

HAZARD PROFILE

4 HAZARD PROFILE

Adams County has experienced many natural disasters in the past 100 years. These disasters have ranged from tornadoes and blizzards, to flooding and droughts. The purpose of this document is to identify the number and frequency of disasters in Adams County to better prepare and deal with them when they do occur. The following sections describe the process of determining upon which hazards to focus, general background information on each hazard as well as hazard events that have occurred in Adams County.

4.1 Initial Hazard Assessment

In order to properly evaluate the natural hazards to which Adams County may be susceptible, a three-step process was utilized. This three-step process was completed in order to “narrow down” the hazards for which Adams County should prepare, and potentially mitigate, in the future. The three steps are described in the following paragraphs.

Step 1 - FEMA’s database was researched to determine which hazards FEMA had documented as possible natural hazards, including future threats, for the State of Ohio. Several hazards that are listed on FEMA’s website include flooding, severe storms, tornadoes and winter storms.

Step 2 - The NCDC was contacted and historic hazard information was reviewed all the way down to the county level. The NCDC website presented each type of hazard and the historic information associated with it for each county, offering several hazard search parameters. These parameters included: droughts, dust storm, flooding, fog, hail, hurricanes, lightning, tornadoes, wild/forest fires, ocean/lake surf, precipitation, snow and ice, temperature extremes and thunderstorms and high winds. Because NCDC information did not address earthquakes or dams and dam safety, other sources were contacted for this data. The information pertaining to earthquake susceptibility was attained from United States Geographical Survey (USGS) data and the Ohio Earthquake Program Manager at OEMA. Dam and dam safety information was gathered from the ODNR’s Division of Dam Safety.

Step 3 - The *Ohio Hazard Analysis and Risk Assessment*, which is a document created in 1998 by OEMA for local and state emergency preparedness officials was reviewed. The *Ohio Hazard Analysis and Risk Assessment* documented both natural and non-natural (technological) hazard event information.

4.2 Risk Assessment Ranking

The research compiled during the initial hazard assessment was provided to the Core Group for their review and assessment. The Core Group evaluated all the hazards being considered and ranked them based on the number of historic events and cumulative damage that has occurred.

The following list shows the Core Group’s ranking of hazards with number one being the hazard of the most concern:

1. Floods
 - a.) Flash Floods
 - b.) Riverine Floods
 - c.) Repetitive Loss Floods
 - d.) Non-Flood Zone Floods
2. Severe Storms
 - a.) Winter Storms
 - b.) Ice Storms
 - c.) Severe Cold
 - d.) Summer Storms
3. Drought
 - a.) Fire Hazards
 - b.) Impact on Water Table
 - c.) Crop Damage
4. Tornadoes
5. Landslides
6. Earthquakes

Other non-natural hazards that the Core Group chose to evaluate include: Karst Topography, Dams, and Well Field Dependency.

Ohio Disaster History According to FEMA
1992 Severe Storms, Tornadoes & Flooding
1995 Severe Storms& Flooding
1996 Severe Storms& Flooding
1996 Severe Storms& Flooding
1997 Severe Storms& Flooding
1998 Severe Storms
1999 Severe Storms
2000 Severe Storms and Flooding
2001 Severe Storms and Flooding
2002 Severe Storms and Tornadoes
2003 Severe Storms and Flooding
2004 Severe Storms and Flooding
2005 Severe Storms and Flooding
2006 No Disasters Declared

Table 4-1 Ohio Disaster History

1.1.1.1 Initial Hazard Assessment	No. of Events	Cost in Millions
Severe Storms (1950-2007)	148	31.25
Winter Storms	25	26.8
T-Storms/High Winds/Lightning	95	4.45
Hail	28	.10
Rain Non-Severe	0	0
Snow Non-Severe	0	0
Floods (1950-2007)	65	31.79
Flash Floods	21	8.5
100-Year/Non-Floodzone Floods	44	23.29
Tornadoes (1950-2007)	9	3.95
Landslide/Subsidence		
Earthquakes	1 epicenter	
Droughts, Excessive Heat and Extreme Cold (1950-2007)	4	1.36

Table 4-2 Adams County Disaster History

4.3 FLOODS

Floods are a naturally recurring event for a river or stream, and are caused by weather phenomena and events that deliver more precipitation to a drainage basin that can be readily absorbed or stored within the basin. Flooding is a localized hazard that is a result of heavy or continuous rainfall exceeding the absorptive capacity of soil and the flow capacity of rivers and streams. Floods can be generally considered in two categories: flash floods, the product of heavy localized precipitation in a short time period over a given location; and riverine floods, caused by precipitation over a longer time period and over a given river basin.

4.3.1 Flash Floods

Flash floods occur within a few minutes or hours of heavy amounts of rainfall, from a dam or levee failure, or from a sudden release of water held by an ice jam. Flash floods can destroy buildings and bridges, uproot trees, and scour out new drainage channels. Heavy rains that produce flash floods can also trigger mudslides. Most flash flooding is caused by slow-moving thunderstorms, repeated thunderstorms in a local area, or by heavy rains from hurricanes and tropical storms.



Although flash flooding occurs often in higher elevation areas, it is also common in urban areas where much of the ground is covered by impervious surfaces. Roads and buildings generate greater amounts of runoff than typical forested land. Fixed drainage channels in urban areas may be unable to contain the runoff that is generated by relatively small, but intense, rainfall events.

4.3.2 Riverine Floods

Riverine flooding refers to periodic flooding of lands adjacent to non-tidal rivers and streams. It is a natural and inevitable occurrence. When stream flow exceeds the capacity of the normal watercourse, some of the above-normal stream flow spills over onto adjacent lands within the floodplain. Riverine flooding is a function of precipitation levels and water runoff volumes within the watershed of the stream or river. The recurrence interval of a flood is defined as the average time interval, in years, expected to take place between the occurrence of a flood of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence interval.

Flooding is an important issue for the residents and business owners of Adams County. Whether it was flash floods or riverine flooding events that have occurred in the past, lives have been disrupted or lost and damage has been extensive. A principal flood problem area exists in the low-lying areas adjacent to the Ohio River, which is subject to periodic flooding. Overbank flooding of Ohio Brush Creek is also a frequent hazard.

4.3.2.1 Special flood zone (100-year Floodplain)

Flood Insurance Rate Maps (FIRM) show areas delineated to be special flood hazards. The Base Flood Elevation (BFE) refers to the elevation associated with a special flood zone, or a flood with a 1% chance of occurring in any given year. Areas within a special flood zone area, also known as the 100-year floodplain, have an elevation lower than the BFE and are categorized into zones. Zone “A” is the flood insurance rate zone that corresponds to a special flood zone area that is determined in the Federal Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or depths are shown within this zone. Zone “AE” is the flood insurance rate zone that corresponds to a special flood zone area that is determined in the Federal Flood Insurance Study by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Adams County has special flood zone floodplains identified within the County. The best way to combat a disaster happening within these special zone flood hazard areas is through public awareness. Adams County is in compliance with state floodplain management standards and participates in the National Flood Insurance Program (NFIP). The following list gives the incorporated jurisdictions that participate in the NFIP, and their FIRM status.

