was first set on July 17, 1942 and tied on June 29, 2012. Daily high temperature records were broken on six of the first seven days of the month. New daily records were 105 degrees on the 1st, 101 on the 2nd, 101 on the 4th, 105 on the 5th, 107 on the 6th, and 104 on the 7th. From the 1st to the 6th, humidity levels were not especially high due to the ongoing drought, so heat index values were close to the actual temperature. Higher humidity on the 7th and 8th raised peak heat index values to between 106 and 113 degrees. Strong high pressure aloft remained anchored over the middle part of the country through the first week of July.

- August 1, 2014 Drought Event

Drought conditions that had started in parts of western Kentucky in July ended by late August. The area of moderate drought conditions extended from Murray to Hopkinsville and Elkton. Impacts of the drought were primarily agricultural. A report from Todd County indicated corn and early-planted soybean yields were projected to be reduced by about 50 percent. The drought ended in August due to the occurrence of thunderstorm complexes that tracked across the region.

SUMMARY AND CONCLUSIONS OF EXCESSIVE HEAT / DROUGHT PROFILE

Combined there have been 16 heat related events in the county during the 5.25 year planning period. This divides out to 3.05 events per year, a better than 100% probability that either a drought or excessive heat event (or both) could occur in any given year. Common sense would dictate that the conditions that generated a heat type event in one county could have generated a heat type event in another. One in every 10 events could prove deadly and almost four heat injuries result from every event. From a county perspective the cost of an Excessive Heat Event is difficult to assess as there are no monetary damages available. Of critical concern to the Calloway County MPT was the potential for human casualties in the form of heat stroke and heat exhaustion causing injury and even deaths.

Information from the above table can be used to define the frequency of Drought Events and the impact of these events throughout the region. Drought is mainly a threat to the agricultural segment of the county economy, but it is also has a significant impact on water and wastewater systems, especially those with cast iron piping, as soil shrinkage causes pipes to snap was brought to the JPHMC attention by the West McCracken Water District during the 2012 plan update cycle.

Based on historic records, there have been no deaths attributed to excessive heat in Calloway County. The complete history of excessive heat and drought events for Calloway County can be reviewed in Appendix 1. As there are no reported damages or injuries for the planning update period, the annualized cost of a heat related event could not be calculated.

Wildfire

A wildfire is an uncontrollable burning of grasslands, brush or woodlands. The potential for wildfire depends on surface fuel characteristics, weather conditions, recent climate conditions, and topography and fire behavior. There are three different types of wildfire classes:

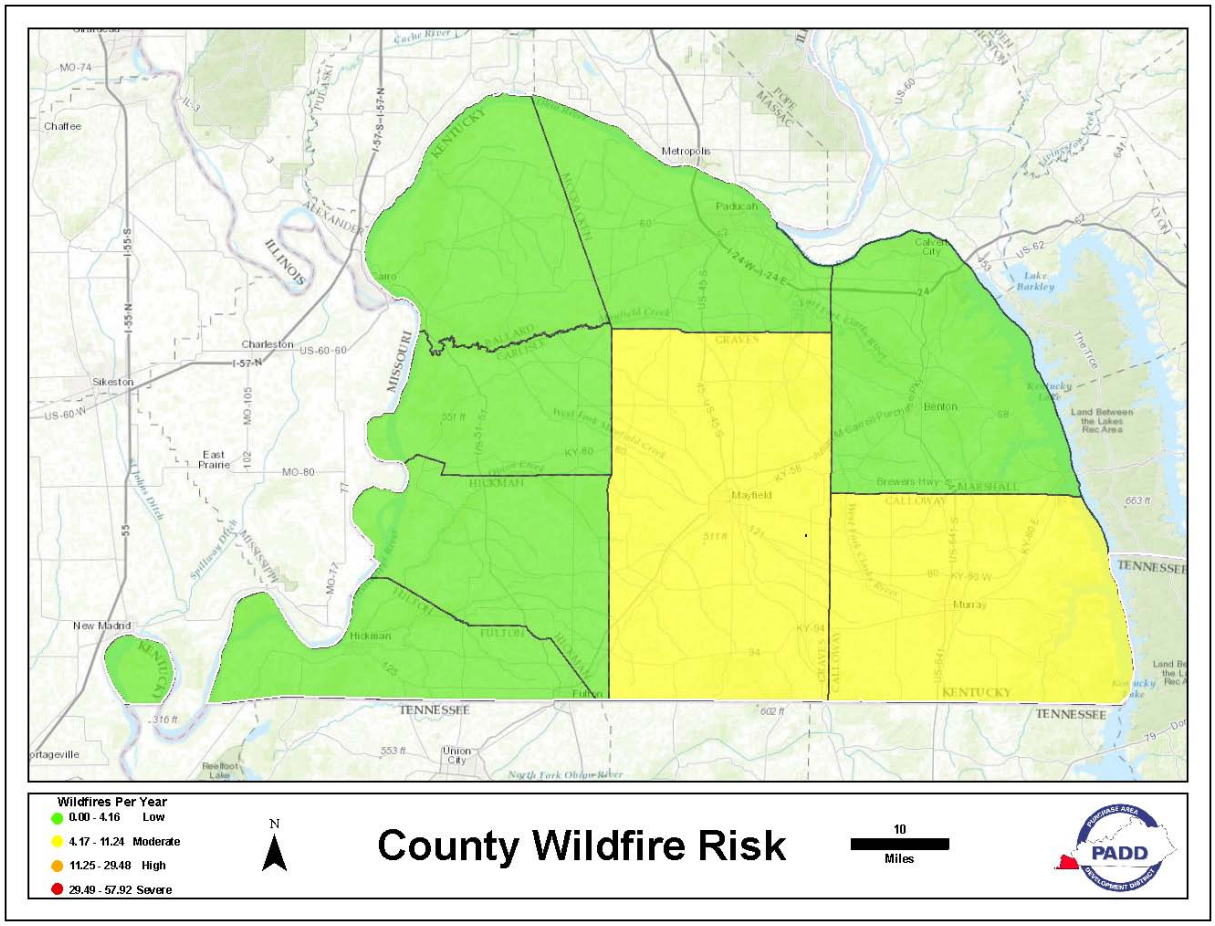
- *Surface fires* are the most common type. These fires burn along the forest floor moving slowly and will damage and kill trees.
- *Ground fires* are usually started by lightening. These fires burn on or below the forest floor.
- *Crown fires* are spread quickly by wind. These fires will move quickly by jumping along tree tops.
    - *Spotting* can be produced by crown fires as well as wind and topography conditions. Large burning embers are thrown ahead of the main fire. Once spotting begins, the fire will be very difficult to control.

Kentucky has two defined wildfire seasons: in the spring, February 15 – April 30 and in the fall, October 1 – December 16. These two seasons are separated by periods of higher moisture and colder, less conducive fire weather. When leaves begin to fall from deciduous hardwood trees a thick litter layer forms in wooded areas creating a fuel source for rapidly expanding wildfires. Also during the fall season, or periods of drought, tall grasses can become very flammable. It is possible for wildfires to occur outside the defined fire seasons during prolonged periods of drought.

Specific outdoor burning laws have been established to lessen the wildfire occurrence during these fire seasons. Kentucky Revised Statute 149.400 prohibits outdoor burning during the defined fire seasons between 6 am and 6 pm unless at a distance of at least 150 feet from woodlands or brushland. In Kentucky, wildfire risks are compounded by the state's extremely high arson rate. Sixty-two percent of Kentucky's wildfires are deliberately set by arsonists.

The biggest threat of wildfires in Kentucky exists in the eastern part of the state. In western Kentucky, specifically the Purchase Region, wildfires are less common. The 2013 State Hazard Mitigation Plan utilized a county risk assessment model to calculate county-level risk. This model was created using the *Average Annual Loss* data for each county. The average annual loss is calculated by multiplying each county's annual rate of occurrence by the average losses (See the 2013 State Hazard Mitigation Plan for more information.) This data was then joined to a county map for display purposes. The Purchase counties are seen in the map below. Based on this model the Purchase counties are at a moderate to low risk of wildfire occurrences. Calloway County is considered to be in the moderate risk category (See Figure 3.8).

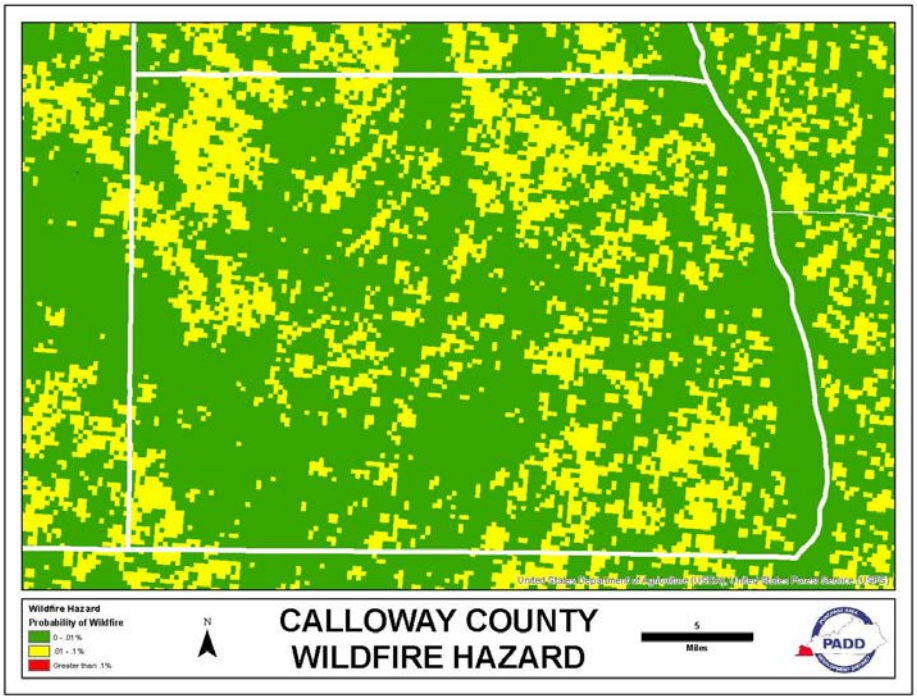
Figure 3.8 County Wildfire Risk



The Regional MPT during the 2012 Plan update cycle believed, as a result of the 2009 Ice Storm, a significant percentage of the forest cover in the Purchase Region has been damaged. Some estimates suggest 30% or more of the existing forest could be killed off. This damage will result in considerable "dead and down" fuel, especially if drought and or wind events combine to exacerbate the problem. During the 2017 review, the general feeling is that this risk is greatly diminished at this time. It is likely that there were some number of small field fires during this period however that expense was not documented.

Information obtained from the Kentucky Division of Forestry, displayed in the Figure 3.9, indicates that a majority of the county has a less than one percent probability of wildfire occurring.

Figure 3.9 Calloway County Wildfires



SUMMARY AND CONCLUSIONS OF WILDFIRE PROFILE

From January 1, 2012 through March 31, 2017, there have been zero occurrences of Wildfire Events reported in Calloway County by the NCEI and likewise zero events for the entire Purchase Region. In a search of the NCEI Storm Events Database there are only 11 reported events for the entire region. These occurred between February 1996 and January 2006. The last and only recorded event in Calloway County occurred on February 19, 2004. The complete history of wildfire events in the Purchase Region can be reviewed in Appendix 1.

With no historic data for damages to support wildfire as a hazard in Calloway County, does not mean that there have not been instances of brush fires that had or will have the potential to grow out of control, especially during periods of drought events. It is therefore included as a Hazard in the risk assessment, albeit a low risk, but a risk that needs to be continually assessed and planned for and perhaps anticipated.

The ice storm of 2009 generated massive amounts of fuel, in the form of fallen limbs, and that this risk is greatly diminished at this time. It is likely that there were some number of small field fires during this period however that expense was not documented. According to information found in the 2013 State Hazard Mitigation Plan, using the county risk assessment model, Calloway County has a 5.96 annual rate of occurrence for wildfires with an average loss of $1,153.00 per event.

Dam Failure

There are approximately 80,000 regulated dams in the United States. In Kentucky the Division of Water regulate 81 dams in the Purchase Region. Dams are classified based on the evaluation of damage possible downstream. The FEMA guide to dam classifications is as follows:

Table 3.15 FEMA Dam Classification

Classification	Description
Class A (Low)	No loss of human life is expected and damage will only occur to the dam owner's property.
Class B (Moderate/Significant)	Loss of human life is not probable, but economic loss, environmental damage, and/or disruption of lifeline facilities can be expected.
Class C (High)	Loss on one or more human life is expected.

