Chapter 3: Hazard Identification and Risk Assessment

The second phase of the planning process is to develop a hazard analysis and risk assessment. In this chapter we identify the hazards that could affect Clarke County and assess the relative risk to the county and its jurisdictions using various criteria. Before a community can assess the on-going mitigation activities, evaluate mitigation measures that should be undertaken, or outline a strategy for implementing mitigation projects, it must be aware of those hazards that, if they occur, could harm the community.

This chapter addresses the following statutory parts of the Stafford Act and parts of the mitigation planning process:

- Hazard identification
- Hazard Profile
- Risk assessment (assets at risk)
- Loss estimation
- Development trends (future properties at risk)

Hazard analysis and risk assessment answers the following fundamental question: What hazards can occur and what would happen if a hazard event occurred in our community? Hazard analysis and risk assessment is the process of measuring the potential loss of life, injury, economic loss, and property loss resulting from hazards. Further, a risk assessment teaches us:

- The hazards to which your community is susceptible;
- What these hazards can do to physical, social, and economic assets;
- What areas are most vulnerable to damage from these hazards; and
- The resulting costs of damages or costs avoided through future mitigation activities.

The hazard analysis identifies potential hazards that could affect Clarke County and the various jurisdictions in the county for the purposes of mitigation planning. It is important to note the focus of mitigation is on reducing long-term risks of damage or threats to public health and safety caused by hazards and their effects. Thus, in some cases, the hazards identified for mitigation will not necessarily include all of or the same hazards identified for preparedness, response, or recovery.

The risk assessment identifies how people, properties, and structures will be damaged by the event. If the hazard can harm people or damage their homes and other structures, they are vulnerable. Finding the weak points in the system, for example, identifying building types that are vulnerable to damage and anticipating the loss in high risk areas will help the community decide what mitigation measures should be undertaken and how to implement the activities they select.

The risk assessment for Clarke County and participating jurisdictions followed the methodology described in the 2013 FEMA *Local Mitigation planning Handbook*, which includes a four-step process:

- Step 1—Describe Hazards
- Step 2—Identify Community Assets
- Step 3—Analyze Risks
- Step 4—Summarize Vulnerability

This chapter is divided into six main parts:

- **Section 3.1 Hazard Identification** identifies the hazards that threaten the planning area and the rationale for acceptance and elimination of hazards from further consideration;
- **Section 3.2 Assets at Risk** provides the planning area's total exposure to hazards, considering critical facilities and other community assets at risk;

- **Section 3.3 Development Since Previous Plan Update** provides information relative to development that has occurred since the previous plan update for each jurisdiction;
- **Section 3.4 Future Land Use and Development** discusses areas of planned future development;
- **Section 3.5 Hazard Profiles and Vulnerability** analyzes each hazard and its effects. The methodology utilized to score or rank the hazards is outlined. For each hazard, this section is divided into two parts: 1) Hazard Profile discusses the threat to the planning area, the geographic location/extent at risk, previous occurrences of hazard events, and probability of future occurrence; and 2) Vulnerability Assessment further defines and quantifies populations, buildings, critical facilities, and other community assets at risk to natural hazards;
- **Section 3.6 Risk Assessment Summary** provides a tabular summary of the hazard ranking for each jurisdiction, an annual loss estimation, and a consequence analysis for the hazards that have potential impact on the planning area. This section also includes a series of risk assessment issue or problem statements.

3.1: Hazard Identification

Clarke County used the State of 2018 Iowa Hazard Mitigation Plan as the basis for the list of hazards the County's mitigation planning team considered for discussion. The Clarke County planning team did not add to this list. FEMA requires that all natural hazards be studied in the mitigation plan. However, the planning team recognized the need for and importance of planning for other hazards also identified in the State plan.

This part of the plan addresses the following Stafford Act requirement:

Section 201.6(c)(2)(i): [The risk assessment shall include a] description of the type … of all natural hazards that can affect the jurisdiction.

For this assessment, the following definitions are used for each natural hazard to be considered:

Dam/Levee Failure: the uncontrolled release of water resulting from a structural failure in a dam, wall, dike, berm, or area of elevated soil that causes flooding.

Drought: a period of prolonged abnormally-low precipitation producing severe dry conditions.

Earthquake: Any shaking or vibration of the earth caused by the sudden release of energy that may impose a direct threat on life and property.

Expansive Soils: Soils and soft rock that tend to swell or shrink excessively due to changes in moisture content.