Table 4-3

Communities Participating in the NFIP	FIRM Status	Participation
Adams County	Original	Y
Cherry Fork Village	Original	N
Manchester Village	Revised	Y
Rome Village	Revised	Y
Peebles Village	All zone C&X published firm	N
Seaman Village	All zone C&X published firm	N
West Union Village	All zone C&X published firm	N
Winchester Village	All zone C&X published firm	N

The Villages of Winchester, Peebles, Seaman, and West Union do not have special hazard areas identified within their village limits.

4.3.3 Repetitive Loss Flooding

In most counties there are areas that periodically suffer damages from floods. They are known as “repetitive loss” properties. Repetitive loss properties are defined as properties with structures that have had two or more insurance claims within a 10-year period. There are three properties that have suffered from repeated flooding occurrences in Adams County – one in West Union and two in Peebles.

4.3.4 Non-Flood Zone Flooding

Flooding occurring outside of designated flood zones has the potential to wreak havoc on homes and businesses that are not prepared for flooding.

4.3.5 Frequency/Probability of Future Occurrence

According to the NCDC, there were 44 flood events and 21 flash flood events recorded in Adams County from 1950 to 2006. Twenty-one of the 44 flood events caused \$23.595 million in property damage. Eight of the 21 flash flood events caused \$8.202 million worth of property damage. Two deaths were recorded for a March 1, 1997 flash flood event, no injuries were recorded.

Past floods are indications of what can happen in the future, but mitigation plans are based on the risk of future flooding. Flood studies interpret historical records to determine the statistical potential that storms and floods of certain magnitude will recur. Such events are measured by their recurrence interval.

Recurrence interval, or frequency of occurrence, is defined as the average number of years between storms of a given intensity. Recurrence intervals commonly used in technical studies and design are 2, 10, 25, 50 and 100 years. Recurrence interval addresses how often a flood of a specific depth will be expected to occur. Structures located within areas considered at higher risk should be prioritized higher as it relates to mitigation.

Since most of Adams County is rural in nature, estimated losses were based on just a few higher populous areas, where significant property damage was likely to occur. Floodplain Resolution attached in appendix O.

4.4 SEVERE STORMS

Hazards that fit into the severe storm category include snow, ice, thunderstorms, high winds, hail, and lightning. One of the biggest problems associated with severe weather is the lack of public education and awareness. Severe storms can do damage, but are often the precursor for much more severe weather to follow.

4.4.1 Winter Storms

A winter storm encompasses several types of storm systems that develop during the late fall to early spring. It deposits any of the following types of precipitation: snow, freezing rain, or ice. Blizzards and ice storms are subcategories of winter storms. A winter storm watch indicates that severe winter weather may affect an area. A winter storm warning indicates that severe winter weather conditions are definitely on the way.

According to the NCDC, there were 27 recorded snow, ice storm and extreme cold events in Adams County from 1993 to 2006. Of these 27 events, 12 were recorded as having caused \$27.694 million worth of property damage, seven deaths and 41 injuries.

4.4.1.1 Blizzards

A blizzard warning signifies that large amounts of falling or blowing snow, and sustained winds of at least 35 mph, are expected for several hours. In order to be classified as a blizzard, as opposed to merely a winter storm, the weather must meet several conditions. The storm must decrease visibility to a quarter of a mile for three consecutive hours, include snow or ice as precipitation, and have wind speeds of at least 35 mph. A blizzard is also characterized by low temperatures.

4.4.2 Ice Storms

An ice storm is defined as a weather event containing liquid rain that falls upon cold objects creating 1/4 inch thick or more accumulation of ice buildup. This ice accumulation creates serious damage such as downed trees and power lines, leaving people without power and communication. It also makes for extremely treacherous road conditions. Occasionally, snow will fall after an ice storm has occurred. With the ice covered, it is nearly impossible to determine which travel areas to avoid. When traveling by car, this snow covered ice causes accidents and when walking it causes people to fall, possibly sustaining injuries.

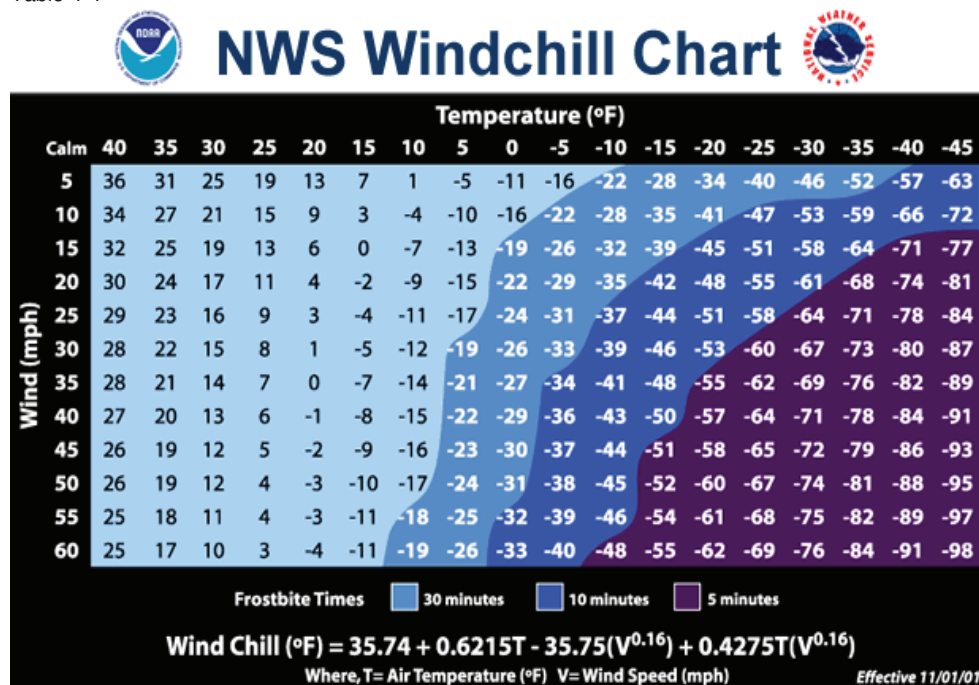
According to the NCDC, there were five ice storm events and no freezing rain events from 1993 to 2006 in Adams County. Of these five events, two events caused \$10.0 million worth of property damage, no deaths and 40 injuries.

4.4.3 Severe Cold

Extreme cold can immobilize an entire region. Even areas that normally experience mild winters can be hit with extreme cold with a wind chill. The impacts include frostbite and hypothermia. The wind chill temperature is how cold people and animals feel when outside. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

On November 1, 2001, the NWS implemented a replacement Wind Chill Temperature (WCT) index for the 2001/2002 winter season. The reason for the change was to improve upon the current WCT Index which was based on the 1945 Siple and Passel Index. For more on the new index, please visit www.nws.noaa.gov/om/windchill/index.shtml. Therefore, the wind makes it feel much colder. If the temperature is 0 degrees Fahrenheit and the wind is blowing at 15 mph, the wind chill is -19 degrees Fahrenheit. At this wind chill temperature, exposed skin can freeze in 30 minutes. The following chart lists wind chill values associated with degrees in Fahrenheit and wind in mph.

Table 4-4



Frostbite is a severe reaction to cold exposure that can permanently damage its victims. A loss of feeling and a white or pale appearance in fingers, toes, or nose and ear lobes are symptoms of frostbite. Hypothermia is a condition brought on when the body temperature drops to less than 90 degrees Fahrenheit. Symptoms of hypothermia include uncontrollable shivering, slow speech, memory lapses, frequent stumbling, drowsiness and exhaustion.