Source: FEMA 333; Federal Guidelines for Dam Safety

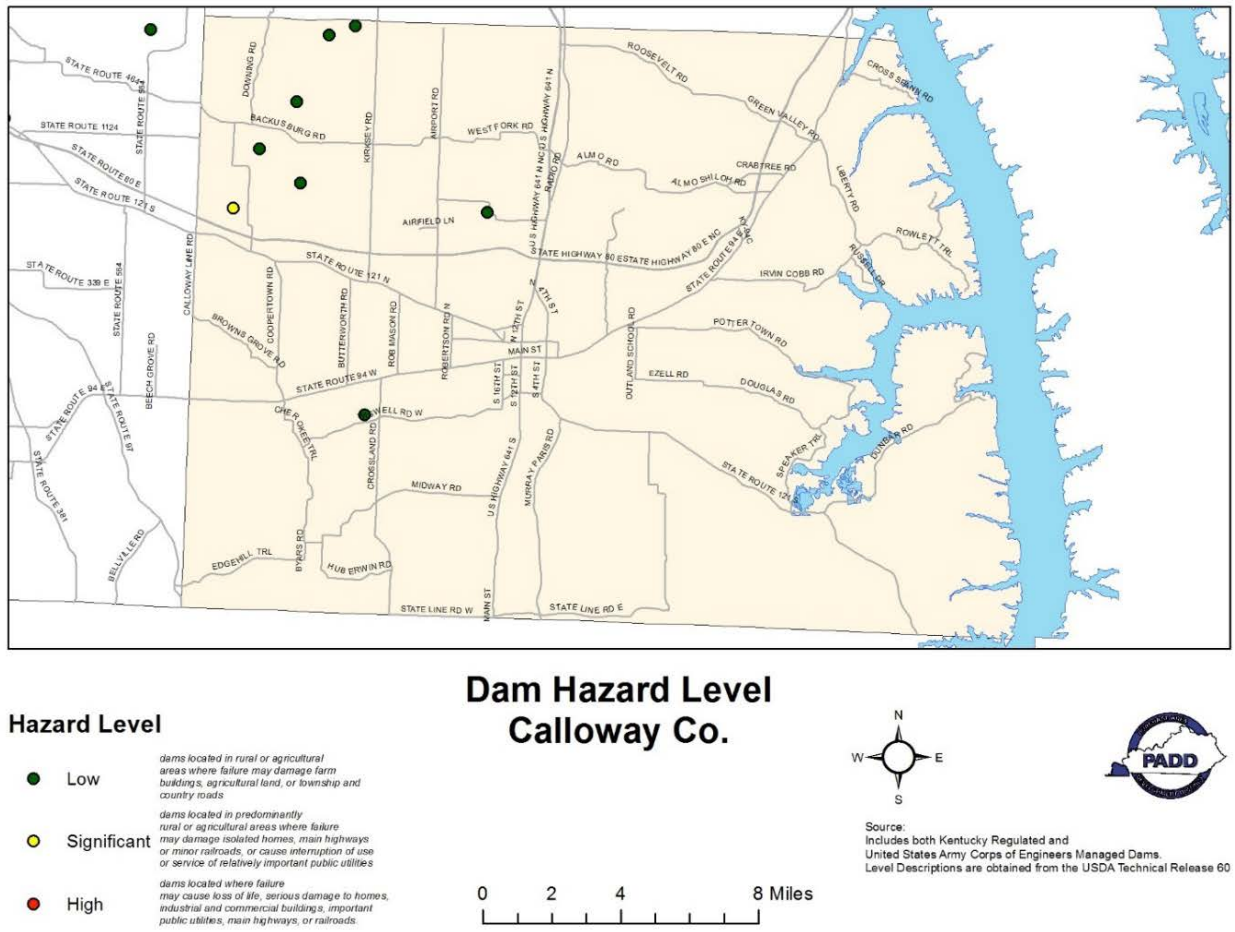
Table 3.16 lists the existing dams in the area by classification. Calloway County has eight structures, seven evaluated as Class A and one evaluated as Class B. The Kentucky Division of Water has surveyed the seven Class A dams in Calloway County.

Table 3.16 Dam Classification by County

County	Class A (low)	Class B (moderate)	Class C (high)
Ballard	3	1	0
Calloway	**7**	**1**	**0**
Carlisle	22	0	1
Graves	23	2	6
Hickman	5	1	0
Marshall	3	1	2
McCracken	**3**	**0**	**0**
Total	**66**	**6**	**9**

Figure 3.10 identifies the approximate location of the State rated dams in Calloway County. Please note that due to scaling, multiple dams may appear as a single structure.

Figure 3.10 Calloway County Dams by Downstream Hazard Potential



The MPT has some concern for possible catastrophic failure of Kentucky Dam, which is located downstream on the Tennessee River and impounds Kentucky Lake. The rapid draw down of water from the impounded area might cause considerable bank destabilization. For security reasons information regarding this structure is not available however the probability of an earthquake affecting the dam is low based on regular maintenance and monthly inspection of all components of this flood control system.

Additional seismic analysis was recently conducted on Kentucky Dam in 2017 and the lone recommendation from the stability analysis and multiple inspections was construction of a 400-foot long sand and stone berm adjacent to the earthen embankment that runs southwest from the concrete portion of the dam toward Kentucky Dam Village. A TVA spokesman described this project as "this berm will take a safe dam and make it safer." This $800,000 project is scheduled for construction in the spring of 2018. For planning purposes, the Calloway MPT can only speculate that the area inundated by failure of one or the other or both of these structures would be at least equal to the 100 year flood zone.

SUMMARY AND CONCLUSIONS FOR DAM FAILURE HAZARD PROFILE

There is no historical occurrence of damage or injury due to a dam failure in Calloway County however it is still considered a hazard. The main question regarding dam failure in Calloway County is the concern for a possible catastrophic failure of Kentucky Dam on the Tennessee River resulting in significant bank destabilization. Inundation maps or projections for the effects for this scenario are not available to the public and are not included in this plan.

3:4.3 Assessing Vulnerability: Identifying Assets Overall Summary Vulnerability

The vulnerability of structures to Severe Weather and Earthquake Hazards in Calloway County is equal to the total structure value of the county. These hazards are not limited to a particular geographic region. All critical facilities in the county were determined to be vulnerable to Severe Weather and Earthquake Hazards.

Calloway County's vulnerability to flooding was determined by GIS analysis. A GPS derived database of Critical Facilities, and the Kentucky Infrastructure Authority database for Water and Waste Water facilities were brought in. FEMA revised Flood Hazard Areas were added as an overlay and where the data intersected those structures/facilities were deemed vulnerable to a 100 year flood. The vulnerability of residential structures was determined by a similar method, laying the Flood Hazard Areas over imagery, to determine which structures were in the flood plain. The value of Critical Facilities and structures exposed to the other identified hazards, which are limited in area extent, varied by hazard type.

Impact & Frequency

The impact and frequency of each hazard has been identified in the previous section through maps and frequency tables. Impact is addressed further in the charts and narrative discussions found in the following asset identification and vulnerability sections of this plan.

Identification of Assets

This section of the plan identifies what can be affected in each jurisdiction by the different hazard events that occur in the Purchase Region. The information to complete this section was collected from a variety of sources including local jurisdictions, HAZUS 4.0 Kentucky Data, the NOAA NCEI, the 2010 Census, U.S Census Bureau 2011-2015 American Community Survey 5 Year Estimates and the Kentucky Revenue Cabinet. The information was collected, mapped and summarized by the PADD staff and reviewed and analyzed by the Calloway County MPT.

This section was prepared using the best available data for identifying the number of buildings, infrastructure and critical facilities and costs associated with them. Point data for flood vulnerability and critical facility locations were developed by the PADD. For this version of the plan, the PADD GIS staff analyzed imagery, for 2009 revised, FEMA mapped, flood prone areas of the county and extracted points for vulnerable structures, using these points to better focus this assessment. Location data for critical facilities vice the flood hazard areas were derived from GPS coordinates collected by the PADD GIS for Homeland Security purposes under contract to the Kentucky Infrastructure Authority.

Calloway County MPT members reviewed the information to determine the vulnerability in each community. For the hazards of Tornado, Thunderstorm Wind, Earthquakes, and Winter Storm. MPT members were not able to identify specific hazard areas for such events which were determined to potentially affect anything within Calloway County. These hazards and their occurrence is not limited to any particular area based on past historical events.

Critical Facilities and Infrastructure

For the purpose of this plan, the JPHMC adopted the definitions of the FEMA HAZUS Loss Estimation Model according to FEMA publication 386-1, version 4.0, pages 3-9 that state the following definitions of critical facilities and infrastructure. HAZUS separates critical facilities into five categories based on their loss potential. All of the following elements are considered critical facilities except Hazardous Materials Facilities. It was determined by the regional council that Hazardous Materials Facilities would not be addressed as critical facilities. Rationale: Hazardous Materials facilities are addressed in existing Emergency Operations Plans at the Facility and jurisdictional level, which are deemed by the committee as being both sufficient and beyond the expertise of the committee.

FEMA Critical Facilities Definitions

- Transportation Facilities include airways – airports, heliports; highways – bridges, tunnels, roadbeds, overpasses, transfer centers; railways – track segments, tunnels, bridges, rail yards, depots; waterways – canals, locks, seaports, ferries, harbors, docks, and piers.

- Lifeline Utility Systems such as potable water, wastewater, oil, natural gas, electric power and communication systems.

- Essential Facilities are essential to the health and welfare of the whole population and are especially important following hazard events. Consider not only their structural integrity and content value, but also the effects on the interruption of their functions because the vulnerability is based on the service they provide rather than simply their physical aspects. Essential Facilities include hospitals and other medical facilities, police and fire stations, emergency operations systems, evacuation shelters, schools, and health and human services to the PADD.

- High Potential Loss Facilities are facilities that would have a high loss associated with them, both physical and economical, such as nuclear power plants, dams, and military installations.

- Hazardous Materials Facilities include facilities housing industrial/hazardous materials, such as corrosives, explosives, flammable materials, radioactive materials, and toxins. (Note: Not considered in this Plan)

Critical Facilities Estimated Replacement Value Methodology

Due to a software compatibility problem between FEMA's HAZUS Program, ESRI's Arc and MS Windows, PADD staff was unable to generate complete critical facilities values for the region. FEMA and KYEM have acknowledged this issue and have committed to resolving this problem however this process will not be complete before the region plan expires.

As a result, staff has supplemented updated HAZUS information when available with local data to establish the estimated value of critical facilities. As a last result, data generated during the 2012 update cycle has been utilized to complete tables. For purposes of the update to the 2018 JPHM Plan, this combination of data sources constitutes the best data available.

PADD staff used a combination of GIS data sources and local GIS data layers to build a map of the critical facilities and infrastructure for each jurisdiction found in the hazard area. Estimates were done on a county basis.

Types and Numbers of Buildings for Severe Weather and Earthquake Hazards

Severe Weather Hazards and Earthquakes have been determined to potentially affect anything within each jurisdiction depending on the path of the hazard event. Severe Weather Events: Winter Storm, Thunderstorm Wind, Tornado, Hail, and the potential of Earthquake Events, are five of the top six priorities identified and ranked by the Calloway County MPT. These hazards and their occurrences are not limited to any particular area based on past historical events and documentation is provided in the hazard profiles.

Table 3.17 identifies the total number of structures vulnerable to Severe Weather Hazards and Earthquakes. This table represents residential structures only and was derived from U.S Census Bureau 2011-2015 American Community Survey 5 Year Estimates. Due to data limitations, the numbers of other types of structures was not available at the time of this plan. Future updates of the plan should include numbers of other types of structures as data becomes available.

Table 3.17 Calloway County Severe Weather/Earthquake Hazard Vulnerable Assets

County	Number of Residential Structures		
	Structures in County	Structures in Hazard Area	% in Hazard Area
Ballard	3,889	3,889	100%
Calloway	**18,237**	**18,237**	**100%**
Carlisle	2,426	2,426	100%
Fulton	3,360	3,360	100%
Graves	16,753	16,753	100%
Hickman	2,335	2,335	100%
Marshall	15,898	15,898	100%
McCracken	31,342	31,342	100%
Total	**94,240**	**94,240**	**100%**

Sources: U.S Census Bureau 2011-2015 American Community Survey 5 Year Estimates

Critical Facilities and Infrastructure at Risk to Severe Weather and Earthquake Hazards
Using the HAZUS MH definition for critical facilities and infrastructure, the PADD staff identified types and numbers of critical facilities and infrastructure that are vulnerable to Tornados, Thunderstorm Wind, Winter Storm, and Earthquakes in Calloway County.

Table 3.18 Calloway County Critical Facilities & Infrastructure Severe Weather and Earthquake

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area
County EOC	1	$705,798	1
Communication-Radio	4	$522,502	4
Fire Stations	10	$12,000000	10
Public Safety Buildings	1	$1,412,000	1
Railways			
Government Buildings	3	$5,895,750	3
Hospitals	1	$379,143,000	1
Electric Power Plants	1	$107,800,000	1
Sewage Plants	5	$550,000	5
PTP	5	$800,000	5
Water Plants	6	$105,000,000	6
H2O Pump Stations	10	$12,500,000	10
Lift Stations	1	$110,000	1
Flood Control Pump Station			
Wells	8	$600,000	8
Storage Tanks	9	$1,766,907	
Schools	10	$150,000,000	10
Airport	1	$47,000,000	1
Natural Gas Facilities			
Dams	8		8
Bridges	36	$20,713,550	36
TOTAL	**120**	**$846,519,507**	**120**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority, Water Resource Information System data and the costs were calculated based on standard planning costs.

Critical Facilities and Infrastructure at Risk to Flooding

The PADD GIS staff produced tables which provide an accurate estimate the number of residential structures and Critical Facilities that are vulnerable to flooding. Imagery coverage flown in 2010 was overlaid with the FEMA Flood Hazard Area Maps revised in 2009. GPS structure points, overlain with the Flood Hazard Areas were the primary source of at risk data, and for all counties the PADD's data and Water Information System data base were used to determine at risk Critical Facilities.

Table 3.19 summarizes the numbers of structures in the Flood Hazard area for each county. The highlighted areas indicate the data for Calloway County.

Table 3.19 Calloway County Flood Hazard Vulnerable Assets

County	Estimated Number of Residential Structures In Flood Hazard Areas		
	Number of Structures in County	Percentage of Structures in Flood Hazard Area	Number of Structures in Flood Hazard Area
Ballard	3,889	3.7%	147
Calloway	**18,237**	**0.5%**	**101**
Carlisle	2,426	3.2%	80
Fulton	3,360	7.8%	268
Graves	16,753	2.2%	361
Hickman	2,335	6.3%	147
Marshall	15,898	2.8%	444
McCracken	31,342	2.5%	768
Total	**94,240**	**2.5%**	**2,316**

Sources: U.S Census Bureau 2011-2015 American Community Survey 5 Year Estimates
PADD GIS Database

The PADD GIS staff produced tables which provide an accurate estimate the number of residential structures and Critical Facilities that are vulnerable to flooding. Imagery coverage flown in 2010 was overlaid with the FEMA Flood Hazard Area Maps revised in 2009. At risk structures were then identified by the PADD's GIS personnel.

Figures 3.11 and 3.12 identify the location of critical facilities relative to the Flood Hazard areas. These maps were presented to the JPHMC and for public comment for review during the identification of vulnerable assets for each jurisdiction.