Extreme Heat: Summertime weather that is substantially hotter and/or more humid than average for a location at that time of year.

Flood - Flash: A flood event occurring with little or no warning where water levels rise at an extremely fast rate.

Flood - River: A temporary condition of partial or complete inundation of normally dry land areas from the overflow of stream banks.

Grass or Wildland Fire: An uncontrolled fire that threatens life and property in either a rural or wooded area.

Landslide: A downward and outward movement of slope-forming materials reacting under the force of gravity.

Severe Winter Storm: Severe winter weather conditions that affect day-to-day activities. These can include blizzard conditions, heavy snow, blowing snow, freezing rain, heavy sleet, and extreme cold.

Sinkhole: The loss of surface elevation due to the removal of subsurface support.

Thunderstorm, Hail, and Lightning: Atmospheric imbalance and turbulence that may result in thunder, heavy rains (which may cause flash flooding), and strong winds reaching or exceeding 58 mph resulting in tornadoes, or surface hail of at least 1 inch in diameter, and lightning.

Tornado/Windstorm: A violent, destructive, rotating column of air taking the shape of a funnel-shaped cloud that progresses in a narrow, erratic path. Windstorms are extreme winds associated with severe winter storms, severe thunderstorms, downbursts, and very steep pressure gradients.

For this assessment, the following definitions are used for each "man-made" hazard to be considered:

Animal/Plant/Crop Disease: An outbreak of disease transmitted from animal to animal or plant to plant.

Hazardous Materials Incident: Encompassing fixed hazardous materials, pipeline transportation, and transportation of hazardous materials, this can include the accidental release of flammable or combustible, explosive, toxic, noxious, corrosive, oxidizable, irritant, or radioactive substances or mixtures that can pose a risk to life, health, or property, possibly requiring evacuation.

Infrastructure Failure: Encompassing a variety of occurrences, including communication failure, energy failure, structural failure, and structural fire, this includes an extended interruption, widespread breakdown, or collapse (part or all), of any public or private infrastructure, that threatens life and property.

Pandemic Human Disease: One that is prevalent over a whole country, region, continent, or world.

Radiological Incident: An occurrence resulting in a release of radiological material at a fixed facility or in transit.

Terrorism: Encompassing a wide variety of human-caused threats including enemy attack, biological terrorism, agroterrorism, chemical terrorism, conventional terrorism, cyber terrorism, radiological terrorism, and public disorder, this includes the use of multiple outlets to demonstrate unlawful force, violence, and/or threat against persons or property causing intentional harm for purposes of intimidation, coercion, or ransom in violation of the criminal laws of the United States.

Transportation Incident: Encompasses air transportation, highway transportation, railway transportation, and waterway incidents, a transportation incident is described as an accident involving any mode of transportation that directly threatens life, property damage, injury, or adversely impacts a community's capabilities to provide emergency services.

Please note that the above definitions have changed slightly in some cases since the previous Clarke County HMP was approved in 2014.

Past Presidential Disaster Declarations Involving Clarke County

The following details the Iowa Presidential declarations since 1990 through February 2021 that included Clarke County, or in some cases when counties impacted are not known.

Figure 3.1: Past Federal Declarations of Major Disaster Involving Clarke County

Event	Declaration #	Year	General Impact
Iowa COVID-19 Pandemic	Federal DR-4483-IA	2020	COVID Emergency – Public and Individual Assistance
Iowa COVID-19	Federal 3480-EM	2020	COVID Emergency – Public Assistance
Severe storms, tornadoes, straight-line winds, and flooding	Federal, 4181	2014	Clarke County Public Assistance
Severe storms, flooding, and tornadoes	Federal, 1930	2010	Clarke County Public Assistance
Severe storms, tornadoes, and flooding	Federal, 1763-DR	2008	Clarke Co. Public and Individual Assistance
Severe storms, tornadoes, and flooding	Federal, 1763-DR	2008	Clarke Co. Public and Individual Assistance
Severe winter storm (ice storm)	Federal, 1737-DR	2008	Clarke County Public Assistance
Severe storms, flooding, and tornadoes	Federal, 1705-DR	2007	Clarke County Public Assistance
Hurricane Katrina (Emergency Dec.)	Federal	2005	All counties, funds to evacuees
Severe storms, flooding, and tornados	Federal, 1230-DR	1998	Clarke County Individual Assistance
Severe snow storm	Federal	1997	Clarke Co. Public and Individual Assistance
Flooding, severe storm (2nd event of yr.)	Federal	1993	Information not available by county
Flooding, severe storm (1st event of yr.)	Federal	1993	Information not available by county
Flooding, severe storm	Federal	1992	Information not available by county
Ice Storm	Federal	1991	Information not available by county
Flooding, severe storms	Federal	1991	Information not available by county
Flooding, severe storm (2nd event of yr.)	Federal	1990	Information not available by county
Flooding, severe storm (1st event of yr.)	Federal	1990	Information not available by county

Source: www.fema.gov , March 2021

Since 1964, Clarke has had an average to below average number of Presidential declarations for the county size and population area.