According to the NCDC, there have been three extreme cold events recorded between 1995 and 2006 in Adams County. These events caused \$1.362 million worth of property damage, 4 deaths and one injury.

4.4.3.1 Frequency/Probability of Future Occurrence

According to the NCDC, there were 27 recorded snow, ice storm and extreme cold events in Adams County from 1993 to 2006. Of these 27 events, 12 were recorded as having caused \$27.694 million worth of property damage, seven deaths and 41 injuries. Based on historical information, Adams County can expect to endure at least two to three winter storms, ice storms or extreme cold events in any given year.

4.4.4 Summer Storms

Hazards that fit into the summer storm category include high winds, hail and lightning. One of the biggest problems associated with severe weather is the lack of public education and awareness. Severe storms can do damage, but are often the precursor for much more severe weather to follow. One example is the direct association of tornadoes with thunderstorms. A severe thunderstorm watch is issued by the National Weather Service (NWS) when the weather conditions are such that damaging winds of 58 mph or more, or hail 3/4 of an inch in diameter or greater, are likely to develop. Citizens should locate a safe place in the home and tell family members to watch the sky and listen to the radio or television for more information. A severe thunderstorm warning is issued when a severe thunderstorm has been sighted or indicated by weather radar. At this point, danger is imminent and citizens should move to a safe place, turn on a battery-operated radio or television, and wait for the "all clear" by the authorities.

Severe storms are also associated with other hazards such as tornadoes and severe flooding. Since tornadoes and flash flooding are spawned by thunderstorms, people should review what action to take under a tornado warning or a flash flood warning when a "severe thunderstorm warning" is issued. When thunderstorms are forecasted to bring heavy rains (which can cause flash flooding), strong winds, hail, lightning and tornadoes, people should get inside a sturdy building and stay tuned to a battery-operated radio for weather information. People should also be aware that lightning and high winds are also major threats during thunderstorms.

4.4.4.1 High Winds

Straight-line winds are often responsible for most of the wind damage associated with a thunderstorm. These winds are often confused with tornadoes because of similar damage and wind speeds. However, the strong and gusty winds associated with straight-line winds blow roughly in a straight line unlike the rotating winds of a tornado.

Property damage and loss of life from windstorms are increasing due to a variety of factors. According to the Ohio Manufactured Housing Association, the use of manufactured housing is on an upward trend, and this type of structure provides less resistance to wind than conventional construction. Uniform building codes for wind resistant construction are not adopted by all states, and population trends show rapid growth in the highly exposed areas.

According to the NCDC, a total of 88 thunderstorm/high wind events and five high wind events were recorded in Adams County between 1950 and 2006. Fifty-eight of these events caused property losses totaling \$3.951 million. The five high wind events were responsible for \$1.977 million of the total property losses. Three deaths were recorded, two due to high winds and one due to thunderstorm/high winds. Twenty-one injuries were also recorded.

4.4.4.2 Hail

Hail is a type of precipitation composed of balls or irregular lumps of ice. It occurs when super-cooled water droplets (remaining in a liquid state despite being below the freezing point, 0 °C/32 °F) in a storm cloud collide with some solid object, such as a dust particle or an already forming hailstone.

Hail often forms in strong thunderstorms, often along a cold front, where the layer of air on top is much colder than that on the bottom. The smaller hailstones can bounce up and down between the warm and cold layers due to updrafts and gravity. The longer the stones bounce around, the larger they grow. These strong, severe, or even supercell thunderstorms can also produce hail in the summer months, even without a cold front.

Hailstones, while most commonly only a few millimeters in diameter, can sometimes grow to several inches or occasionally even bigger. Such large hailstones can do serious damage, notably to automobiles, skylights, and glass-roofed structures. Pea or golf ball-size hailstones are not uncommon in severe storms. Rarely, massive hailstones have been known to cause concussions or to kill people by causing head trauma. According to the NCDC, there were 28 hail events recorded from 1950 to 2006 by the NCDC. One of these events, in Peebles caused \$10,000 worth of property damage. No deaths or injuries were recorded.

4.4.4.3 Lightning

Lightning kills between 75 and 100 people a year. It is the second largest killer of natural hazard events, exceeded only by floods. Lightning strikes can happen anywhere and affect anyone. Only 10% of lightning strikes result in death, leaving the rest with various degrees of disability, most being central nervous system issues.

According to the NCDC, there were two recorded lightning strikes in Adams County from 1950 to 2006. One event in 1994 caused \$500,000 worth of crop damage.

4.4.4.4 Frequency/Probability of Future Occurrence

According to the NCDC, there were 121 thunderstorm, high wind and hail events recorded from 1950 to 2006 in Adams County. There were two recorded lightning events. Of these 123 events, 60 caused nearly \$4.5 million in property damage, three deaths and 21 injuries. Severe storms for Adams County quantitatively have the highest likelihood of occurring on a yearly basis. Based on historical information, Adams County can expect to endure at least two severe storms in any given year.

4.5 DROUGHT/EXTREME HEAT

A drought is a period of abnormally dry weather that persists long enough to produce a serious hydrologic imbalance (i.e., crop damage, water supply shortage, etc.) The severity of the drought depends upon the degree of moisture deficiency, the duration and the size of the affected area. The worst drought in 50 years affected 35 states during the long, hot summer of

1988, when some areas had been suffering from lack of rainfall since 1984. Rainfall totals in 1988 throughout the mid-west, Northern Plains and the Rockies were 50% to 85% below normal. Crops and livestock died, and some areas became desert. Forest fires began over the Northwest that left 4,100,000 acres destroyed by autumn. A heat wave or extreme heat event is defined as a prolonged period of excessive heat and humidity. Medical conditions that a population could suffer from during a heat wave are heat exhaustion and heat stroke.

According to the NCDC, drought conditions existed in Adams County from July to August 1999. The total dollar loss amount is unknown. No deaths or injuries were recorded for this event. According to the NCDC, there was one excessive heat event that occurred July 20, 1999 in Adams County. No property damage, 13 deaths and no injuries were recorded for this event.

4.5.1 Fire Hazards

Rural counties are susceptible to wild land fires especially during drought conditions. When most people think of wild fires, the first thing that comes to mind is the devastating and disastrous western fires that are quite prevalent during the summer months.

With more people than ever living, working, traveling and recreating in the urban/urban interface, the odds of wild land fires are increasing. Causes of wild land fires include the careless burning of debris, household trash and cigarettes, lightning, equipment and vehicles, railroad accidents, electrical fires, and arson. Fire fighters talk of the fire triangle in terms of the heat of combustion, fuel and oxygen all being necessary for fire to occur. Wild land fire fighters are concerned with the wild land fire triangle of fuel (grass, brush, forests, crops, etc.), terrain (open flat lands, steep slopes and everything conducive to wild land fire spread) and weather (hot, dry, windy conditions are typical wild land fire weather). During an average year in Ohio, an estimated 15,000 wildfires and natural fuel fires occur. Typically, a reported 1,000 wild land fires burn an average between 4,000 to 6,000 acres in Ohio each year.

According to the NCDC, there was no recorded forest or wild land fires from 1950 to 2006 in Adams County.