Figure 3.11 Calloway County Flood Zone Including Industry and Critical Facilities

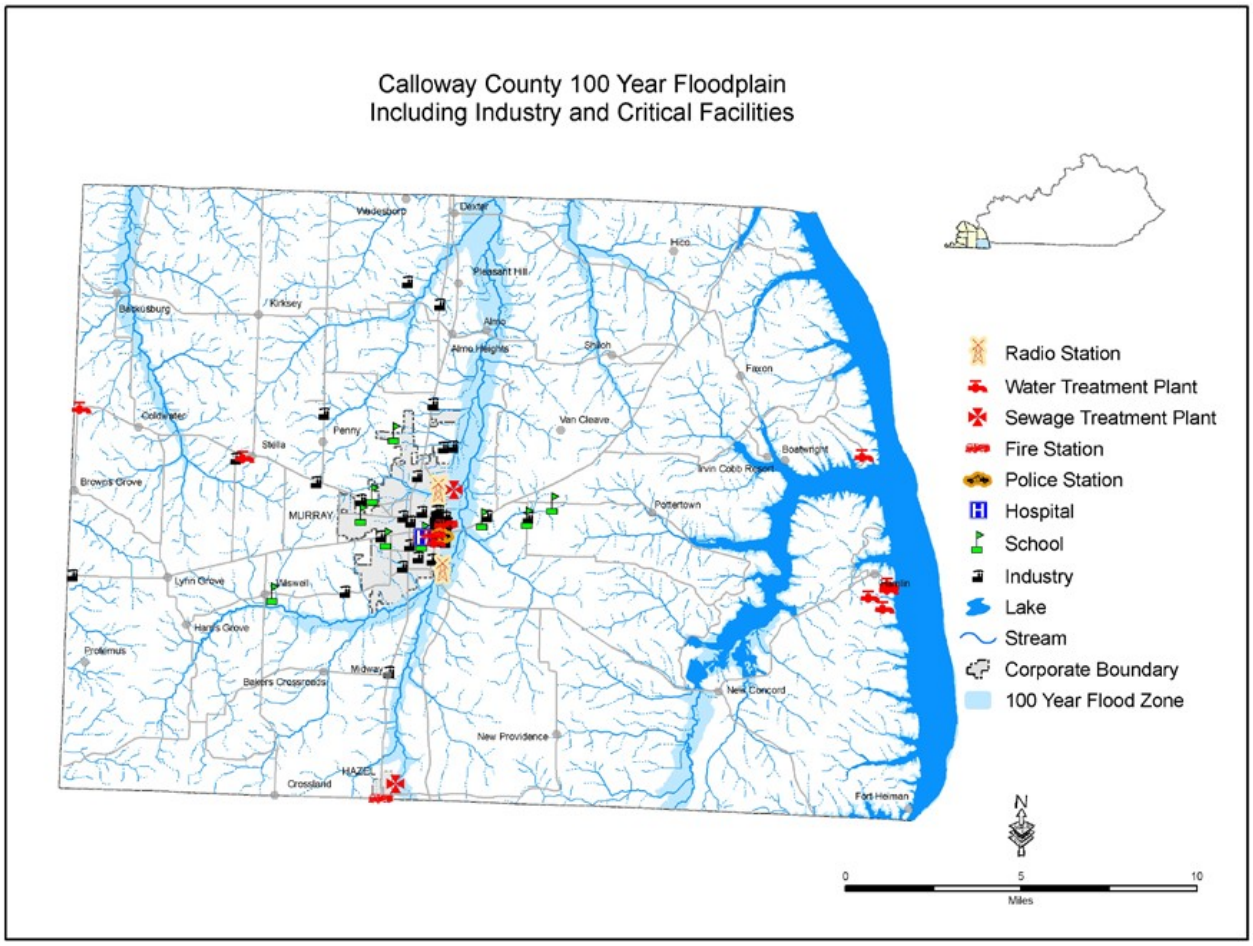


Figure 3.12 City of Murray Flood Hazard Area

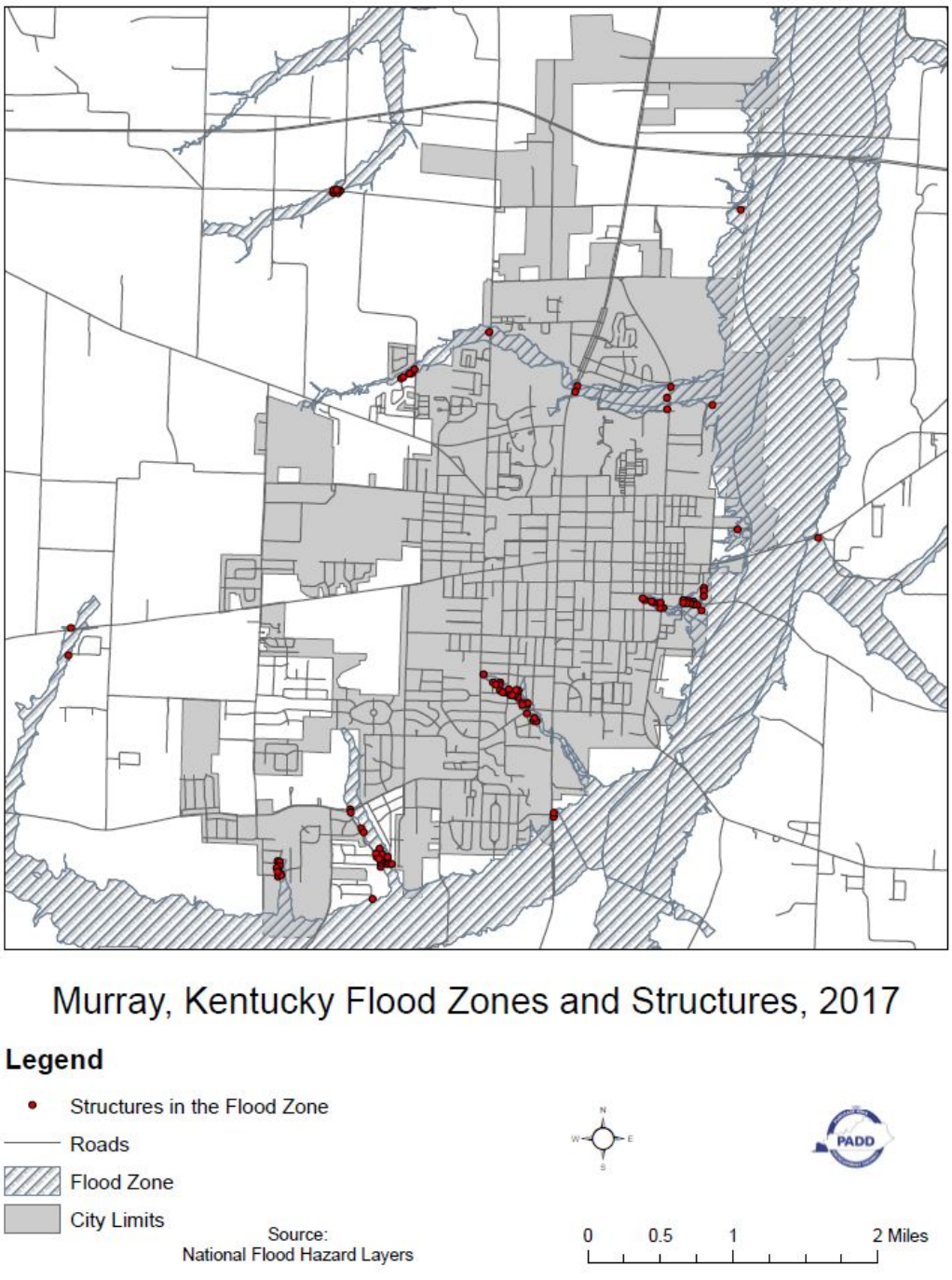


Table 3.20 summarizes the types and number of critical facilities and infrastructure in the identified Flood Hazard areas.

Table 3.20 Calloway County Flood Vulnerability: Critical Facilities and Infrastructure

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area
County EOC	1	$705,798	
Communication-Radio	4	$522,502	
Fire Stations	10	$1,200,000	1
Public Safety Buildings	1	$1,412,000	
Railways			
Government Buildings	3	$5,895,750	
Hospitals	1	$379,143,000	
Electric Power Plants	1	$107,800,000	
Sewage Plants	5	$550,000	1
PTP	5	$800,000	1
Water Plants	6	$105,000,000	
H2O Pump Stations	10	$12,500,000	
Lift Stations	1	$110,000	
Flood Control Pump Station			
Wells	8	$600,000	
Storage Tanks	9	$1,766,907	
Schools	10	$150,000,000	
Airport	1	$47,000,000	
Natural Gas Facilities			
Dams	8		8
Bridges	36	$20,713,550	36
TOTAL	**120**	**$846,519,507**	**47**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority, Water Resource Information System data and the costs were calculated based on standard planning costs.

Calloway County is a member of the NFIP. It has a Flood Plain Management Ordinance in accordance with the appropriate State Revised Statutes. As a consequence, development is not likely to occur in flood regions identified on the FIRMS and by the flood data used in this plan.

Industrial expansion that takes place will be in existing industrial parks. If industrial expansion were to occur in the 100 year floodplain, it would be in accordance with all State and Local ordinances. Critical facilities are largely engineered out of the flood zones in Calloway County.

Types and Numbers of Buildings for Wildfire Hazard

For Calloway County, the potential for wildfire was deemed as a Moderate Risk Hazard. However in accordance with the state wildfire overlay, no Critical Facilities or residential structures were found to be in any threat category higher than "Low". Much of the wooded area of Calloway County has a higher seasonal population due to its proximity to Kentucky Lake. These areas are heavily wooded, and densely populated by comparison to the rest of the rural county.

Table 3.21 represent residential structures only and was derived from U.S. Census Bureau 2011-2015 American Community Survey 5 Year Estimate data. Due to data limitations, the numbers of other types of structures was not available at the time of this plan.

Table 3.21 Calloway County Wildland/Urban Interface Wildfire Risk:

County	Number of Residential Structures		
	Structures in County	Structures in Hazard Area	% in Hazard Area
Ballard	3,889	72	1.9
Calloway	18,237	153	0.8
Carlisle	2,426	5	0.2
Fulton	3,360	6	0.2
Graves	16,753	156	0.9
Hickman	2,335	5	0.2
Marshall	15,898	168	1.1
McCracken	31,342	148	0.5
Total	**94,240**	**713**	**0.8%**

Sources: U.S. Census Bureau 2011-2015 American Community Survey 5 Year Estimate, Purchase Area Development District GIS Database

Critical Facilities and Infrastructure at Risk in the Wildland/Urban Interface

Using the HAZUS MH definition for critical facilities and infrastructure, the PADD staff identified types and numbers of critical facilities and infrastructure that are in or adjacent to the Wildland/Urban interface, and consequently at risk to wildfires. (See Table 3.22.)

Table 3.22 Calloway County Wildfire Vulnerability

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area
County EOC	1	$705,798	
Communication-Radio	4	$522,502	
Fire Stations	10	$1,200,000	
Public Safety Buildings	1	$1,412,000	
Railways			
Government Buildings	3	$5,895,750	
Hospitals	1	$379,143,000	
Electric Power Plants	1	$107,800,000	
Sewage Plants	5	$550,000	
PTP	5	$800,000	3
Water Plants	6	$105,000,000	5
H2O Pump Stations	10	$12,500,000	6
Lift Stations	1	$110,000	1
Flood Control Pump Station			
Wells	8	$600,000	6
Storage Tanks	9	$1,766,907	
Schools	10	$150,000,000	1
Airport	1	$47,000,000	1
Natural Gas Facilities			
Dams	8		
Bridges	36	$20,713,550	
TOTAL	**120**	**$846,519,507**	**23**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority, Water Resource Information System data and the costs were calculated based on standard planning costs.

Future Development: Types and Numbers of Future Buildings, Critical Facilities, and Infrastructure

There will likely be a slow increase in the number of residential structures, critical facilities, and infrastructure over the next 10 years. There are no significant changes in land use anticipated for Calloway County. Should land use changes occur, they will be included in future updates of the plan where applicable.

Table 3.23 Census Projections for the Purchase Region of Kentucky

County	Census 2000	Census 2010	Census 2015	Census Projection				
				2020	2025	2030	2035	2040
Kentucky	4,041,769	4,339,367	4,425,092	4,533,464	4,634,415	4,726,382	4,808,682	4,886,381
Ballard	8,286	8,249	8,212	8,164	8,097	8,005	7,906	7,780
Calloway	**34,177**	**37,191**	**38,343**	**39,328**	**40,487**	**41,687**	**42,604**	**43,503**
Carlisle	5,351	4,874	5,036	4,737	4,604	4,450	4,298	4,139
Fulton	7,752	6,238	6,528	5,726	5,252	4,789	4,349	3,939
Graves	37,028	37,421	37,433	37,883	38,243	38,483	38,657	38,788
Hickman	5,262	4,612	4,767	4,349	4,077	3,803	3,563	3,306
Marshall	30,125	31,101	32,301	31,149	31,060	30,830	30,347	29,980
McCracken	65,514	65,018	66,188	65,317	65,487	65,376	64,918	64,273
Purchase	193,495	195,819	195,313	196,653	197,307	197,423	196,732	195,708

Source: U.S. Census Bureau, http://www.ksdc.louisville.edu/data-downloads/projections/ 2017

There are no significant changes in land use anticipated for Calloway County. Should land use changes occur, they will be included in future updates of the plan where applicable.

New Residential Structures – Tornado, Earthquake, Severe Thunderstorm, Severe Winter Storm

The PADD staff calculated the estimated future residential structure growth by multiplying the existing number of residential structures by the expected growth rate for each county. Results of these calculations are represented in the Table 3.24. These numbers would represent the approximate number of future residential structures vulnerable to tornadoes, earthquakes, thunderstorm wind, and winter storms.

Table 3.24 Estimated Future Structure Growth for the Purchase Region

County	Estimated Housing Units (2015)	Estimated % Household Growth Rate (2025)	Estimated Future Growth	Median Structure Value	Estimated Value of Future Growth
Ballard	3883	0.79%	31	$101,800	$3,155,800
Calloway	**18,537**	**7.20%**	**1335**	**$119,900**	**$160,066,500**
Carlisle	2437	-6.53%	-159	$77,200	*
Fulton	3,359	-15.81%	-531	$61,000	*
Graves	16,741	2.79%	467	$92,900	$43,384,300
Hickman	2,338	-8.68%	-203	$68,400	*
McCracken	31,544	2.04%	643	$111,600	$71,758,800
Marshall	15,982	1.45%	232	$124,400	$28,860,800
Purchase	**94,821**	**2.01%**	**1906**		

* Projected Negative Growth Rate

Source: EHHGR - Kentucky State Data Center (Vintage 2016)

EHU - US Census Bureau, Population Division (June 2017)

MSU - American Community Survey 5- Year Estimates (2011-2015)

The PADD staff and Calloway County MPT members discussed potential increase in numbers of vulnerable critical facilities, industry and infrastructure; however, there was no consensus for making a reliable calculation. In future updates, involvement from the local planning process may assist in estimating the increase of critical facilities and infrastructure based on projected population growth.