Obviously, the types of hazards that can affect Clarke County include all those in which FEMA assistance was given, but many other hazards have occurred and affected the county.

Potential Hazards in Clarke County – Initial Hazard Screen

The initial hazard screen is an initial review process to determine what kind of information is available about each potential hazard and then a determination of the potential for the hazard to occur in the future, based on the various official and anecdotal data sources. Hazards are identified as either: a) has occurred, b) can occur but has not occurred, or c) cannot occur.

Figure 3.2: Initial Hazard Screen Matrix

Hazard	Where Information Was Found, Planning Team Comments	Has Occurred	Can Occur	Cannot Occur
	Natural Hazards			
Dam/Levee Failure	2018 State Mitigation Plan, Watershed maps, Conservation Board, and the planning team states it can happen at the various smaller to mid-sized earthen public and private dams in and upstream of county, which are not often inspected. Several large lakes exist in the county and all are inspected regularly. This event can occur in some jurisdictions. The planning team knows of no levees. Agricultural terraces can and do fail, impacting cropland only with no long-term damages.		X	
Drought	2018 State Mitigation Plan, USDA websites, past disaster declarations, local news media, consultant personal experience, planning team indicates droughts are common and affect rural farmland areas severely.	X		
Earthquake	2018 State Mitigation Plan, geological and seismic maps, maps of past events. Minor tremors have been noted in the County in the late 1980s. Epicenters of minor quakes have occurred 125 miles southwest in Fremont County (Iowa) and 225 miles east near Davenport. Events have been limited with minimal felt effects.	X		
Expansive soils	2018 State Mitigation Plan, soils maps, USDA and USGS websites, small areas of expansive soils have occurred in a widespread area in the county due to clay soils, the planning team reports. Officials serving the rural area and many of the towns report this event has happened. Many basements have been impacted, including cracks and shifting foundations.	X		
Extreme heat	2018 State Mitigation Plan, federal storm data sources, NWS, Weather Channel, local news media, consultant personal experience, and planning team comments. Excessive heat occurs at least once most summers.	X		
Flood - Flash	2018 State Mitigation Plan, past disaster declarations, county/city surveys, federal storm data sources, consultant personal experience, planning team, and local news media. Flash flooding is found in most areas of the county after the heaviest of rains. Some areas have common events. Undersized infrastructure is the main concern or problem, with topography a close second. Most jurisdictions report past events and the remaining indicate potential events.	X		
Flood - River	2018 State Mitigation Plan, federal storm data sources, FIRM maps, past disaster declarations, city/county surveys, consultant personal experience, watershed maps, and planning team comments. Flooding can and has occurred in rural areas and several jurisdictions. The entire county is mapped.	X		
Grass and wildland fire	2018 State Mitigation Plan, local news media, fire dept. reports, planning team, city/county surveys. The team indicates that small grass and forest fires occur during dry seasons annually. Most jurisdictions report past events and most others indicate potential events.	X		
Landslide	2018 State Mitigation Plan, city/county surveys, planning team, soils maps, county engineer, and conservation staff. Landslides have affected properties along road and rail cuts and have affected utilities and roadside ditches.	X		
Severe winter storm	2018 State Mitigation Plan, federal storm data sources, past disaster declarations, local news media, Weather Channel, NWS, consultant personal experience, planning team. Heavy snow, ice storms, and/or severe wind chills occur most winters.	X		
Sinkhole	2018 State Mitigation Plan, USGS, maps of past mining and caverns, city/county surveys, planning team. After review of data, planning team indicates sinkholes can occur in several jurisdictions. Mining is not common in the past, but installation of infrastructure can result in small-scale incidents. Filled in wells have collapsed with no warning.	X		