4.5.1.1 Urban/Rural Fire Interface

The wildland-urban interface can be defined as the zone where structures and other human developments meet or intermingle with undeveloped lands. Topography plays a major role in how fast a wildfire spreads. Steep slopes are the greatest topographical influence on fire behavior. As the steepness of a slope increases, fires spread more quickly. A fire will spread twice as fast on a 30% slope than it will on level ground. This fast speed is due to the fact that a fire starting at the bottom of a slope has a longer upslope run with more available fuel in its path.

4.5.2 Impact on Water Table

Droughts have the potential to significantly lower a regions natural water table and affect both municipal drinking water wells as well as private. Withdrawing too much water for industrial and agricultural usage during periods of drought can lower aquifer height even more substantially. If aquifer levels drop too low, deeper and more costly wells must be drilled in order to keep an adequate water supply. Sufficient planning and prediction of well shortages can help to mitigate a potential problem.

4.5.3 Crop Damage

Droughts occurring in urban and agricultural areas such as Adams County have the potential to reduce crop yields and even destroy an entire crop. Reduced yields mean less income for farmers and can distress the local agricultural economy. In areas where irrigation is used, a drought triggers higher cost inputs through the use of irrigation equipment and can further add to groundwater deprivation.

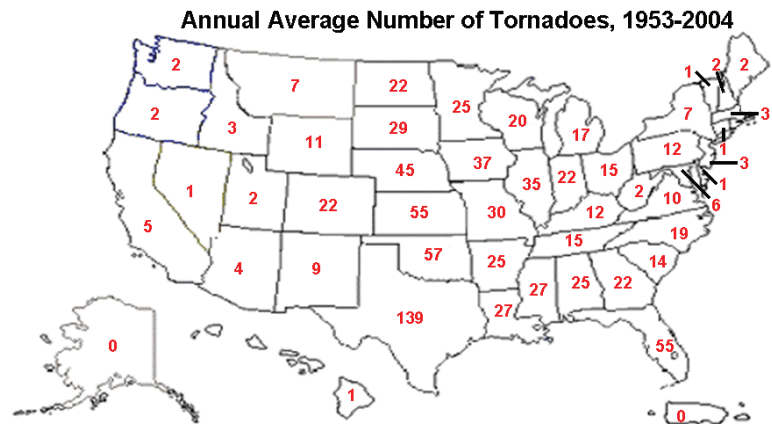
4.5.4 Frequency/Probability of Future Occurrence

In Adams County, there was one drought, one extreme heat event and no wildfires recorded from 1950 to 2006, according to the NCDC. The extreme heat event caused 13 deaths. There was no property damage or injuries recorded for either of the events.

According to the NCDC, Adams County has experienced one drought of significance in the past 56 years. The odds of future occurrences based on this information are less than 1% (.01). The Core Group concluded that this damage is not always recorded but still has a detrimental effect on the County. The Core Group also realized that, unlike other hazards such as flooding or tornadoes, there is little mitigation that can be preplanned to reduce the amount of agricultural damage caused by a drought.

4.6 TORNADOES

Tornadoes are produced from the energy released during a thunderstorm, but account for only a tiny fraction of the overall energy generated. What makes them particularly dangerous is that the energy is concentrated in a small area, perhaps only 100 yards across. Not all tornadoes are the same and science does not yet completely understand how a portion of a thunderstorm's energy becomes focused into something as small as a tornado. Tornadoes



occur mostly in the central plains of North America, east of the Rocky Mountains and west of the Appalachian Mountains. They occur primarily during the spring and summer – the tornado season comes early in the south and later in the north according to the seasonal changes in relation to latitude – usually during the late afternoon and early evening. They have been known to occur in every state in the United States and every continent on the earth, any day of the year, and at any hour. The damaging strong winds generated from tornadoes can reach 300 mph in the most violent tornadoes, causing automobiles to become airborne, ripping ordinary homes to shreds, and turning broken glass and other debris into lethal missiles. The biggest threat to living creatures, including humans, during tornadoes is flying debris and being tossed about in the wind. Contrary to previous belief, it is not true that the pressure in a tornado contributes to damage by making buildings "explode."

According to the NWS, the development of Doppler radar has made it possible, under certain circumstances, to detect tornadic winds with radar. However, spotters remain an important part

of the system to detect tornadoes, because not all tornadoes occur in situations where the radar can "see" them. Citizen volunteers comprise what is called the SKYWARN (www.skywarn.org) network of storm spotters, who work with their local communities to watch out for approaching tornadoes to ensure that appropriate action is taken during tornado events. Spotter information is relayed to the NWS, who operates the Doppler radars and issues warnings, usually relayed to the public by radio and TV, for communities ahead of the storms. The NWS utilizes all the information they can obtain from weather maps, modern weather radars, storm spotters, monitoring power line breaks, as well as additional sources for issuing tornado warnings.

Although the process by which tornadoes form is not completely understood, scientific research has revealed that tornadoes usually form under certain types of atmospheric conditions. Those conditions can be predicted, but it is not yet possible to predict in advance exactly when and where they will develop, how strong they will be, or precisely what path they will follow. According to the NWS, there are some "surprises" every year, when tornadoes form in situations that do not look like the right conditions in advance, but these are becoming less frequent. Once a tornado is formed and has been detected, warnings can be issued based on the path of the storm producing the tornado, but even these cannot be perfectly precise regarding who will, or will not, be struck.

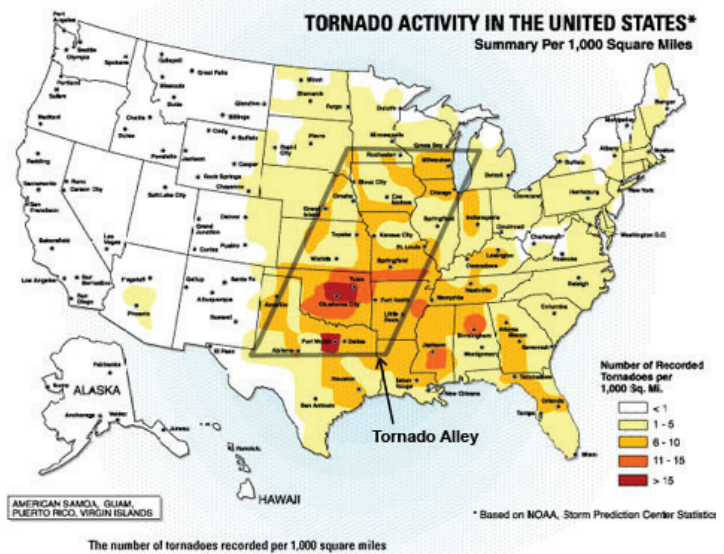


Table 4-5 shows that although the State of Ohio may not have the most tornadoes, those that do hit Ohio are significant in damage and have other indication factors of a large scale tornado.