3:4.4 Assessing Vulnerability: Estimating Potential Losses

Winter Storm, Thunderstorm Wind, Tornado, Earthquake

The total valuation of adjusted property as provided by the Kentucky Department of Revenue was used to estimate the potential dollar loss for all vulnerable structures for the following hazards: Severe Winter Storm, Severe Thunderstorm, Tornado, and Earthquake.

Table 3.25 summarizes the total value of adjusted property as provided by the Kentucky Department of Revenue, and the population for each county as provided by 2011-2015 American Community Survey 5 Year Estimate. These values were used to determine potential dollar losses and the number of people at risk in a county and all its jurisdictions, for those hazards that have no defined area: Winter Storm, Thunderstorm Wind, Tornado, and Earthquake. Table 3.26 is specifically focused on residential structures. The figures for Calloway County are highlighted.

Table 3.25 Total Value of Adjusted Property for the Purchase Region

County	County Square Miles	Population 2011-2015 ACS	Total Property Value 2016($)
Ballard	273.70	8,256	545,949,576
Calloway	**412.50**	**38,106**	**2,355,178,011**
Carlisle	199.10	4,984	234,857,047
Fulton	230.70	6,422	277,810,192
Graves	556.00	37,502	1,886,576,304
Hickman	253.20	4,720	265,028,387
Marshall	340.00	31,181	2,457,186,169
McCracken	268.30	65,408	5,111,587,459
Region	**2,433.5**	**196,579**	**13,134,173,145**

Source: Kentucky State Hazard Mitigation Plan. 2011-2015 American Community Survey 5 Year Estimate, Kentucky Revenue Cabinet, Year Estimate, Kentucky Revenue Cabinet, https://revenue.ky.gov/Property/Pages/default.aspx

Table 3.26 Severe Weather/Earthquake Hazard Vulnerable Asset

County	Structures in County	Structures in Hazard Area	% in Hazard Area
Ballard	3,889	3,889	100%
Calloway	**18,237**	**18,237**	**100%**
Carlisle	2,426	2,426	100%
Fulton	3,360	3,360	100%
Graves	16,753	16,753	100%
Hickman	2,335	2,335	100%
Marshall	15,898	15,898	100%
McCracken	31,342	31,342	100%
Region	**94,240**	**94,240**	**100%**

Sources: U.S. Census Bureau 2011- 2015 American Community Survey 5-Year Estimates

PADD staff and the Calloway County MPT determined that all 18,237 residential structures in the county are vulnerable to the "area" threats of weather and earthquake. According to the 2011-2015 American Community Survey 5-Year Estimates, the median house value for Calloway County is $119,900. An estimate of the maximum potential residential loss for Calloway County is $2,186,616,300.

Critical Facilities and Infrastructure for Severe Weather and Earthquakes

Table 3.27 summarizes of vulnerable critical facilities and infrastructure to the non-geospecific hazards of Severe Weather and Earthquakes, as well as the potential dollar losses associated with structures in the high priority hazard areas. It was the determination of PADD staff that the best way to estimate the potential dollar loss associated with critical facilities and infrastructure was to use insurance replacement values, when available, for those structures provided by the jurisdictions, or default to values from the HAZUS tables.

Table 3.27 Calloway County Critical Facilities & Infrastructure Severe Weather and Earthquake

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area	Replacement Cost
County EOC	1	$705,798	1	$705,798
Communication-Radio	4	$522,502	4	$522,502
Fire Stations	10	$1,200,000	10	$1,200,000
Public Safety Buildings	1	$1,412,000	1	$1,412,000
Railways				
Government Buildings	3	$5,895,750	3	$5,895,750
Hospitals	1	$379,143,000	1	$379,143,000
Electric Power Plants	1	$107,800,000	1	$107,800,000
Sewage Plants	5	$550,000	5	$550,000
PTP	5	$800,000	5	$800,000
Water Plants	6	$105,000,000	6	$105,000,000
H2O Pump Stations	10	$12,500,000	10	$12,500,000
Lift Stations	1	$110,000	1	$110,000
Flood Control Pump Station				
Wells	8	$600,000	8	$600,000
Storage Tanks	9	$1,766,907	9	$1,766,907
Schools	10	$150,000,000	10	$150,000,000
Airport	1	$47,000,000	1	$47,000,000
Natural Gas Facilities				
Dams	8		8	
Bridges	36	$20,713,550	36	$20,713,550
TOTAL	**120**	**$846,519,507**	**120**	**$846,519,507**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority, Water Resource Information System data and the costs were calculated based on standard planning costs

Flood

Residential Structures: After the vulnerability maps were created for the flood hazard areas, the cost associated with replacing those structures was evaluated. It was the determination of the PADD staff that the best way to estimate the potential dollar loss associated with the flood hazard areas was to use the median structure value as identified by the 2011- 2015 American Community Survey 5-Year Estimates for residential structures. Table 3.28 summarizes the median residential structure value used to determine the value of structures located in flood hazard areas. The data for Calloway County is highlighted.

Table 3.28 2011 – 2015 Selected Housing Characteristics

** U.S Census Bureau 2011-2015 American Community Survey 5 Year Estimates*
*** 2010 Census*

Subject	Ballard	Calloway	Carlisle	Fulton	Graves	Hickman	Marshall	McCracken	Purchase Region
Total Housing Units	3,889	**18,237**	2426	3360	16,753	2335	15,898	31,342	94,240
Occupied Housing Units	3288	**14,834**	2059	2568	14,390	1973	12,062	27,514	79,228
Vacant Housing Units	601	**3403**	367	792	2363	362	3296	3828	15,012
Mobile Homes	657	**2306**	500	205	2220	360	2966	2988	12,202
Owner-occupied	2678	**9355**	2059	2568	14,390	1470	9813	18,511	60,844
Renter-occupied	610	**5479**	367	792	2363	503	2789	9003	21,906
Household Size – Owner	2.42	**2.49**	2.34	2.51	2.63	2.26	2.50	2.46	2.45
Household Size– Renter	2.73	**2.09**	2.58	2.07	2.37	2.39	2.18	2.06	2.31
Median House Value -	$101,800	**$119,900**	$77,200	$61,000	$92,900	$68,400	$111,600	$124,400	$94,650

Table 3.26 also identifies the average number of people per household for Calloway County according to 2011-2015 ACS 5-Year Estimates. This value was used to determine the number of people in a flood hazard area. Using imagery and GPS structure points PADD staff estimated that 101 residential structures are located in areas with a map flood hazard. According to the 2011-2015 ACS 5-Year Estimates the median house value for Calloway County is $119,900. An estimate of the potential residential flood damage for Calloway County is $12,109,900.

Table 3.29 represents a comparison of estimated of potential dollar loss of vulnerable residential structures in flood hazard areas by county. The data for Calloway County is highlighted.

Table 3.29 Flood Hazard Vulnerable Residential Structures by County

County	Number of Residential Structures			Total Property Value		Number of People		
	Structures in County*	Structures in Hazard Area**	% in Hazard Area**	Total Value in County***	Value in Hazard Area**	Residents*	Residents in Hazard Area**	% in Hazard Area**
Ballard	3,889	147	3.7%	$545,949,576	$18,016,336	8,256	305	3.7%
Calloway	**18,237**	**101**	**0.5%**	**$2,355,178,011**	**$9,420,712**	**38,106**	**229**	**0.6%**
Carlisle	2,426	80	3.2%	$234,857,047	$751,543	4,984	199	4%
Fulton	3,360	268	7.8%	$277,810,192	$21,669,195	6,422	450	7%
Graves	16,753	361	2.2%	$1,886,576,304	$41,504,679	37,502	1,013	2.7
Hickman	2,335	147	6.3%	$265,028,387	$16,696,788	4,720	189	4.0%
Marshall	15,898	444	2.8%	$2,457,186,169	$68,801,213	31,181	1,871	6.0%
McCracken	31,342	768	2.5%	$5,111,587,459	$127,789,686	65,408	2,158	3.3%
Total	**94,240**	**2,818**	**2.9%**	**$13,134,173,145**	**$304,650,152**	**196,579**	**6,733**	**3.2%**

*Sources: * U.S Census Bureau 2011-2015 American Community Survey 5 Year Estimates,*
*** PADD GIS Database, HAZUS & PVA information, ***Kentucky Revenue Cabinet and PVA data.*

Critical Facilities and Infrastructure for Flood Hazards

It was the determination of the PADD staff that the best way to estimate the potential dollar loss associated with critical facilities and infrastructure was to use the insurance replacement values for those structures provided by the jurisdictions to the maximum extent possible, or values from the HAZUS data tables. Table 3.30 summarizes the potential dollar loss of vulnerable critical facilities and infrastructure in flood hazard areas by county.

Table 3.30 Calloway County Critical Facilities & Infrastructure Flood Vulnerability

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area	Replacement Cost
County EOC	1	$705,798		
Communication-Radio	4	$522,502		
Fire Stations	10	$1,200,000	1	$1,200,000
Public Safety Buildings	1	$1,412,000		
Railways				
Government Buildings	3	$5,895,750		
Hospitals	1	$379,143,000		
Electric Power Plants	1	$107,800,000		
Sewage Plants	5	$550,000	1	$110,000
PTP	5	$800,000	1	$160,000
Water Plants	6	$105,000,000		
H2O Pump Stations	10	$12,500,000		
Lift Stations	1	$110,000		
Flood Control Pump Station				
Wells	8	$600,000		
Storage Tanks	9	$1,766,907		
Schools	10	$150,000,000		
Airport	1	$47,000,000		
Natural Gas Facilities				
Dams	8		8	
Bridges	36	$20,713,550	36	$20,713,550
TOTAL	**120**	**$846,519,507**	**47**	**$22,183,550**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority (KIA), Water Resource Information System (WRIS) data and the costs were calculated based on standard planning costs.

Wildfire Hazard for Residential Structures

After the vulnerability maps were created for the Wildfire hazard areas, the cost associated with replacing those structures was evaluated. It was the determination of the PADD staff that the best way to estimate the potential dollar loss associated with the Wildfire Hazard areas was to use the median structure value as identified by the 2011-2015 ACS 5-Year Estimates for residential structures. Table 3.31 summarizes the wildfire risk to residential structures in the Purchase Region. The data for Calloway County is highlighted.

Table 3.31 Calloway County Wildland/Urban Interface Wildfire Risk

County	Structures in County	Structures in Hazard Area	% in Hazard Area
Ballard	3,889	72	1.9
Calloway	**18,237**	**153**	**0.8**
Carlisle	2,426	5	0.2
Fulton	3,360	6	0.2
Graves	16,753	156	0.9
Hickman	2,335	5	0.2
Marshall	15,898	168	1.1
McCracken	31,342	148	0.5
Region	**94,240**	**713**	**0.8%**

Sources: American Community Survey 2011-2015 Five Year Estimate, 2010 Census, State Hazard Mitigation Plan, HAZUS, PADD GIS Database, Combined Calculations of Census and PVA data

Using wildfire vulnerability data obtained from the United States Department of Agriculture, United States Forestry Service PADD Staff estimated that 0.8% by area or 153 residential structures are in the wildfire threat area. According to the 2011-2015 ACS 5-Year Estimates the median house value for Calloway County is $119,900. An estimate of the potential residential Wildfire damage for Calloway County is $18,344,700.

Critical Facilities and Infrastructure at Risk in the Wildland/Urban Interface

Using the HAZUS MH definition for critical facilities and infrastructure, the PADD staff identified types and numbers of critical facilities and infrastructure that are in or adjacent to the Wildland-Urban interface, and consequently at risk to wildfires.

Table 3.32 Calloway County Critical Facilities & Infrastructure Wildfire Vulnerability

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area	Replacement Cost
County EOC	1	$705,798		
Communication-Radio	4	$522,502		
Fire Stations	10	$1,200,000		
Public Safety Buildings	1	$1,412,000		
Railways				
Government Buildings	3	$5,895,750		
Hospitals	1	$379,143,000		
Electric Power Plants	1	$107,800,000		
Sewage Plants	5	$550,000		
PTP	5	$800,000	3	$480,000
Water Plants	6	$105,000,000	5	$87,500,00
H2O Pump Stations	10	$12,500,000	6	$75,000
Lift Stations	1	$110,000	1	$110,000
Flood Control Pump Station				
Wells	8	$600,000	6	$450,000
Storage Tanks	9	$1,766,907		
Schools	10	$150,000,000	1	15,000,000
Airport	1	$47,000,000	1	$47,000,000
Natural Gas Facilities				
Dams	8			
Bridges	36	$20,713,550		
TOTAL	**120**	**$846,519,507**	**23**	**$150,615,000**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority (KIA), Water Resource Information System (WRIS) data and the costs were calculated based on standard planning costs.

3:4.5 Assessing Vulnerability: Analyzing Development Trends

The Purchase Region grew 1.2% in population between 2000 and 2010 compared to a growth of 7.4% for the state of Kentucky. Calloway County is projected to grow by approximately 5.7 percent between 2010 and 2020.

Calloway County is primarily rural in nature. Most residential construction occurs in developments near Murray and in the lake region. The county can expect an increase in residential development over the next ten years to replace existing housing stock. Essential facilities and services may increase due to demand rather than population pressure. Table 3.33 outlines growth trends in the PADD as reported by the Kentucky State Data Center using Census information.

Table 3.33 Population Projections for the Purchase Region

County	Census 2000	Census 2010	Census 2015	Census Projections				
				2020	2025	2030	2035	2040
Kentucky	4,041,769	4,339,367	4,425,092	4,533,464	4,634,415	4,726,382	5,808,682	4,886,381
Ballard	8,286	8,249	8,212	8,164	8,097	8,005	7,906	7,780
Calloway	34,177	37,191	38,343	39,328	40,487	41,687	42,604	43,503
Carlisle	5,351	4,874	5,036	4,737	4,604	4,450	4,298	4,139
Fulton	7,752	6,238	6,528	5,726	5,252	4,789	4,349	3,939
Graves	37,028	37,421	37,433	37,883	38,243	38,483	38,657	38,788
Hickman	5,262	4,612	4,767	4,349	4,077	3,803	3,563	3,306
Marshall	30,125	31,101	32,301	31,149	31,060	30,830	33,886	29,980
McCracken	**65,514**	**65,018**	**66,188**	**65,317**	**65,487**	**65,376**	**64,918**	**64,273**
Purchase	**193,495**	**195,819**	**195,313**	**196,653**	**197,307**	**197,423**	**196,732**	**195,708**

Source: U.S. Census Bureau, http://www.ksdc.louisville.edu/data-downloads/projections/ 2017

Land Use

Farmland is the principal land use in Calloway County. Land use for commercial purposes is primarily concentrated in the downtown areas of incorporated cities. Industrial development takes place primarily in industrial parks. Calloway County also makes use of land for recreation and greenspace. Calloway County has both city and county parks for recreational purposes.