Hazard	Where Information Was Found, Planning Team Comments	Has Occurred	Can Occur	Cannot Occur
Thunderstorm, hail, lightning	2018 State Mitigation Plan, federal storm data sources, Weather Channel, NWS, local news media, past disaster declarations, consultant personal experience, and planning team. Thunderstorms that are deemed severe by the NWS occur almost every year, usually many times per year. Large hail has occurred in all areas of the county and can occur in all seasons.	X		
Tornado/windstorm	2018 State Mitigation Plan, federal storm data sources, Weather Channel, NWS, local news media, past disaster declarations, consultant personal experience, and planning team. Tornados of EF0-EF2 occur most years in the county and EF3 and larger have occurred. Warnings and sighting have occurred in all jurisdictions but not necessary all jurisdictions have been directly hit. Straight-line winds have exceeded 70 MPH, causing extensive damage in the county. Sustained winds above 40 MPH over many hours during fair weather can cause significant damage to unsecured property and traveling vehicles.	X		
Man-made and Combination Hazards				
Animal/crop/plant disease	2018 State Mitigation Plan, local news media, Iowa Dept. of Public Health website, Iowa State Extension website, USDA website, planning team. Team members indicated no major outbreaks but remain concerned over oncoming diseases and pests.	X		
Hazardous materials incident	2018 State Mitigation Plan, local news media, Iowa DNR contaminated sites website, Iowa Utilities Board website, chemical and pipeline company websites, Iowa DOT website, DOE website, EPA Tier II facility maps, planning team, first responders, planning team. Events have occurred in Osceola and various rural areas and can occur in other jurisdictions because of sewer lagoons, factories, and agricultural facilities as well as transportation of extensive volumes of agricultural chemicals. Osceola and other parts of Clarke County have been impacted by relatively minor cuts in gas lines.	X		
Infrastructure failure	2018 State Mitigation Plan, Iowa DOT website, communications system map, energy systems maps, utility company websites, Iowa Utilities Board, city/county surveys, planning team, first responders and fire department reports, visual survey of building condition, assessor's data on age of buildings. Some buildings and structures have collapsed, mostly on a small scale. There have been no sudden major failures. Communications failures have been scattered and mostly short-term. Energy failures due to things like ice storms have lasted multiple days. Structural fires occur at least a dozen times a year throughout the county.	X		
Pandemic human disease	2018 State Mitigation Plan, Iowa Dept. of Public Health website, Clarke Co. Public Health, regional TV stations, planning team, CDC. Public Health reports H1N1 impacts in 2009-10 and COVID hit the county considerably in 2020-21.	X		
Radiological incident	2018 State Mitigation Plan, IDPH and EPA websites, planning team. There are no appreciable radiological sites identified in the county; the hospital and clinics present very small risk. An incident can occur but should be controlled quickly with no significant effect on people and properties outside of where it occurs. The BNSF Railway and I-35 have occasional shipments.		X	
Terrorism	2018 State Mitigation Plan, DHS website, USDA website, DHS website, EPA website, communications websites, news media, planning team. After review of data, relatively minor events, mostly threats that were not carried out, have occurred of the biological and conventional types. Cyber terrorism is difficult to identify, but breaches of wider systems (not directly targeting the county) have impacted the county. Public disorder nearing a riot occurred in the 1940s.	X		
Transportation incident	2018 State Mitigation Plan, IDOT crash data, IDOT and FAA airplane data, BNSF Railway website, planning team, first response agencies, and local news media. With the Interstate and other highways, events occur requiring extensive response and road closures each year. Several jurisdictions have had incidents. I-35 and US Highway 34 pass through the heart of the county and have high traffic volumes. Crashes sometimes involving multiple cars occur each year. The BNSF mainline and Amtrak travel through the county. All cities are at risk. There are an estimated 30 to 50 trains per day on this line, including two daily Amtrak passenger trains. People have drowned in waterway incidents. Several Clarke County water bodies are popular in all seasons for fishing, swimming, and boating.	X		

Figure 3.3 shows the survey results of an online public survey in which 18 members of the public were asked about their personal level of concern over each of the following hazards. The following are the results.