Table 4-5

State Tornado Ranking

Rank	Total Number of Tornadoes	Deaths per 10,000 sq. miles	Number of Killer Tornadoes	Total Tornado Path Length per 10,000 sq. miles	Killer Tornadoes as a % of all Tornadoes	Annual Tornadoes per 10,000 sq. miles
1	Texas	Massachusetts	Texas	Mississippi	Tennessee	Florida
2	Oklahoma	Mississippi	Oklahoma	Alabama	Kentucky	Oklahoma
3	Florida	Indiana	Arkansas	Oklahoma	Arkansas	Indiana
4	Kansas	Alabama	Alabama	Iowa	Ohio	Iowa
5	Nebraska	Ohio	Mississippi	Illinois	Alabama	Kansas
6	Iowa	Michigan	Illinois	Louisiana	Mississippi	Delaware
7	Missouri	Arkansas	Missouri	Kansas	N. Carolina	Louisiana

8	Illinois	Illinois	Indiana	Indiana	Michigan	Mississippi
9	S. Dakota	Oklahoma	Louisiana	Nebraska	New York	Nebraska
10	Louisiana	Kentucky	Tennessee	Wisconsin	Massachusetts	Texas

Although the number of tornadoes in Ohio does not rank high compared to other states in the United States, the State does average around 14 tornadoes a year. Ohio's peak tornado season runs from April through July, with most tornadoes occurring between 2 p.m. and 10 p.m. Even though June has been the month with the most tornado occurrences, many of the State's major tornado outbreaks have taken place in April and May. However, history has shown that tornadoes can occur during any month of the year and at any time of the day or night. Tornadoes are considered the most violent atmospheric phenomenon on the face of the earth with their strength being measured by the Fujita Scale as described in Table 4-6. This scale is the mechanism used to determine the potential type of tornado that may have affected a particular community. It is based on velocity of wind and the type of damage the tornado caused. Many F0 and F1 tornadoes have touched down in Ohio, but Ohio has also been struck by some of the most destructive (F5) tornadoes ever, including the April 3, 1974 tornado which devastated Xenia, killing over 30 people and destroying 2,000 buildings.

Table 4-6

The Fujita Tornado Scale

Wind Speeds	Typical Effects
F0 Category Tornado	
40-72 mph	Gale Tornado. Light Damage: Some damage to chimneys; breaks twigs and branches off trees; pushes over shallow-rooted trees; damages signboards; some windows broken; hurricane wind speed begins at 73 mph.
F1 Category Tornado	
73-112 mph	Moderate Tornado. Moderate damage: Peels surfaces off roofs; mobile homes pushed off foundations or overturned; outbuildings demolished; moving autos pushed off the roads; trees snapped or broken.
F2 Category Tornado	
113-157 mph	Significant Tornado. Considerable damage: Roofs torn off frame houses; mobile homes demolished; frame houses with weak foundations lifted and moved; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
F3 Category Tornado	
158-206 mph	Severe Tornado. Severe damage: Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forests uprooted; heavy cars lifted off the ground and thrown; weak pavement blown off roads.
F4 Category Tornado	
207-260 mph	Devastating Tornado. Devastating damage: Well constructed homes leveled; structures with weak foundations blown off some distance; cars thrown and disintegrated; large missiles generated; trees in forest uprooted and carried some distance away.
F5 Category Tornado	
261-318 mph	Incredible Tornado. Incredible damage: Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 300 ft (100 m); trees debarked; incredible phenomena will occur.

4.6.1 Frequency/Probability of Future Occurrence

According to the NCDC, there were nine recorded tornadoes from 1950 to 2006 in Adams County. Of these nine events, only one did not cause any property damage, deaths or injuries. The eight remaining events caused \$515,000 in property damage, one death and no recorded injuries. The tornadoes that occurred in 1997 and 2002 each caused \$100,000 in property damages, while a tornado that occurred in 1979 caused \$250,000 in property damages. Adams County has had a significant history of tornado occurrences. On average, tornadoes occur in the County every six years. The probability of future tornadic events is high and the likelihood of severe damage based on past events is moderate. Adams County could expect to suffer even more severe damage if a tornado were to touch down in highly populated areas.

4.7 LANDSLIDES

A landslide is a geological phenomenon which includes a wide range of ground movement, such as rock falls, deep failures of slopes and shallow debris flow. Although gravity's action on an over-steepened slope is the primary reason for a landslide, there are other contributing factors affecting the original slope stability. Natural causes include erosion by rivers, rock and soil slopes weakened through saturation by snowmelt or heavy rains, earthquakes, groundwater pressure, and even thunder and lightning. Human causes include vibrations from machinery, road construction, blasting, stockpiling of rock or ore onto already weak slopes, mining, logging, and overgrazing.

4.7.1 Frequency/Probability of Future Occurrence

Due to the mountainous terrain of areas of Adams County, the potential for landslides is high. But due to the low population, landslides in Adams County tend to go unnoticed unless it affects a roadway or an inhabited area.

4.8 EARTHQUAKES

The problem with earthquakes are major earthquakes are a low probability, high consequence event. It is because of the potential high consequences that geologists, emergency planners and other government officials have taken a greater interest in understanding the potential for earthquakes in some of the areas of the eastern United States and educating the population as to the risk in their areas. Although there have been great strides in increased earthquake awareness in the eastern United States, the low probability of such events makes it difficult to convince most people that they should be prepared.

It is surprising to many Ohioans that the State has experienced more than 160 earthquakes since 1776, and that 15 of these events have caused minor to moderate damage. The largest historic earthquake in Ohio was centered in Shelby County in 1937. This event, estimated to have had a magnitude of 5.4 on the Richter scale, caused considerable damage in Anna and several other western Ohio communities, where at least 40 earthquakes have been felt since 1875. Northeastern Ohio, east of Cleveland, is the second most active area of the state. At least 20 earthquakes have been recorded in the area since 1836, including a 5.0 magnitude event in 1986 that caused moderate damage. A broad area of southern Ohio has experienced more than 30 earthquakes.

Although the New Madrid Line is in close proximity to the State of Ohio, there has not been an earthquake of any significance since 1875 caused by this fault line. An earthquake on June 18, 1975 caused damage in western Ohio, and affected a total area estimated at over 40,000 square miles. Walls were cracked and chimneys thrown down in Sidney and Urbana. The shock was felt sharply at Jeffersonville, Indiana. The affected area included parts of Illinois, Indiana, Kentucky and Missouri.

4.8.1 Monitoring of Earthquakes

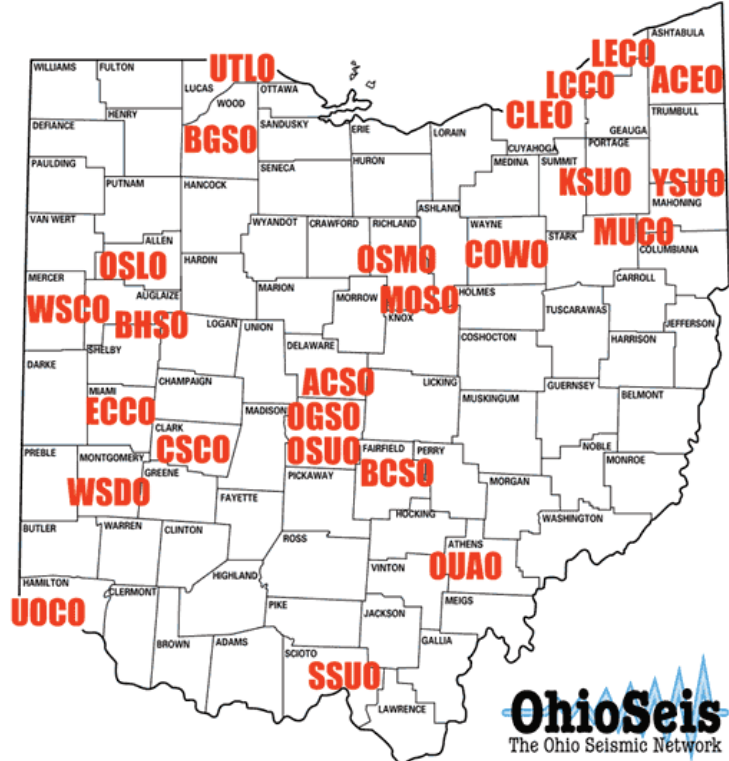
The ODNR Division of Geological Survey has established a 25 station cooperative network of seismograph stations throughout the State in order to continuously record earthquake activity. The network, which went on line in January 1999, ended a five-year gap during which there was only one operating station in Ohio. The State was dependent on seismographs in Kentucky and Michigan to record Ohio earthquakes.