Economic and Social Growth Trends

The economy in the Purchase Region is experiencing trends similar to those of the state averages, both in growth and decline. There have been new businesses and industries to open in the region, but in turn there have been layoffs and closures within the market. The fastest growing sectors of the local economy in the Purchase Region were services and manufacturing. The following table represents the expansion and location of plants in the Calloway County from 2010 to present. This information was retrieved from the Kentucky Cabinet for Economic Development website www.thinkkentucky.com

Table 3.34 Summary of Recent Locations and Expansions, 2014-Present

		Reported	
	Companies	Jobs	Investment
Manufacturing Location	0	0	$0
Manufacturing Expansion	6	91	$65,412,125
Service & Technology Location	0	0	$0
Service & Technology Expansion	0	0	$1,600,000

Note: Totals include announced locations and expansions.
Source: Kentucky Cabinet for Economic Development (8/8/2017)

Table 3.35 Employment by Major Industry by Place of Work, 2015

	McCracken County		Labor Market Area	
	Employment	Percent	Employment	Percent
Total All Industries	16,403	100.0	66,026	100.0
Total Private Industries	11,889	72.5	50,284	76.2
Natural Resources and Mining	N/A	N/A	226	0.3
Construction	673	4.1	3,945	6.0
Manufacturing	2,608	15.9	11,673	17.7
Trade, Transportation and Utilities	4,343	26.5	12,805	19.4
Information	204	1.2	668	1.0
Financial Activities	436	2.7	2,086	3.2
Professional and Business Services	823	5.0	3,072	4.7
Education and Health Services	861	5.2	3,451	5.2
Leisure and Hospitality	1,631	9.9	5,543	8.4
Other Services and Unclassified	257	1.6	1,399	2.1

Source: U.S. Department of Labor, Bureau of Labor Statistics

Table 3.36 Top 20 by Employment: Manufacturing, Service, and Technology Firms Only

Firm	Product(s)/Service(s)	Emp.	Year Established
Associated Warehousing Inc	Warehousing and distribution	10	1999
Boone's Inc	Industrial laundry services, dry-cleaning, coin laundry	18	1931
Briggs & Stratton Corp	Small engines for various applications.	604	1985
Drywall Systems Plus Inc	Headquarters	95	1920
Hutson Inc	Farm and garden machinery and equipment merchant wholesalers. Headquarters location.	42	1996
iwis Engine Systems LP	Chain drive systems, chains and chain parts	75	2013
Kenlake Foods	Powdered beverages, hot cereal & salted nut products	340	1982
Murray Ledger & Times	Newspaper publishing & printing	21	1879
Numeritex Displays Inc	Electronic message boards; electronic LED fuel price changers; electronic Portable LED Safety Signs, scoreboards, time and temperature displays; contract manufactuing.	20	2004
Paschall Truck Lines	Trucking, long haul dry van, US and Mexico. Headquarters.	1502	1937
Pella Corporation	Windows and doors manufacturer	822	2002
Printing Services & Supplies	Offset, digital & lithographic printing; graphic design and typesetting; business forms; glue, spiral & saddle stitch binding	12	1964
Rudolph's Inc	Wholesale tire distributor	28	1981
Saputo Dairy Foods USA	Single serve-flavored milk in plastic bottles, private packaging, nondairy flavored creamers	315	1924
Schwarz Supply Source	Distribution center	128	2008
Shane Lee Inc	Women and children clothing	15	1982
Sleep Central	Distribute pharmaceuticals	200	1999
S'portable Scoreboards Inc	Scoreboards; electronic display products; marquees	45	1986
TapLogic LLC	Software and technology to provide the agriculture market with an information technology tracking and reporting system	27	2005
Vanderbilt Chemicals LLC	Industrial chemical additives & petroleum product accelerators	97	1969

Source: Kentucky Cabinet for Economic Development (8/8/2017).

While manufacturing and service sectors are important to the region's economy, agriculture proves to be a vital part of the economy as a whole. The changes, both hazard related and non-hazard related, that affect farming greatly impact the Purchase Region. Hazards such as hail, flooding, tornadoes, and high wind damage crops and thus have an effect on the economy of the region.

Farming is the most prevalent land use, by area in Calloway County. Table 3.347 is a summary of the farmland located in the Purchase Region and the land use for those acres. This data was retrieved from the United States Department of Agriculture.

Table 3.37 Total Farmland Located in Purchase Region

County	Number of Farms	Land in Farms(acres)	Avg. Farm Size(acres)
Ballard	408	107,186	263
Calloway	**821**	**176,076**	**214**
Carlisle	325	98,620	303
Fulton	178	83,382	468
Graves	1,442	291,813	202
Hickman	298	141,131	474
Marshall	719	94,879	132
McCracken	447	67,192	150
Total	**4,638**	**1,060,279**	**276**

Source: U.S. Department of Agriculture, National Agricultural Statistics Service 2012 Census of Agriculture http://www.nass.usda.gov:8080/census/Pull_Data_Census

Social growth trends also play an important role in the economy of the Purchase Region. Median income and housing characteristics of the region are valuable tools in analyzing these growth trends. Tables 3.38 and 3.39 describe the median income and housing characteristics retrieved from the Kentucky State Data Center Census 2010 information.

Little to no population growth (0.4%) is expected to occur in the Purchase Region between 2010 and 2020. Calloway County is projected to grow by 5.7% during that same time period. Calloway County is an exception to the overall slow growth of the region. The expected growth to come from Murray State University and retirees that relocate to the lake region of the county. There has been a growing trend among students to find employment and settle in Murray after college graduation. Development is not likely to occur in flood regions identified in each jurisdiction, because the threat of flooding is known and occurs on an annual basis. The county is a member of the NFIP and has implemented a Flood Plain Ordinance in accordance with the applicable paragraphs of the Kentucky Revised Statues.

Table 3.38 2010 Census and ACS 2011-2015 Median Household Income

	Median Household Income		
Area	**2010 Census***	**ACS 2011-2015****	**Percent Change**
Kentucky	**$42,302**	$43,740	**3.3%**
Ballard	**$39,995**	$42,240	**5.3**
Calloway	**$34,947**	**$37,034**	**5.6**
Carlisle	**$35,853**	$38,829	**7.7**
Fulton	**$27,524**	$28,359	**2.9**
Graves	**$34,550**	$39,530	**12.6**
Hickman	**$37,045**	$41,218	**10.1**
Marshall	**$41,891**	$45,212	**7.3**
McCracken	$40,976	$44,067	7.0

*Source: *2010 data http://www.thinkkentucky.com/edis/cmnty/QuickFacts.aspx?cw=096, Kentucky State Data Center; **U.S. Census Bureau, 2011-2015 American Community Survey 5 Year Estimate*

Table 3.39 2010 Census: Selected Housing Characteristics for the Purchase Region

Subject	Ballard	Calloway	Carlisle	Fulton	Graves	Hickman	Marshall	McCracken
Total Housing Units*	3,889	**18,237**	2,426	3,360	16,753	2,335	15,898	31,342
Occupied Housing Units*	3,288	**14,834**	2,059	2,568	14,390	1,973	12,602	27,514
Vacant Housing Units*	601	**3,403**	367	792	2,363	362	3,296	3,828
Seasonal Use Units**	547	**5,654**	353	144	1442	290	1,426	1,678
Mobile Homes*	657	**2,306**	500	205	2,220	360	2,966	2,988
Owner- occupied*	2,678	**9,355**	2,059	2,568	14,390	1,470	9,813	18,511
Renter- occupied*	610	**5,479**	367	792	2,363	503	2,789	9,003
Household Size – Owner*	2.42	**2.49**	2.34	2.51	2.63	2.26	2.50	2.46
Household Size – Renter*	2.73	**2.09**	2.58	2.07	2.37	2.39	2.18	2.06
Median House Value – Owner Occupied*	$101,800	**$119,900**	$77,200	$61,000	$92,900	$68,400	$111,600	$124,400

*Source * U.S. Census Bureau, 2011-2015 American Community Survey 5 Year Estimate*
***2010 Census Updates; http://ksdc.louisville.edu/1census.htm*

3:5 Mitigation Strategy

3:5.1 Capability Assessment

Mitigation strategies were developed in response to the hazard profiles and vulnerability of the assets in each jurisdiction. These strategies provide each jurisdiction with a blueprint for reducing potential losses identified in the risk assessment. These strategies are based on existing authorities, policies, programs, resources, and the ability to expand on and improve the existing tools.

The capability assessment has been divided into three sections:

(A) Existing Authorities, Policies, Programs, and Resources
(B) Existing Governmental Structure
(C) Existing Professional Staff Departments

The purpose of the capability assessment is to identify potential hazard mitigation opportunities available to each jurisdiction through daily operations as a local unit of government. This assessment will highlight the positive measures already in place in the jurisdiction as well as identify weaknesses that could increase vulnerability in a jurisdiction. The capability assessment serves as the foundation for an effective hazard mitigation strategy by establishing goals and objectives for jurisdictions.

(A) Existing Authorities, Policies, Programs, and Resources

The PADD, along with MPT members, evaluated existing authorities, policies, programs, and resources in each jurisdiction. Table 3.40 is a summary of each jurisdiction and the current status of these authorities. Local committee members evaluated this information to determine what goals, objectives, and actions would be necessary to effectively mitigate the vulnerability of a jurisdiction and what resources they currently have that can be used to implement the mitigation strategies identified in this plan.

Table 3.40 Existing Authorities, Policies, Programs, and Resources in the Purchase Region

Jurisdiction	Floodplain Management Ordinance	CRS & FMA Plans	Zoning Regulations	Subdivision Regulations	Land Development Plans	Fire Prevention Code	Comprehensive Plan	Capital Improvement Plan	Stormwater Management Plan	CERT Team	NWS StormReady Program	Local Economic Development	Regional Economic Development	City Class
Ballard County	X							X		X		X	X	
City of Barlow								X				X	X	6
City of Kevil								X				X	X	6
City of La Center					X		X	X				X	X	5
City of Wickliffe	X							X				X	X	5
Calloway County	**X**		**X**	**X**						**X**	**X**	**X**	**X**	
City of Murray	**X**		**X**	**X**	**X**		**X**		**X**			**X**	**X**	**3**
City of Hazel												**X**	**X**	**6**
Carlisle County	X									X	X	X	X	
City of Bardwell	X											X	X	5
City of Arlington	X											X	X	6
Fulton County	X									X		X	X	
City of Fulton	X		X	X	X		X	X				X	X	4
City of Hickman	X		X		X		X					X	X	4
Graves County	X									X		X	X	
City of Mayfield	X		X	X	X		X		X			X	X	3
City Wingo												X	X	6
Hickman County										X	X	X	X	
City of Clinton	X											X	X	5
City of Columbus													X	5
Marshall County	X				X	X				X	X	X	X	
City of Benton	X		X				X					X	X	4
City of Calvert City	X		X	X	X		X	X	X			X	X	4
City of Hardin	X											X	X	5
McCracken County	X		X	X	X	X	X			X	X	X	X	
City of Paducah	X		X	X	X		X	X	X			X	X	2

All jurisdictions are members of the PADD. Services are provided by the district in GIS/GPS, Economic Development, Community Development, Aging Services, Workforce Development, and Fiscal Management.

The existing authorities, policies, and programs are further explained in relation to the existing governmental structure and powers of the local jurisdiction. It is the responsibility of each local jurisdiction to develop, enact, and enforce the above referenced authorities and programs.

(B) Existing Governmental Structure

Tables 3.41 (county government) and 3.42 (city government) summarize the governmental structure for each jurisdiction in the PADD. Each jurisdiction is responsible for the implementation of mitigation strategies in their community. These governmental structures were reviewed by the JPHMC to determine the capability of implementing and enforcing existing and future authorities, policies, programs, and resources.

Table 3.41 County Government Structure in the Purchase Region

County	Type of Government
Ballard County	Judge/Executive and 5 magistrates
Calloway County	**Judge/Executive and 4 magistrates**
Carlisle County	Judge/Executive and 3 magistrates
Fulton County	Judge/Executive and 4 magistrates
Graves County	Judge/Executive and 3 commissioners
Hickman County	Judge/Executive and 3 magistrates
Marshall County	Judge/Executive and 3 commissioners
McCracken County	Judge/Executive and 3 commissioners

Table 3.42 Governmental Structure and Class of Incorporated Cities

City	Class	County	Type of Government
City of Barlow	6	Ballard	Mayor and 4 commissioners
City of Kevil	6	Ballard	Mayor and 6 council members
City of La Center	5	Ballard	Mayor and 4 commissioners
City of Wickliffe	5	Ballard	Mayor and 6 council members
City of Murray	**3**	**Calloway**	**Mayor and 12 council members**
City Hazel	**6**	**Calloway**	**Mayor and 6 council members**
City of Bardwell	5	Carlisle	Mayor and 6 council members
City of Arlington	6	Carlisle	Mayor and 4 commissioners
City of Hickman	4	Fulton	Mayor and 4 commissioners
City of Fulton	4	Fulton	Mayor and 4 commissioners
City of Mayfield	3	Graves	Mayor and 10 council members
City of Wingo	6	Graves	Mayor and 4 commissioners
City of Clinton	5	Hickman	Mayor and 6 council members
City of Columbus	5	Hickman	Mayor and 6 council members
City of Benton	4	Marshall	Mayor and 6 council members
City of Calvert City	4	Marshall	Mayor and 6 council members
City of Hardin	5	Marshall	Mayor and 6 council members
City of Paducah	2	McCracken	Mayor and 4 commissioners

Legal Authority of Local Jurisdictions

There are many tools available to local governments in Kentucky that may help them implement mitigation programs, policies and actions. Any hazard mitigation program can utilize any or all of the five types of government powers granted by the State of Kentucky: Regulation; Acquisition; Taxation; Spending, and Education.