Figure 3.3: Planning Team and Public Concern Over Various Hazards

Hazard	Very concerned	Significantly concerned	Moderately concerned	Unconcerned
Dam/Levee Failure	1	0	6	**11**
Drought	3	6	**8**	1
Earthquake	0	0	1	**17**
Expansive soils	0	0	8	**10**
Extreme heat	1	2	**9**	5
Flood – flash	1	5	**7**	5
Flood – river	0	1	3	**14**
Grass and wildland fire	1	**7**	**7**	3
Landslide	0	0	0	**18**
Severe winter storm	4	**11**	2	1
Sinkhole	1	0	4	**13**
Thunderstorm, hail, lightning	2	**8**	7	1
Tornado/windstorm	4	**8**	6	0
Animal/plant/crop disease	Not asked	Not asked	Not asked	Not asked
Hazardous materials incident	0	2	7	**8**
Infrastructure failure	4	**8**	5	1
Pandemic human disease	Not asked	Not asked	Not asked	Not asked
Radiological incident	Not asked	Not asked	Not asked	Not asked
Terrorism	Not asked	Not asked	Not asked	Not asked
Transportation incident	3	6	**8**	1

Overall, the surveyed public was not overly concerned about these hazards, with no more than 4 people giving a "very concerned" rating for any hazards. Several hazards, such as earthquake, river flood, landslide, and sinkhole have overall very little concern. Severe winter storm, tornado/windstorm, and infrastructure failure garnered the most concern. It should be noted that the survey occurred in January and February, when severe winter conditions were occurring.

Clarke County Hazard Identification by Jurisdiction

Based on the above results, the planning team has used various data sources to determine in which participating or other government jurisdiction the various hazards have occurred, might occur, and will not occur. Note that this table considers whether the hazard can occur within the jurisdiction and does not consider the potential that hazards occurring outside of a jurisdiction may impact the jurisdiction in question.

Figure 3.4: Potential Hazards by Jurisdiction (Y = occurred, P = can occur, N = cannot occur)

Hazard	**Rural Clarke Co.**	**Murray**	**Osceola**	**Woodburn**	**Clarke Schools**	**Murray Schools**	**Southwestern Comm. College**	**Clarke Co. Hospital**
Natural Hazards								
Dam/Levee Failure	P	N	P	N	N	N	N	N
Drought	Y	Y	Y	Y	Y	Y	Y	Y
Earthquake	Y	Y	Y	Y	Y	Y	Y	Y
Expansive soils	Y	Y	Y	Y	P	P	P	P
Extreme heat	Y	Y	Y	Y	Y	Y	Y	Y
Flood – flash	Y	Y	Y	Y	P	Y	P	P
Flood – river	Y	N	Y	Y	N	N	N	N
Grass and wildland fire	Y	P	Y	P	P	N	P	N
Landslide	Y	N	P	P	N	N	N	N
Severe winter storm	Y	Y	Y	Y	Y	Y	Y	Y
Sinkhole	Y	P	P	P	P	P	P	P
Thunderstorm, hail, lightning	Y	Y	Y	Y	Y	Y	Y	Y
Tornado/windstorm	Y	Y	Y	Y	Y	Y	Y	Y
Man-made and Combination Hazards								
Animal/plant/crop disease	Y	Y	Y	Y	N	N	N	N

Hazard	Rural Clarke Co.	Murray	Osceola	Woodburn	Clarke Schools	Murray Schools	Southwestern Comm. College	Clarke Co. Hospital
Hazardous materials incident	Y	Y	Y	P	P	P	P	P
Infrastructure failure	Y	Y	Y	Y	Y	Y	Y	Y
Pandemic human disease	Y	Y	Y	Y	Y	Y	Y	Y
Radiological incident	P	P	P	P	Y	Y	Y	P
Terrorism	Y	P	Y	P	P	P	P	P
Transportation incident	Y	Y	Y	P	P	P	P	P

Of the 13 natural hazards considered, all of them can or have occurred in at least one jurisdiction. Of the 7 other hazards, all of them have occurred in at least one jurisdiction. Hazards are most likely to occur in the rural unincorporated part of the county because it is the largest geographically. The hazard profiles later in this chapter describe reported hazard events where listed in the above table.

3.2: Assets at Risk

Step 3 of the HARA process involves the assessment of risk to the assets in the county's jurisdictions. The assessment of risks includes an analysis of how each hazard affects: a) populations, b) structures, and c) land. Of notable interest is the impact on essential facilities, which are those facilities that are to be the target of potential mitigation projects because of the risk caused by hazards and importance to the community. The vulnerability assessment includes at a minimum: 1) assessment of each hazard and how it impacts the community, 2) types of structures and populations at risk, 3) the impact on future development, and 4) estimation of losses. The data in this section is based on the best available or, in the absence of qualified data, estimated data. Data sources included the 2018 Iowa Hazard Mitigation Plan, US Census Bureau, local officials, Iowa Homeland Security and Emergency Management, Iowa DNR, the previous Clarke County HMP, and other agencies and sources as cited.