The 25 stations of the new seismograph network, which is called OhioSeis, are distributed across the State, but are concentrated in the most seismically active areas or in areas that provide optimal conditions for detecting and locating very small earthquakes that are below the threshold of human notice. These small micro earthquakes are important because they occur more frequently and help to identify the location of faults that may periodically produce larger, potentially damaging earthquakes.

The OhioSeis seismograph stations are located at colleges, universities and other institutions, employing new technology that not only makes them very accurate, but also relatively inexpensive and easy to operate and maintain. In contrast to the old technology, in which a pen made a squiggly line on a paper drum, the new system is entirely digital and uses a desktop computer to continuously record and display data. Two other innovations have made the system unique. An inexpensive Global Positioning System (GPS) receiver is used to keep very precise time on the continuously recorded seismogram, and each station's computer is connected to the Internet for rapid data transfer.

Each OhioSeis station is a cooperative effort. Seismometers, the instrument that detects Earth motions, and other seismic components were purchased by the Division of Geological Survey with funds provided by FEMA through the OEMA, as part of the National Earthquake Hazards Reduction Program. The computers and Internet connection were purchased and provided by the cooperating institutions.

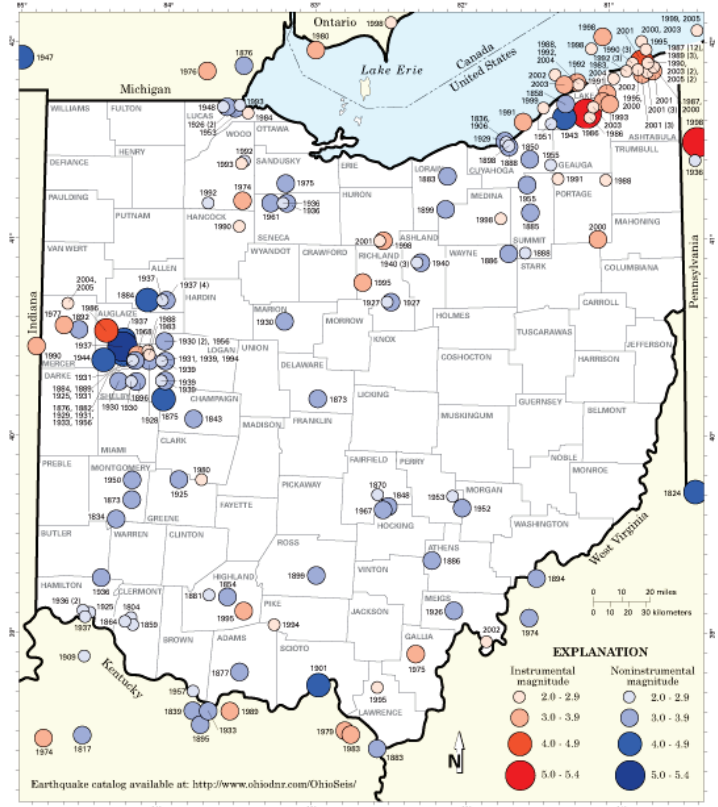
The Division of Geological Survey is coordinating the seismic network and has established the Ohio Earthquake Information Center at the Horace R. Collins Laboratory at Alum Creek State Park, north of Columbus. This facility functions as a repository and laboratory for rock core and well cuttings, but has a specially constructed room for earthquake recording. The seismograph system allows for very rapid location of the epicenter and calculation of the magnitude of any



earthquake in the State. The earthquake records, or seismograms, from at least three seismograph stations are needed to determine earthquake locations (epicenters). These records can be downloaded from the internet at any station on the network, and location and magnitude can be determined. Small earthquakes were in many cases not even detected by distant, out-of-date seismograph stations.

The OhioSeis network provides a whole new dimension of understanding about the pulse of the Earth beneath Ohio. Although the new seismograph network will not predict earthquakes or provide an alert prior to an event, it will provide insight into earthquake risk in the State so that intelligent decisions about building and facility design and construction, insurance coverage and other planning decisions can be made by individuals, business and industry, and governmental agencies.

According to historical records, the risk in Adams County's seismic zone is low. Though Adams County may have had earthquake tremors in the past, the natural geology lends itself to stable conditions if an earthquake were to occur.



4.8.2 Frequency/Probability of Future Occurrence

According to the ODNr OhioSeis Division, only one 1877 epicenter was recorded from 1804 to 2006 in Adams County. However, scientists speculate that the New Madrid Fault line, which runs in close proximity to the State of Ohio, has a high probability of activity within the next 50 years. These earthquakes will probably register low on the Richter scale and be of insignificant detriment. Based on historical occurrences of earthquakes in Adams County, the odds of an earthquake occurring are minimal.

4.9 OTHER HAZARDS

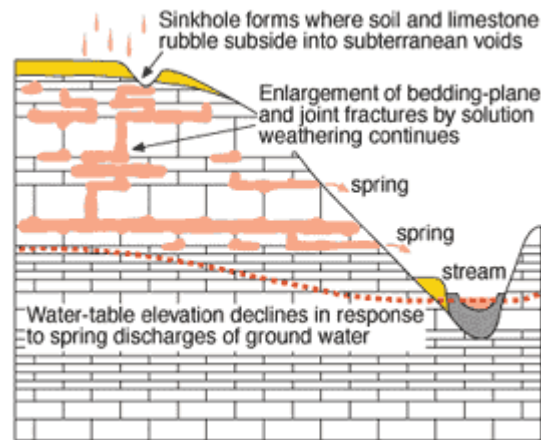
4.9.1 Karst Topography

Karst topography is a landform that develops on or in limestone, dolomite or gypsum by dissolution and is characterized by the presence of characteristic features such as sinkholes, underground (or internal) drainage through solution-enlarged fractures (joints) and caves. Approximately 10% of Earth's continents, including about 20% of the United States (not including Alaska or Hawaii), are underlain by karst-modified bedrock. The greatest

concentration of karst terrain and karst features is in Florida, where the entire state is underlain by karst-forming carbonate bedrock.

Nearly one-third of Ohio is directly underlain by Ordovician, Silurian and Devonian carbonate bedrock that has the potential for karst areas to develop. This potential is confirmed by the fact that solution-enlarged fractures are visible in the highwalls of most of the state's limestone and dolomite quarries. Even so, less than 2% of the Ohio landscape includes karst terrain. The percentage is low because most near-surface carbonate bedrock in Ohio is covered with a thick mantle of glacial deposits which greatly impede or preclude active karst-forming processes. In addition, the abrasive work of Ice Age glaciers is believed to have destroyed much of the karst terrain that had developed in Ohio prior to glaciation.