Regulation

- Police Power: Local governments have been granted broad regulatory powers in their jurisdictions. Kentucky Revised Statutes grant the general police power to local governments, allowing them to enact and enforce ordinances and laws that define, prohibit, regulate or abate acts, omissions, or conditions detrimental to the health, safety and welfare of the citizens of their jurisdiction. The general police power also has the ability to define and abate nuisance ordinances, including those related to public health.

- Jurisdictions can include hazard mitigation requirements in their ordinances as protection of public health, safety and welfare. They may also use this power to enforce nuisance ordinances identifying nuisances that threaten the general health and safety of the public.

- Building Codes and Inspection: The construction and rehabilitation of homes, business and other structures according to standards that will make the structures more resistant to the impact of natural hazards is a big part of mitigation activity in a jurisdiction. These standards can be enforced in a jurisdiction through building codes. Through the adoption and enforcement of building codes in each jurisdiction, it can be assured that mitigation strategies are in place for the planning area.

- Land Use: Local governments can control the use of land in the jurisdiction through regulatory powers granted to them by the State of Kentucky. Jurisdictions can control certain aspects of development under these powers. The amount and type of growth in a jurisdiction can greatly affect the vulnerability of the community in the event of a natural hazard. Land use powers include the power to enact and enforce zoning ordinances, floodplain ordinances, and subdivision controls, as well as the power to engage in planning.

    - Acquisition**:** The State of Kentucky Revised Statutes allows for jurisdictions to acquire property for public purpose. Acquisition can be a useful tool for mitigation goals in that property in hazard prone areas may be acquired so that future development is prohibited in a hazardous area.

    - Taxation**:** Local governments have been given the power to levy taxes and special assignments by the State of Kentucky. Taxation extends beyond the collection of revenue and can provide the means by which the community develops in the future.

    - Spending**:** Local governments have also been given the power to make expenditures on behalf of the public in their interest. Hazard mitigation principles should be incorporated in the spending decisions made by the local government in a jurisdiction.

- Education**:** Although most residents in a jurisdiction have some knowledge of the natural hazards that potentially threaten their community, most of them have had little formal education about what they as individuals can do to reduce their vulnerability to a natural hazard event. Education involving mitigation strategies and potential vulnerability will be essential for all jurisdictions in the planning area.

(C) Existing Professional Staff Departments

Members of Calloway County MPT reviewed their existing capabilities based on their current professional staff departments. During the public input meetings, participants determined that the implementation of Mitigation Strategies and Projects would depend on the capability of that department in each jurisdiction.

Table 3.43 Capabilities Assessment: Existing Professional Staff Departments

Jurisdiction	Board of Education	Building Inspectors	Court Clerk	Emergency Management	County/City Treasurer	Mayor /County Judge/Executive	Health Department	Road Department	Sheriff Department	City Police Department	PVA (Tax Assessment)	Social Services	Utilities Department
Ballard County	X		X	X	X	X	X	X	X		X	X	X
Wickliffe				X	X	X							X
Barlow				X	X	X							X
Kevil				X	X	X							X
LaCenter				X	X	X							X
Calloway County	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**
Murray	**X**	**X**		**X**	**X**	**X**		**X**		**X**			**X**
Hazel				**X**	**X**	**X**							**X**
Carlisle County	X	X	X	X	X	X	X	X	X		X	X	X
Bardwell		X		X	X	X		X		X			X
Arlington		X		X	X	X		X					X
Fulton County	X		X	X	X	X	X	X	X		X	X	X
HIckman				X	X	X		X		X			X
Fulton	X			X	X	X		X		X			X
Graves County	X		X	X	X	X	X	X	X		X	X	X
Mayfield	X	X		X	X	X		X		X			X
Wingo				X	X	X							X
Hickman County	X		X	X	X	X	X	X	X		X	X	X
Clinton				X	X	X				X			X
Columbus				X	X	X							X
Marshall County	X	X	X	X	X	X	X	X	X		X	X	X
Benton		X		X	X	X		X		X			X
Calvert City		X		X	X	X		X		X			X
Hardin				X	X	X							X
McCracken County	X	X	X	X	X	X	X	X	X		X	X	X
Paducah	X	X		X	X	X		X		X			X

The following definitions summarize the duties and responsibilities of the professional staff departments listed in Table 3.43.

The **Board of Education** maintains the operations of the county school system. This board is elected at large by the people of the community. County funds usually maintain the buildings and provide for other capital projects. State funds usually pay for salaries and the purchase of textbooks and supplies.

The **Building Inspectors** are responsible for enforcing the State Building Code, the NFIP, the Community Rating System, and other applicable local codes. These items are enforced through an inspection and permitting program.

The **PVA, Court Clerk,** and **Sheriff** are elected every four years by the citizens in the county. The PVA is responsible for the valuation of property for tax purposes. The Court Clerk is the custodian of the court system in each county. This office is financed through the State of Kentucky. The Sheriff operates on a budget approved annually by the magistrates (fiscal court) of each county and is responsible for the enforcement of state and local laws.

The **City Police Departments** are responsible for enforcing local and state laws in their designated jurisdiction.

The **Road Departments** are responsible for the care and maintenance of the public roadways in their designated jurisdiction.

The **Utility Departments** are responsible for providing water, gas, electric and sewer services to the public.

The **Emergency Management Service** is responsible for the mitigation, preparedness, response and recovery operations for both natural and man-made disasters. The formation of an emergency management office in each county is mandated under the Kentucky Revised Statutes.

The **County/City Treasurers** are responsible for the management of the budget and fiscal programs for their jurisdiction. This also includes the administration of state and federal grants.

The **Mayor or County Judge/Executive** is responsible for overseeing the daily operations of county or city government in their respective jurisdictions. They are also responsible for the enforcement of county/city policies and regulations.
The **Health Departments** and **Social Services** have separate boards appointed by commissioners. Employment in these departments is approved by the commissioners with state personnel policies applying. These agencies protect and promote public health and provide social services for medical care and governmental social programs for displaced families.

The **Emergency Management, Road Department, Building Inspectors, and Utilities Department** have been identified as the specific departments that will be responsible for carrying out mitigation activities. Each of these departments has been involved in the hazard mitigation planning process by participating in the JPHMC meetings.

It has been determined by the committee that each of these departments have limited available staff that are responsible for multiple duties within their departments. All jurisdictions have limited funding resources available to hire additional staff. Each staff member is adequately trained to accomplish their current work load. Increase in work activities, including hazard mitigation activities, will increase the need for additional staff to effectively perform tasks.

The PADD, as a regional planning agency, has become a primary resource for technical assistance for all jurisdictions in the region. The PADD staff are trained in planning, GIS/GPS, financial management and project development.

SUMMARY: Capability Assessment

The available staff and financial resources of the departments in each jurisdiction determine the ability for expansion and improvement of existing authorities, policies, programs, and resources to reduce potential losses. Each county in the PADD has equal ability to enforce and implement mitigation strategies.

The capability of cities in the Purchase Region varies so communities often work cooperatively with county government to perform projects that improve the quality of life for residents, including mitigation projects and activities. Because counties have more resources available to implement mitigation activities, it has been suggested that the goals and objectives be prioritized at a county level. City jurisdictions will have the opportunity at any given time to implement mitigation activities if their capabilities expand and the opportunity exists.

The jurisdictions that have participated in the mitigation planning process are identified in this plan. In addition to local participation, the PADD staff has provided professional assistance in GIS and plan development to help enhance the ability of the local jurisdictions to implement mitigation activities. Based on the above information, the local Hazard Mitigation Goals, Objectives and Actions were compiled at a county level, taking city jurisdiction public input into consideration.

3:5.2 Hazard Mitigation Goals

The Calloway County MPT along with PADD staff, analyzed the loss estimates in the risk assessment to establish goals and objectives for loss reduction. The goals were established with the input from local city participants. The goals and objectives will serve as a guide to develop specific actions to reduce potential losses caused by hazard events. These goals and objectives concur with existing community goals and the goals set forth by the Kentucky State Hazard Mitigation Plan.

Mitigation Goals – The mitigation goals were set to be general, long-term guidelines for hazard mitigation in the jurisdictions.

Mitigation Objectives – The mitigation objectives define the strategies and process of implementation to achieve the identified goals. The objectives are specific, measurable, and have a defined completion.

The following goals and objectives were determined to have the greatest influence on hazard loss reduction in Calloway County.

Goal 1: Improve the survivability of critical facilities and infrastructure in order to preserve their capabilities to provide essential services during a hazard event, by reducing the vulnerability of these facilities.

Purpose of Goal in Relation to the Risk Analysis: Recent events such as the 2009 Ice Storm, 2011 flooding and tornadoes, underscored the vulnerability of critical facilities and infrastructure during natural hazards. Loss of these capabilities directly affected public health and safety. During a natural hazard event, roadways can be damaged and utility services knocked out. These types of damages hinder emergency first responders from being able to effectively get help to those in need.

The following objectives have been developed as a result of this goal:

1.1: Enhance the rapid restoration of transportation systems.
1.2: Enhance the rapid restoration of utility systems.
1.3: Where possible, move the critical facilities out of flood prone areas.
1.4: Enhance the resistance of/harden critical facility structures to the effects of natural hazards.
1.5: Enhance the capability to maintain essential public health and public safety services by providing back-up sources of power and redundant communications to critical facilities.

Goal 2: Reduce the potential damaging effects of natural hazards through development policies without limiting the goals for growth of the community.

Purpose of Goal in Relation to the Risk Analysis: It has been determined that potential losses associated with development in the Calloway County may be greatly reduced by enforcing or developing county and city policies that regulate development in hazard prone areas. Policies that regulate and guide the development of future infrastructure, residential, and industrial projects will reduce the vulnerability of these facilities.

The following objectives have been developed as a result of this goal:

2.1 Enforce existing policies and authorities.
2.2 Develop new policies such as ordinances and building codes that require new structures to meet standards that will resist natural hazards.
2.3 Develop land use planning policies that restrict development in hazard prone areas such as flood zones.
2.4 Develop subdivision requirements to protect utilities, such as buried power and phone lines.

Goal 3: Protect public health and safety by increasing public awareness of natural hazards that affect Calloway County and by fostering a sense of responsibility within the public for mitigating risks associated with those natural hazards.

Purpose of Goal in Relation to the Risk Analysis: It has been determined that the general public in Calloway County needs to be aware of the high risk areas, and potential harm associated with the natural hazards that affect their area. While policies can be developed to reduce the development in hazard prone areas, public education will ensure that those policies are utilized to their fullest to reduce the number of existing and future structures in those areas. Through public education, individuals may realize the seriousness of potential hazards and act upon this realization by taking steps to secure their property and protect their families against the risks of natural hazards.

The following objectives have been developed as a result of this goal:

3.1 Educate the public on potential natural hazards that affect their Calloway County.
3.2 Increase public understanding and support of the hazard mitigation process.
3.3 Educate the public on how they can take personal responsibility for their own health, safety and property protection.
3.4 Develop and maintain emergency evacuation routes. Educate the public to the location and use of evacuation routes.
3.5 Maintain Calloway County's status as a Storm Ready Community.
3.6 Pursue Firewise Community status for Calloway County and the City of Murray.

Goal 4: Efficiently make use of public and private funds to increase the capabilities of local jurisdictions to reduce potential losses associated with flood hazard events.

Purpose of Goal in Relation to the Risk Area: It has been determined that potential losses can be reduced in Calloway County by their ability to effectively communicate, plan, and implement mitigation projects. Efficiently using public or private money to improve communication, planning, and implementation capabilities for the general public as well as key critical facilities can reduce the impact a hazard has on Calloway County.

The following objectives have been developed as a result of this goal:

4.1 Promote inter-agency and inter-local cooperation for the use of mitigation funds and activities.

4.2 Take advantage of State Hazard Mitigation grants associated with Disaster Declarations, Pre-Hazard Mitigation Grant announcements, and other grants to fund Mitigation Projects.

4.3 Leverage State and local funding, local match sources and in-kind match resources to get the maximum utility from available Mitigation Funds.

Goal 5: Protect Calloway County's most vulnerable populations, buildings and critical facilities and infrastructure through the implementation of cost-effective and technically feasible mitigation projects.

Purpose of Goal in Relation to the Risk Area: During the review of the risk analysis, council members determined several structures and critical facilities and infrastructure that will need to have specific mitigation actions taken in order to be effective in reducing the vulnerability. Some identified structures and critical facilities and infrastructure need to be removed from the flood hazard area completely or built to appropriate standards to reduce the potential losses.

The following objectives have been developed as a result of this goal:

5.1 Increase the availability of adequate shelters and community shelters for protection from the direct and indirect effects of severe weather events.

5.2 Continue to improve early warning of impending severe weather events.

5.3 Reduce the number critical facilities and infrastructure in identified flood hazard areas.

5.4 Utilize available mitigation measures to reduce the number of vulnerable structures in the flood hazard areas.

5.5 Utilize available mitigation measures such as structure elevation to reduce the vulnerability of structures in the flood hazard areas.

5.6 Identify and remove stream blockages of tree limbs and trunks, form effective check dams and barrages, and result in the pooling of water during flood events.

Goal 6: Protect dwellings, structures and their occupants along the Wildland/Urban interface from the potential of Wildfire.

While there is not historic data to support damaging wildfires in Calloway County, small field fires and brush fires do occur, especially during periods of drought. These events, historically, have been very small threats and generally not considered a risk. Although considered a low risk, it should be continually planned for and perhaps, anticipated.

The following objectives have been developed as a result of this goal:

6.1 Ensure the protection of first responders.
6.2 Enhance the response capability to brush fires to mitigate their growth into wildfires.
6.3 Facilitate communities/neighborhoods participation in the State's "Firewise" program.
6.4 Reduce the quantity of available wildfire fuels in proximity to critical facilities and to any/all structures in Calloway County
6.5 Incorporate fire buffer planning into the design considerations for any new critical facility.

Goal 7: Support and participate in regional Hazard Mitigation Planning.

Purpose of the Goal in Relation to the Risk Area: Calloway County, the City of Murray, the City of Hazel, and representatives of various groups and organizations represented the county and participated in the JPHMC and the development of the regional portion of the plan. Because a regional "authority" does not exist, the realization of the goals and objectives of the JPHM Plan depends on the support and cooperation of Calloway County and the City of Murray and City of Hazel. This is especially true in that; the Regional Goals and Objectives affect all jurisdictions in the Purchase Region, damage to or destruction of the Regional Critical Facilities identified in the plan affect all jurisdictions in the region, the strategies and mitigation projects that will evolve from these goals require the participation of all the jurisdictions in the region and the results will benefit all the participants. In the same vein, Calloway County, and the City of Murray and City of Hazel will require the cooperation and assistance of other jurisdictions, both neighboring and region wide, and the assistance of Regional organizations such as the PADD, the Kentucky State Police, KYTC District One, Calloway County Health Department to help plan, fund and implement Hazard Mitigation projects.

The following objectives have been developed as a result of this goal:

7.1 Request Kentucky Geological Survey and the University of Kentucky to conduct/expand further studies into seismicity, soils and ground shaking potential within the region.
7.2 Develop a regional high resolution, spatially accurate imagery database to extract precise point locations and structure footprints for buildings and other critical facilities.
7.3 Adopt an All-Hazard Week public awareness campaign to include earthquake, flood, tornados and severe storms.

Goal 8: Obtain the best data and analysis available to assess the downstream hazard posed by Kentucky Dams in the event of failure.

Purpose of Goal in Relation to the Risk Area: Potential losses can be reduced in a jurisdiction by their ability to effectively plan and implement mitigation projects. In order to do so, an accurate assessment of the threat posed by Dam Failure must be made to determine the geographic extent of the hazard and the potential impact of the Hazard in terms of threat to the populace and property.

The following objectives have been developed as a result of this goal.

8.1 Acquire inundation maps for both Kentucky Dam.
8.2 Identify and map vulnerable structures, critical facilities, and risk prone areas.
8.3 Update county EOP as required
8.4 Support and participate in simulations and preparedness exercises relating to dam failure.
8.5 Monitor other existing dams in cooperation with the State Department of Water.

3:5.3 Identification and Analysis of Mitigation Measures

The intention of this section is to identify, evaluate, and analyze a range of mitigation actions that will help reduce the potential effects of hazard events identified in the risk assessment section of the plan. These actions were derived based on the analysis of the risk assessment and support the goals and objectives identified in the plan.

The following list of general actions describes potential loss reduction mitigation actions and techniques identified for mitigation of hazard events. These actions and objectives were determined to have the greatest influence on hazard loss reduction in Calloway County. Hazard specific mitigation actions are listed in order of priority in accordance with the High Risk Hazards for the county as identified and prioritized by the Calloway County MPT.

- Prevention activities are designed to keep current problems from getting worse and to eliminate the possibility of future problems. Prevention activities reduce a jurisdiction's vulnerability to hazard events. This type of activity is especially effective in hazard prone areas where development has not occurred. Prevention activities include the following:
  - Planning and Zoning
  - Floodplain regulations
  - Stormwater management
  - Building codes
  - Capital improvement programs
  - Open space preservation
  - Dam inspection and monitoring

- Property protection activities are designed to adapt existing structures to withstand natural hazards or to remove structures away from hazard prone areas. Property protection activities include the following:
  - Acquisition
  - Relocation
  - Foundation elevation
  - Insurance – flood and homeowner's
  - Retrofitting (includes activities such as wind-proofing, flood-proofing, and seismic design standards)

- Structural projects lessen the impact of a natural hazard by changing the natural progression of the hazard. These types of projects are usually designed by engineers. Structural projects include the following:
  - Storm sewers
  - Floodwalls
  - Highway Projects
  - Retention Basins
  - Reservoirs
  - Dams
  - Levees
  - Dredging
  - Minor flood control projects
  - Culvert resizing
  - Retaining walls
  - Safe rooms

- Emergency services minimize the impact that a natural hazard has on the residents of a jurisdiction. Usually, actions are taken by emergency response services immediately before, during, or in response to a hazard event. Emergency service activities include the following:
  - Warning systems: sirens / automated calling system
  - Evacuation planning and management
  - Sandbagging for flood protection
  - Emergency response services
  - Protection of critical facilities
  - Emergency generators

- Public information and awareness activities are used to educate the residents of a jurisdiction about the potential hazards that affect their area, hazard prone areas, and mitigation strategies they can take part in to protect themselves and their property. Public information and awareness activities include the following:
  - Public speaking events
  - Outreach projects
  - Availability of hazard maps
  - School programs
  - Library materials
  - Hazard Awareness Weeks
  - Real estate disclosure
  - Storm Ready Community Program
  - Firewise Community Program
  - CERT Teams and CERT Training
  - Citizens Corps Organizations

- Natural resource protection activities include those that minimize hazard losses and preserve or restore the functions of natural systems. Natural resource protection actions include the following:
  - Sediment and erosion control
  - Stream corridor restoration
  - Watershed management
  - Forest and vegetation management
  - Wetlands preservation and management

Hazard Specific Actions

Hazard specific mitigation activities defined for each goal and objective are listed by priority of risk, and partly based on the capability of the county to acquire funding for such activities. Specific projects included in this plan or under consideration; Establish designated Tornado shelters, determine vulnerability of Almo Fire Station to flood hazard and protect if required, protect wells from inundation, evaluation and replacement/slip line (HDPE) of City of Murray aged cast iron, asbestos cement (AC) and VCP earthquake vulnerable water and waste water lines, storm shelter planning and construction.

Table 3.44 Calloway County Hazard Summary Table

HIGH RISK HAZARDS	TORNADO THUNDERSTORM WIND FLOOD / FLASH FLOOD WINTER STORM/ICE STORM
MODERATE RISK HAZARDS	EARTHQUAKE EXCESSIVE HEAT / DROUGHT HAIL
LOW RISK HAZARDS	WILDFIRE DAM FAILURE

SOURCE: Calloway County MPT 2017

Tornado Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Develop a plan of action for a tornado event – include home, work, school, and outdoor situations.
- Have tornado drills on a regular basis
- Encourage all households to maintain a disaster supply kit:
  - A 3-day supply of water (1 gallon per person per day)
  - Non-perishable food items
  - One change of clothing and shoes per person
  - One blanket or sleeping bag per person
  - A first-aid kit, including all prescription medicines
  - A battery-powered NOAA weather radio with warning alarm and extra batteries
  - A flashlight and extra batteries
  - Special items for infants, elderly or disabled individuals

- Listen to the latest forecasts, especially when planning outdoor activities.
- Publicize multi-media access to tornado watches and warnings.
- Inspect designated tornado shelters for compliance with building codes to ensure their ability to withstand high winds.
- Install warning systems that are not completely dependent upon electricity.
- Increase the density of early warning sirens throughout the county with special emphasis on more densely populated communities and resort areas. “The county as a whole, outside the cities of Murray and Hazel, does not have warning sirens. A few years ago the Calloway County Fire-Rescue took the lead and developed a grant proposal, there was an application made for a grant to install sirens at each of the rural county fire stations (there are 10 such). The grant was not funded.
- Pursue programs to provide or subsidize the provision of weather radios to low income populations.
- Evaluate the need for tornado safe rooms, particularly for mobile home parks.
- Analyze the shelter requirements for temporary residents/visitors to the elder care facilities.
- Evaluate the need for tornado safe rooms, particularly for mobile home parks.
- Initiate mobile home anchoring program
- Build tornado safe room where deemed necessary.
- Ensure all critical facilities have a backup source of power – generators
- Train, equip and maintain Storm Spotter cadre
- Build community shelters in critical locations, in close proximity to the County EOC.

Flood Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Enforce city and county Floodplain Ordnances
- Participation in the NFIP
- Promote the purchase flood insurance.
- Elevate the lowest floor level of existing structures above the floodplain
- Elevate flood prone roads
- When feasible, relocate structures out of the floodplain
- Acquire and demolish structures in the floodplain
- Provide openings in foundation walls to allow water to flow in and out
- Install backflow valves to drains, toilets, and other sewer connections
- Maintain ditches and storm water drainage systems
- Ensure all critical facilities have a backup source of power – generators
- Wetland restoration
- Stream re-alignment
- Increase culvert cross section
- Identification and removal of stream blockages of tree limbs and trunks forming effective check dams and barrages, and resulting in the pooling of water during flood events

Almo Fire Station Flood Hazard Area:

Mitigate impact of flooding on the Almo Fire Station." The water surrounds the station. It got half way up the driveway last time. The station is then out of service because it is about 5 feet deep on 1st Street at the end of the driveway, then you have to turn toward KY 464 that is about 50 feet. (Figure 3.13)

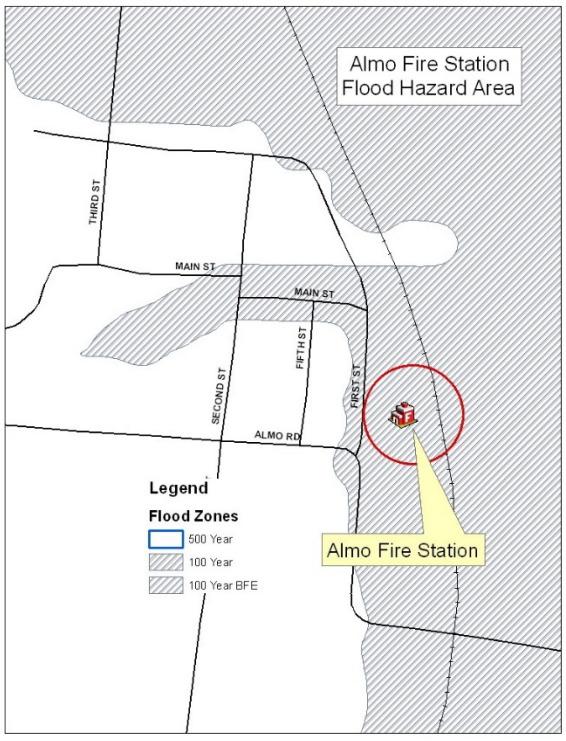


Figure 3.13

Thunderstorm Wind /Hail Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Listen to the latest forecasts, especially when planning outdoor activities
- Keep a NOAA weather radio with extra batteries nearby to listen for weather updates.
- Listen especially for severe thunderstorm watches and warnings.
- Practice lightning safety.
  - Outdoor activities should not take place when lightning is present.
  - Fully enclosed vehicles and large permanent buildings provide safe havens from lightning.
- Pursue programs to provide or subsidize the provision of weather radios to low income populations.
- Promote trimming of tree limbs and debris, particularly in areas close to critical facilities and infrastructure such as power lines.
- Ensure all critical facilities have a backup source of power – generators.
- Evaluate the need for additional warning sirens throughout the county.

Winter Storm / Ice Storm Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Make sure critical facilities have a backup source of heat
- Provide public education as to the safe use of back up heat sources
- Promote trimming of tree limbs and debris, particularly in areas close to critical facilities and infrastructure such as power lines.
- Evaluate subdivision regulations for inclusion of underground utilities for new development
- Promote public education to individuals and families, business, and schools for winter Storm Events and include the following:
  - Insulate the walls and attic of structures
  - Caulk and weather-strip doors and windows
  - Allow water to slowly drip from faucets to prevent pipes from freezing
  - Check the antifreeze and battery in vehicles
  - Stay off snow or ice covered roads if possible
  - Keep a supply of non-perishable food and water
- Ensure all critical facilities have a backup source of power - generators

Earthquake Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Support, encourage, and lobby for the continuing study of the threat of ground shaking from the Wabash and New Madrid Seismic Zones.
- Evaluate public critical facilities and infrastructure to determine their resistance to ground movement.
- Replacement of brittle water and waste water infrastructure specifically cast iron pipe, asbestos cement pipe, and vitreous clay pipe.
- Ensure that all homes and other structures are secured to their foundations.
- Enforce existing seismic building standards (current building code)
- Promote public education to individuals and families, business, and schools for hazard events that may include the following:
- Identify “safe places” in structures that are vulnerable during an earthquake. A safe place might include space under a sturdy table or desk against an interior wall. Stay away from windows.
- Practice the “drop and cover” technique in each identified safe place. Drop, duck your head between your knees, and cover the back of your neck with your hands. Practice makes this process an automatic response in the event of an earthquake.
- Develop an action plan for an earthquake event – include home, work, school, and outdoor situations.
  - Secure heavy furniture to walls. Brace or anchor high or top-heavy objects.
  - Purchase earthquake insurance if available.
  - Install strong latches on all cabinet doors. This will prevent them from spilling their contents in the event of an earthquake.
  - Secure items on shelves or bookcases that might fall and cause injury during an earthquake. Move large or heavy items to lower or bottom shelves.
  - Store breakable or glass items in cabinets with latches.

  - Brace overhead light fixtures.
  - Secure water heater to wall studs.
  - Install flexible pipe fittings. These fittings are less likely to break.
- Participate in any/all earthquake planning and exercises at the State and National level.

Excessive Heat and Drought Mitigation Activities: Promote public education to individuals and families, business, and schools for hazard events that may include the following.

- Programs focused on at risk populations, Senior Citizens, very young children
- Air conditioner/fan loan or subsidized purchase program
- Identification of cooling shelters.
- Replacement of brittle water and waste water infrastructure specifically cast iron pipe

Wildfire Mitigation Activities: Promote public education to individuals and families, business, and schools for hazard events that may include the following.

- Each community to strive to be a "Firewise" Community.
- Promote public education to individuals and families, business, and schools for Wildfire Threat include the following:
  - Proper storage of flammables or Class Shingles or tin on roofs or Masonry construction
  - Remove plants with resins, waxes, or oils from landscaping
  - Remove dead branches
  - Reduce the amount of fuel around homes
- Aggressively reduce available fuels in the vicinity of critical facilities
- Amnesty programs for hazardous materials/storage vessels
- Tire amnesty programs
- Removal of potential fuels from the vicinity of Critical Facilities.
- Pursue the acquisition of equipment and training to rapidly respond to brush fires to mitigate their becoming wildfires.

Dam Failure Mitigation Activities: Promote public education to individuals and families, business, and schools for hazard events that may include the following.

- Access and analyze USACE and TVA inundation maps or models for the projected downstream impact of the catastrophic failure of the Kentucky Dam and Barkley Dam.
- Assess the structures at risk to inundation.
- Continue to participate in the State Department of Water monitoring Program for the 3 DOW identified dams in Calloway County.

3:5.4 Implementation of Mitigation Measures

The purpose of this section is to provide a road map on how the mitigation actions identified in section 3:5.3 will be prioritized, implemented and administered in Calloway County.