While karst landforms and features are commonly striking in appearance and host to some of Ohio's rarest fauna, they also can be a significant geologic hazard. Sudden collapse of an underground cavern or opening of a sinkhole can cause surface subsidence that can severely damage or destroy any overlying structure such as a building, bridge or highway. Improperly backfilled sinkholes are prone to both gradual and sudden subsidence, and similarly threaten overlying structures. Sewage, animal wastes, and agricultural, industrial and ice-control chemicals entering sinkholes as surface drainage are conducted directly and quickly into the groundwater system, thereby posing a severe threat to potable water supplies.



First line formation of sinkholes on Karst topography.
Source: ODNR Division of Geological Survey

According to the ODNR Division of Geological Survey, Adams County contains the largest and most dense area of karst topography in the state. Nearly the entire County except for its eastern edge contains karst topography.

4.9.2 Dam Safety

Dam failures are often referred to as disasters. By definition, a disaster is any event that causes great harm or damage, serious or sudden misfortune. Because of the rapid and unexpected manner in which dam failures can occur, they are classified in the same general magnitude as earthquakes and tornadoes.

Because of the dams existing upstream of Adams County, the Core Group chose to discuss dam safety in this Mitigation Plan.

4.9.2.1 Dams in Ohio

A dam is an artificial barrier usually constructed across a stream channel to impound water. Timber, rock, concrete, earth, steel or a combination of these materials may be used to build the

dam. In Ohio, most dams are constructed of earth. Dams must have spillway systems to safely convey normal stream and flood flows over, around, or through the dam. Spillways are commonly constructed of non-erosive materials such as concrete. Dams also have a drain or other water-withdrawal facility to control the pool or lake level and to lower or drain the lake for normal maintenance and emergency purposes.

Most dams in Ohio are small and are constructed by farmers and other private individuals for water supply, recreation, swimming and fishing. Numerous other, usually larger, dams are built by cities and industry to form reservoirs for water supply or liquefied waste storage. Ownership of dams is diverse and maintained by both public and private interests. The federal government owns and operates over 30 dams for flood control, recreation and water supply. The state of Ohio has more than 100 dams, primarily located instate park and wildlife areas for recreational purposes. Flood control and some water supply are provided by dams owned by watershed conservancy districts. The oldest dams in Ohio were constructed over 150 years ago to create water supply reservoirs for a network of navigational canals. Buckeye Lake Dam, built in about 1825 as part of the canal system and located in Licking and Fairfield counties, is the oldest dam in the state. The highest dam in Ohio is located in Jefferson County and is 240 feet high.

4.9.2.2 History of Dam Safety in Ohio

Construction of dams in Ohio dates back to the early 1800s when reservoirs such as Buckeye Lake and Grand Lake St. Marys were built to supply water to the canal system, which provided a means of transportation for agricultural trade and commerce. Dam construction continued at a modest pace for about the next 100 years with relatively few dams built by private entities. In the early part of the nineteenth century, several large municipally-owned dams and reservoirs were built for public water supply. Severe floods also prompted the formation of conservancy districts which constructed dams for flood control.

Although the true forerunner of current dam safety laws in Ohio was enacted in 1963, legislation pertaining to the construction of dams was enacted as early as 1937. This early set of laws aimed to encourage construction of dams for the storage of water in response to recent drought periods in Ohio and the "dust bowl" days on the Great Plains. The regulatory agency responsible for the enforcement of these early laws was the Division of Conservation and Natural Resources in the State Department of Agriculture. Due to the availability of large earthmoving equipment after World War II, Ohio saw a significant increase in the number of dams built by individuals and private companies. Although the water storage and recreational capabilities provided by these dams were important benefits, concern about the adequacy of design and construction was prompted by the loss of life and property damage resulting from dam failures, which led to a greater interest in dam safety.

The ODNR's Division of Water has been involved in dam safety since 1963. During this year, the first Ohio law requiring construction permits for building new dams was enacted. In addition, following the failure of several dams in northeast Ohio during the severe flood of 1969, the General Assembly revised the law to include periodic inspections of existing structures. Inspections were required to help assure that the continued operation and use of a dam, dike or levee does not pose a hazard to life, health, or property. In 1972, the failure of Buffalo Creek Dam in West Virginia, which caused great loss of life and severe property damage, led to the enactment of the National Dam Safety Act. This law, administered by the Corp of Engineers, called for an inventory of dams in the United States and the inspection of those dams that could create the most hazards if they failed. The Corps contracted with the Division of Water to inventory roughly 4,500 non-federal dams in Ohio.

4.9.2.3 Classification of Dams in Ohio

According to Ohio Administrative Code Rule 1501:21-13-01, dams are classified as follows:

Class I: A dam shall be placed in Class I when failure of the dam would result in probable loss of human life. Dams having a storage volume greater than 5,000 acre-feet or a height of greater than 60 feet shall be placed in Class I.

Class II: Dams having a storage volume greater than 500 acre-feet or a height of greater than 40 feet shall be placed in Class II. A dam shall be placed in Class II when failure of the dam would result in at least one of the following conditions, but loss of human life is not envisioned:

- (a) Possible health hazard, including but not limited to, loss of a public water supply or wastewater treatment facility.
- (b) Probable loss of high-value property, including but not limited to, flooding of residential, commercial, industrial, publicly owned, and/or valuable agricultural structures, structural damage to downstream Class I, II, or III dams, dikes or levees, or other dams, dikes or levees of high value.
- (c) Damage to major roads, including but not limited to, interstate and state highways and roads which provide the only access to residential or other critical areas such as hospitals, nursing homes or correctional facilities as determined by the Chief of ODNR's Division of Water.
- (d) Damage to railroads, or public utilities.

Class III: Dams having a height of greater than 25 feet, or a storage volume of greater than 50 acre-feet, shall be placed in Class III. A dam shall be placed in Class III when failure of the dam would result in at least one of the following conditions, but loss of human life or hazard to health is not envisioned.

- (a) Property losses, including but not limited to, rural buildings not otherwise listed as high-value property in paragraph (A) of this Rule and Class IV dams, dikes and levees not otherwise listed as high-value property in paragraph (A) of this Rule. At the request of the dam owner, the Chief of ODNR's Division of Water may exempt dams from the criterion of this paragraph if the dam owner owns the potentially affected property.
- (b) Local roads including but not limited to roads not otherwise listed as major roads in paragraph (A) of this rule.