All jurisdictions will adopt the JPHM Plan upon approval in 2018. Each county in the PADD has equal ability to enforce and implement mitigation strategies. The smaller cities in the Purchase Region, depend greatly upon the county government, and the PADD for support and combine resources to perform projects that improve the quality of life for residents, including mitigation projects and activities.

Given the (small) size of most of the Purchase region's cities, the planning process from which the following mitigation actions derived and were prioritized occurred at the county level. However, each city was represented at county-level meetings. Further, within each county-level planning meeting, individual city mitigation actions were discussed and prioritized. In practice, a city would derive one or two structural or property protection projects that it intended to pursue during the next five years and, first, discussed these projects' feasibility to implement in terms of local financing. Predictably, local financing was a significant constraint for both the county and its cities.

Preventative, natural resource protection, emergency service measures, and public information mitigation actions certainly were discussed at each planning meeting. However, the actions are not highly specific actions, by nature. Building code enforcement and enhancement, floodplain mapping and data, floodplain regulation, storm-water management, and planning activities, as examples, do not typically appear distinctive amidst a county and its cities. It is generally universally important, uncontroversial, and prescient to enforce codes, map and regulate floodplains, manage storm-water activity, and plan and zone. Similar that emergency service activities and public information activities are uncontroversial and generally sought (and not mutually exclusively) by both counties and its cities. So while such activities were discussed individually for counties and for cities, their inclusion within the following mitigation action list will appear similar within each jurisdiction's list. In other words: Calloway County and its incorporated cities Murray and Hazel all agreed that preventative activities, emergency service measures, and public information activities primarily should be implemented using local and federal-cum-state financing (e.g., EMPG) and are a high priority for pursuance during the next five years.

The jurisdictions that have participated in the mitigation planning process are listed in this plan. In addition to local participation, the PADD staff has provided professional assistance in GIS and plan development to help enhance the ability of the local jurisdictions to implement mitigation activities.

Funding: Outside of local financing and state financing options, the jurisdictions of the PADD will attempt to utilize the following funding sources in implementing goals, objectives and actions when possible: the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance

Program (FMA), the Pre-Disaster Mitigation Program (PDM), Hazard Mitigation Technical Assistance Programs (HMTAP), the National Earthquake Technical Assistance Program, the Wind and Water Technical Assistance Program, and federal-state matching programs. It should be noted that the above list represents known funding sources at the time of this writing. It is not exhaustive.

Project Prioritization: Calloway County will maintain the list of set goals, objectives, and actions that have been identified in this plan. These items were prioritized based on a set of criteria located in the FEMA Multi-Hazard Mitigation Planning Guidance that includes social, technical, administrative, political, legal, economic, and environmental factors (STAPLE+E) within the county jurisdictions.

As mentioned above, this mitigation strategy will divide mitigation actions into Community-Rating System (CRS) categories *preventative activities*, *property protection activities*, *natural resource protection activities*, *emergency services measures*, *structural projects*, and *public information activities*.

Mitigation actions falling under *preventative activities*, *emergency services measures*, and *public information activities* generally (i.e., unless otherwise specified) are process-driven by nature and driven by uncontroversial and laudable goals. It is thus muddying and complicated to subject such measures to a formal, qualitative, and subjective prioritization mechanism like STAPLE+E. How does a community distinguish "technical assistance" or "hazard response operations" or "enforcement of building codes" as of equally or of higher priority than the construction of a community safe room? Consequently, such process-oriented actions are treated as default "High" in priority and are considered pursued by Calloway County and its incorporated cities of Murray and Hazel, e.g., Calloway County will "enforce building codes" while its cities may not.

The categories *structural projects*, *property protection activities*, and *natural resource protection activities* primarily will include actions that involve construction activity toward new and existing building structures. It is these intended projects and project categories that were prioritized using STAPLE+E.

Each structural/construction action for each community was given a High, Medium, or Low priority using the STAPLE+E framework. Because STAPLE+E relies upon qualitative and subjective assessment, Table 2.43 defines how each component of the STAPLE+E framework was interpreted. Generally, the mitigation actions with the highest priority were the most cost-effective and most compatible with the jurisdiction's social and cultural values. The below list of structural/construction actions includes a column specifying which components of the STAPLE+E framework as defined below were relevant in the designation of the projects' priority status. "E1" in the project lists refers to the "Economic" consideration. "E2" refers to the "Environmental" consideration.

The PADD staff reviewed each jurisdiction's priorities annually to ensure that they were properly prioritized. The designated council representative from each jurisdiction will be responsible for maintaining this list.

The STAPLE+E criteria guidelines for action prioritization that were given to the council members in order to analyze their actions were as follows:

Table 3.45 STAPLE+E Criteria Explanation

S - Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T – Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A – Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P – Political	Mitigation actions can truly be successful if all stakeholders have been offered and opportunity to participate in the planning process and if there is public support for the action.
L – Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E – Economic	Budget constraints can significantly deter the implementation of mitigation actions. It is important to evaluate whether an action is cost-effective, as determined by a cost-benefit review, and possible to fund.
E - Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with Federal, State, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Tables 3.46-3.48 represent non-process actions requiring construction or acquisition related to the goals and objectives set forth in this plan, prioritized by each jurisdiction. The table identifies the hazard the action addresses, the action, the action priority, the entity responsible for the action, the potential sources of funding for the action, and to which Community Rating System (CRS) action category each project belongs.

Table 2.49 represents process actions that, thusly, are of High priority to Calloway County *and* to its incorporated jurisdictions equally: For example, it is expected that "adopting and enforcing building codes" applies with equally "High" priority to Calloway County and to its incorporated cities Murray and Hazel.

Construction/Non-Process Projects to Be Pursued by Each Jurisdiction:

Table 3.46: Calloway County, Unincorporated

Hazard	Action	Priority	STAPLE+E	Responsible Entities	Potential Funding Sources	CRS Action Category	Completion Timeframe
All Hazards	Establish a dedicated EOC	High	S, T, A, P, L, E1, E2	Fiscal Court	Local, State, Federal Grant Programs	Emergency Services Measures	Immediate
Flooding	Elevate segments of roads prone to flooding & evaluate causes and remedy in the Robertson Road area	High	S, T, A, P, L, E1, E2	Fiscal Court; KYTC	Local, State, Federal Grant Programs	Structural	Long Term
Flooding	Acquire/Demolish Repetitive-Loss Properties	High	S, T, A, P, L, E1	Fiscal Court; KYEM; FEMA	FEMA HMA, Local	Property Protection	On Going
Flooding	Relocate Critical Facilities out of flood-prone areas or Elevate them, with particular attention to the Almo Fire Station	High	S, T, P, L, E2	Fiscal Court; Owners of Facilities	Local, State, Federal Grants Programs	Property Protection	On Going
Tornadoes	Purchase and Install Emergency Warning Sirens for the Lynn Grove, Dexter, Kirksey & Shiloh Communities	High	S, T, A, P, E1	Fiscal Court	Local, FEMA HMA	Emergency Services Measures	Immediate
Tornadoes	Construct Community Safe Room for Lynn Grove, Dexter, Kirksey and Shiloh Communities; consider similar measures for campgrounds	High	S, T, A, P, L, E1	Fiscal Court	FEMA HMA, Local	Structural; Emergency Services Measures	Immediate
All Identified Hazards	Purchase Generators for Critical Facilities	High	S, T, A, P, E1	Fiscal Court	Local, FEMA HMA	Emergency Services Measures	On Going
All Identified Hazards	Purchase Emergency Power Sources for rural areas' designated shelters	High	S, T, P, L, E1	Fiscal Court	Local, FEMA HMA	Emergency Services Measures	On Going
Flooding	Develop a Debris Removal Plan for Streams and Ditches	Medium	S, P, L, E1, E2	Fiscal Court; Public Works	Local, Federal Grants	Public Information; Natural Resource Protection	On Going
Tornadoes; Severe Storms; Ice Storms	Trim Trees and Debris from Overhead Powerlines	Medium	S, P, L, E1	Utilities Providers	Private, Local	Preventative Activities	On Going
Wildfires	Purchase Equipment to suppress brush fires	Medium	S, P, E1	Fire Departments; Fiscal Court	Non-Profit, Private, Local, Federal Grants	Natural Resource Protection	Long Term
All Identified Hazards	Upgrade Emergency Services Communication Equipment (for Critical Facilities)	Medium	S, T, P, E1	Emergency Management Agency	FEMA/DHS, Other Federal Grants, Local	Emergency Services Measures	On Going

Table 3.47: Murray, City of

Hazard	Action	Priority	STAPLE+E	Responsible Entities	Potential Funding Sources	CRS Action Category	Completion Timeline
Flooding	Identify & implement measures to protect water & wastewater treatment facilities from flooding	High	S, T, A, P, L, E1, E2	City	Local, State, Federal Grant Programs	Structural	Immediate
Flooding	Study cause of flooding in the vicinity of Bee Creek and identify measures to alleviate flooding	High	S, T, A, P, L, E1, E2	City	Local, State, Federal Grant Programs	Structural	On Going
Tornadoes	Purchase and Install Emergency Warning Sirens for portions of Murray that don't have adequate coverage	High	S, T, A, P, E1	City; Fiscal Court	Local, FEMA HMA	Emergency Services Measures	Immediate
Tornadoes	Construct Community Safe Room for mobile home parks	High	S, T, A, P, L, E1	City	FEMA HMA, Local	Structural; Emergency Services Measures	Immediate
All Identified Hazards	Purchase Generators for Critical Facilities	High	S, T, A, P, E1	City	Local, FEMA HMA	Emergency Services Measures	On Going
Tornadoes; Severe Storms; Ice Storms	Trim Trees and Debris from Overhead Powerlines	Medium	S, P, L, E1	Utilities Providers	Private, Local	Preventative Activities	On Going
All Identified Hazards	Upgrade Emergency Services Communication Equipment (for Critical Facilities)	Medium	S, T, P, E1	Calloway County Emergency Management Agency	FEMA/DHS, Other Federal Grants, Local	Emergency Services Measures	On Going

Table 3.48: Hazel, City of

Hazard	Action	Priority	STAPLE+E	Responsible Entities	Potential Funding Sources	CRS Action Category	Completion Timeline
Flooding	Study flooding & identify measures to alleviate flash flooding in Hazel	High	S, T, A, P, L, E1, E2	City	Local, FEMA HMA	Structural	Immediate
Tornadoes	Purchase and Install Emergency Warning Sirens for the areas in Hazel that don't have adequate coverage	High	S, T, A, P, E1	City	Local, FEMA HMA	Emergency Services Measures	Immediate
Tornadoes	Construct Community Safe Room for the City of Hazel	High	S, T, A, P, L, E1	City	FEMA HMA, Local	Structural; Emergency Services Measures	Immediate
All Identified Hazards	Purchase Generators for Critical Facilities	High	S, T, A, P, E1	City	Local, FEMA HMA	Emergency Services Measures	On Going
Tornadoes; Severe Storms; Ice Storms	Trim Trees and Debris from Overhead Powerlines	Medium	S, P, L, E1	Utilities Providers	Private, Local	Preventative Activities	On Going
All Identified Hazards	Upgrade Emergency Services Communication Equipment (for Critical Facilities)	Medium	S, T, P, E1	Calloway County Emergency Management Agency	FEMA/DHS, Other Federal Grants, Local	Emergency Services Measures	On Going

Table 3.49: Process Mitigation Actions That Apply to Calloway County and Each of Its Incorporated Cities (Murray and Hazel) with Equally (i.e., "High") Priority

Hazard	Action	Priority	Responsible Entities	Potential Funding Sources	CRS Action Category	Completion Timeline
Flooding	Enforce NFIP Flood Ordinances	High	County and City Executives; Floodplain Managers	Fiscal Court; City Councils	Preventative Activities	On Going
Flooding	Monitor, Evaluate, Collect Damages Data to determine additional and on existing Repetitive-Loss Properties	High	County EMAs; City-Appointed Designees; Floodplain Managers	Fiscal Court; City Councils	Preventative Activities; Property Protection	On Going
Flooding	Provide Updated Floodplain Mapping and other information regarding flood-prone areas to Public	High	County and City EMA and EM agents; Floodplain Managers	Fiscal Court; KYEM; KDOW	Public Information; Preventative Activities	On Going
Earthquakes; Flooding	Public Outreach regarding Importance of and Availability of Earthquake and Flood Insurance	High	County; City; County EMA and EM agents; Floodplain Managers; Insurance	Fiscal Court; City Councils; KYEM; KDOW; UK-KGS	Public Information; Preventative Activities	On Going
All Identified Hazards	Adopt and Enforce Building Codes	High	County; City; Building Inspection agents	Fiscal Court; City Councils; KYEM; FEMA (through HMGP Initiative)	Preventative Activities	On Going
All Identified Hazards	Public Outreach for the Development of Evacuation Plans and Procedures relevant to All Identified Hazards	High	County; City	Fiscal Court; City Councils; KYEM	Public Information; Emergency Services Measures; Preventative Activities	Long Term
All Identified Hazards	Develop additional Zoning and Land-Use Ordinance to regulate development	High	County; City; Developers	Fiscal Court; City Councils	Preventative Activities; Natural Resource Protection	Long Term

Hazard	Action	Priority	Responsible Entities	Potential Funding Sources	CRS Action Category	Completion Timeline
Flooding	Participate in Wetlands Restoration projects along the Clarks River and other drainage basins.	High	County (with City Councils' support)	Fiscal Court; City Councils; USACE; KDOW;	Preventative Activities; Emergency Services Measures; Natural Resource Protection ; Public Information	As Needed
All Identified Hazards	Develop and Implement a Protection Program for Critical Information Systems	High	County; City	Fiscal Court; City Councils	Emergency Services Measures; Preventative Activities	On Going
Flooding	Participate in Wetlands Restoration projects along the Clarks River drainage basin	High	County; City; Ad-hoc Regional Entities	Fiscal Court; City Councils; Federal Grants	Natural Resource Protection	Long Term
All Identified Hazard	Promote the usage of NOAA Weather Radios	Medium	County and City EMA and EM Agents	Fiscal Court; City	Preventive Activities; Public Information	On Going

**All actions and projects apply to the county and all city jurisdictions within the county.*

As funding becomes available, these projects will be pursued. However, this listing is not a commitment by the jurisdictions to pursue each project. Some projects may be cost prohibitive, not as desirable as initially thought, or overridden by competing priorities.