Class IV: When failure of the dam would result in property losses restricted mainly to the dam and rural lands, and not loss of human life or hazard to health is envisioned, the dam may be placed in Class IV. Dams which are twenty-five feet or less in height and have a storage volume of fifty acre-feet or less, may be placed in Class IV. No proposed dam shall be placed in Class IV unless the applicant has submitted the preliminary design report required by Rule 1501:21-5-02 of the Administrative Code. Class IV dams are exempt from the permit requirements of Section 1521.06 of the Revised Code pursuant to paragraph (A) of Rule 1501:21-19-01 of the Administrative Code. (www.dnr.ohio.gov/water/dsafety/whatdam.htm)

There are more than 50,000 dams identified in Ohio. A great majority of these dams are small and do not fall under the jurisdiction of Ohio's Dam Safety Laws. The number of dams, which fall under state law jurisdiction number as of April 2000 and their classifications are as follows:

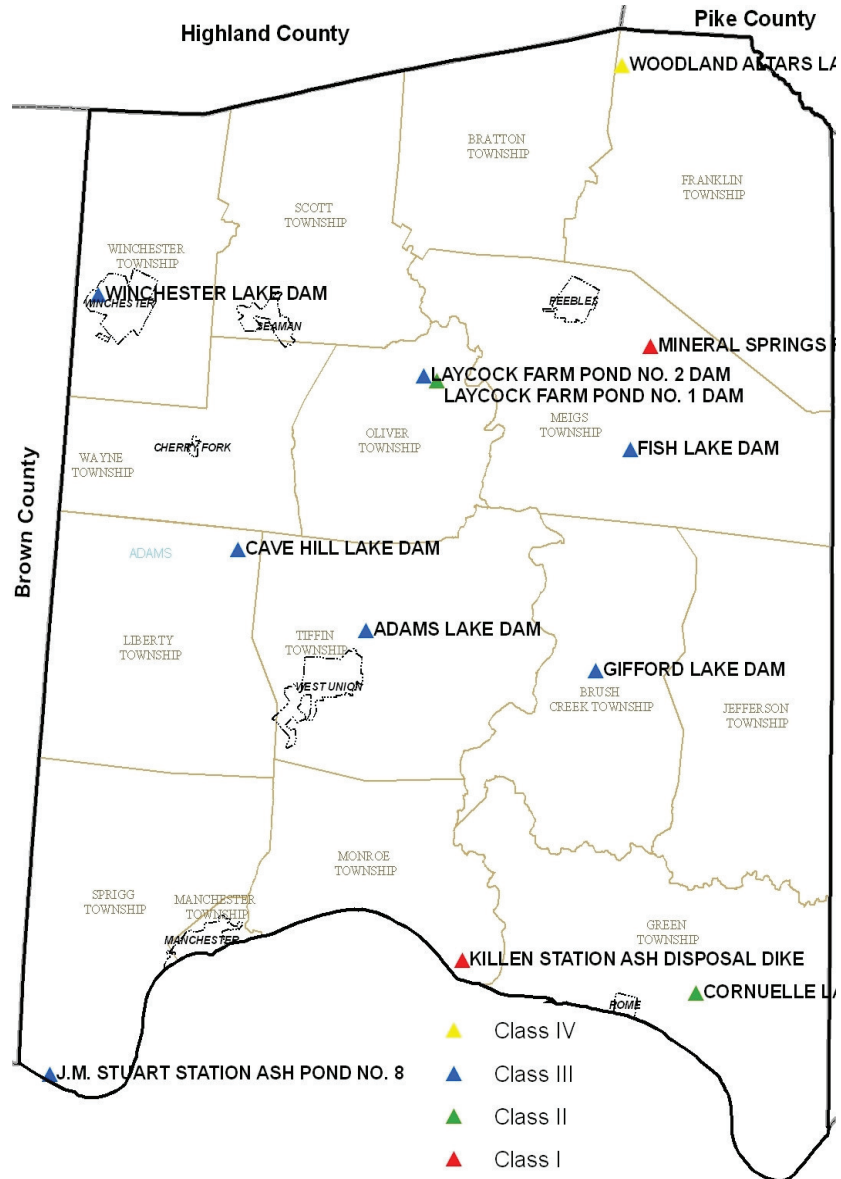
- Class I Dams - 499

- Class II Dams - 539
- Class III Dams - 704
- Class IV Dams – 952

According to the ODNR, Adams County has 11 dams within its boundaries. The number of dams and their classifications are as follows:

- Class I - 2
- Class II - 2
- Class III - 7
- Class IV – 1

There are potential problem areas as they relate to dam failure in Adams County. The Class I Dams located in the County are the Killen Generating Station Ash Disposal Dike which is located in Manchester along the Ohio River and the Mineral Springs Resort Lake Dam located in Peebles. Damage caused by failure of the Killen Generating Station Dike would likely be minimal due to its proximity to the Ohio River, but failure of the Mineral Springs Resort Lake Dam could affect parts of northeastern Meigs and southern Franklin townships. The other dam with large volume capacity is the Class III J.M. Stuart Station Ash Pond No. 8, located in the southwest corner of the County along the Ohio River. However, failure would likely cause minimal damage due to its proximity to the Ohio River.



Due to the hilly terrain of the County, failure of any dam would likely restrain damage to the lowest-lying valleys downstream, while higher ground would likely be safe from damage. However, the steepness of the valleys creates the potential for fast-moving waters which could wreak havoc where flooding does occur.

4.9.2.4 Frequency/Probability of Future Occurrence

Adams County does not have a significant history of dam failure. The State of Ohio Dam Safety Program is in place to monitor and provide dam owners in Adams County pertinent information to support their dam's maintenance requirements. The Dam Safety Program regulates the construction, operation and maintenance of Ohio's dams, dikes and levees to protect life and

property from damages due to failure. This regulation is accomplished through periodic inspection, new dam construction permits and regulation of improvements, maintenance and operation of existing dams. The probability of future dam failure occurrences is quite low. However, the likelihood of severe damage if a Class I or potentially a Class II Dam were to fail is determined on a case by case basis.

4.9.3 Well Field Dependency

Drinking water within the County is supplied by private wells and two municipal water treatment plants located in Manchester. The County's largest public water system is the Adams County Regional Water District (ACRWD), which uses eight groundwater wells for its supply. The eight wells are drilled about 75 feet deep into the Ohio River Valley Aquifer. The well field is situated on the south side of US 52 and just west of the Wrightsville area. The other public water system in Adams County is the Village of Manchester which is supplied by three groundwater wells.

4.9.3.1 Well Field Contamination

A recent study was completed by the Ohio EPA of Adams County Regional Water District. The study identifies potential contaminant sources and provides guidance on protecting the drinking water source. According to this study the Ohio River Valley Aquifer, from which ACRWD obtains its water, has a high susceptibility to contamination. This determination is based on the following:

- Lack of a protective layer of clay overlying the aquifer.
- Shallow depth of the aquifer.
- Presence of significant potential contaminant sources in the area

4.9.3.2 Frequency/Probability of Future Occurrence

This susceptibility means that under current existing conditions, the likelihood of the aquifer becoming contaminated is relatively high. This likelihood can be minimized by implementing appropriate protective measures. Some measures that can be utilized are as follows:

- Check your septic system and make sure it is always working properly.
- Dispose of all oil and petroleum products the proper way.
- Keep all junk piles cleaned up as runoff from these can contaminate the source water.
- Maintain vehicles so leaks will not contaminate the source water.
- Report to the Water District anything that looks questionable.

4.9.3.3 Well Field Exhaustion

If a well field is drawn upon faster than water can be cyclically replaced, the well field may become exhausted and dry up. Since Adams County's sole source of water is from wells, exhaustion has the potential to cause serious problems for its citizens and various industries.

4.10 Significant Events

Significant events pertaining to Adams County were chosen by evaluating the NCDC tables that listed hazards in Adams County that have produced the largest amount of damage based on human or monetary measures. The Core Group also used the collective knowledge they had coupled with the vast amount of local experience and history to determine which events they considered significant.