This part of the plan addresses the following Stafford Act requirements:

Section 201.6(c)(2)(ii)A: The plan should describe vulnerability in terms of the types and numbers of *existing* and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

Section 201.6 (c)(iii): For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

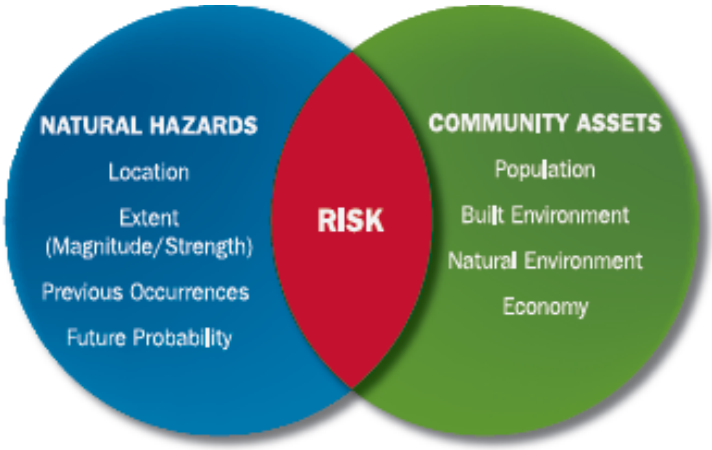
This remainder of this chapter is organized into several parts related to the topic of assets at risk:

- Description and itemization of assets at risk;
- Assets at risk by hazard (for geographically specific hazards);
- Summary of development and new risks since the original plan was adopted;
- Estimation of future assets at risk and future growth; and
- General description of vulnerability.

Plan Update Changes in Assets at Risk

In this update, the planning team focused on the hazards that have been identified as presenting the greatest concern to the county. Some new ways of analyzing these hazards have been incorporated along with an update of the quantitative impacts to properties, property values, and populations. Also, this new plan is organized quite differently than the previous plan, organized by hazard and then by jurisdiction.

Figure 3.5: Risk Graphic



Note: Modified from U.S. Geological Survey and Oregon Partnership for Disaster Resilience Models.

This chapter addresses the convergence of hazards with the structures, properties, and people that are in the area where hazards occur. The following illustrates this concept, calling risk the potential for loss due to the hazards interacting with assets. While this illustration is for natural hazards, it can apply to all kinds.

DMA 2000 calls for the determination of the assets at risk for various hazards, both hazards that can affect all assets and those that can affect only certain areas. The following tables show asset data by jurisdiction in the planning area. In the hazard profile section of this chapter are breakdowns of assets at risk to specific hazards.

FEMA requires that assets at risk are described in two ways, as outlined under the following headings.

Description of Assets at Risk By Structure/Land Use

This assessment includes a summary of each hazard's potential impact on the multiple jurisdictions' vulnerable structures and properties. The following pages detail the estimated impacts of each hazard event on the assessed valuation of each property category, including infrastructure and government buildings. These estimates are not losses. Rather, this section covers the percentage of structures and the population *that can be* impacted negatively by the hazard, from minimal to total loss.

Notes for tables in this section:

- Estimated value is based on County Assessor data when possible, directly from the source when available, and from HAZUS or other State data when available.
- Number of people is the total population, estimate during peak business hours, or facility census, as relevant. It will usually vary from the Census population because it takes in consideration the maximum regular population in each category.
- Taxable infrastructure includes private utilities, gas and electric, and railroads
- Government/institutional facilities are government facilities, schools, non-profit organizations, churches, parks/recreation, public roadways as a whole, and land used for public and non-profit purposes.

Description of Critical Assets

The planning team used existing resources and FEMA "Understanding Your Risks" worksheets to determine what should be included as locally identified essential assets and lifeline utilities and transportation systems. Numerous tables in this chapter detail the assets. The values used in the tables provided from local data sources, where available, and the remaining values are estimated. The consultant worked with the planning team and others to determine approximate values.

The following are the types of facilities and assets that the planning team defined as critical:

- Economic assets: Major employers that do not fall into the other critical asset categories but have a transformative nature on the local economy.

- Essential facilities: Those essential for the health and welfare of the whole population and are vital during and after hazard events. They include hospitals, medical facilities, police and fire stations, EOCs, schools, colleges, and shelters.
- Essential transportation systems: Those essential for the transportation of the emergency supplies to and within the community and evacuation from it.
- Lifeline utility systems: Those essential for basic public health and economic recovery, such as potable water, wastewater collection, gas pipelines, electric power systems, and central communications.
- High potential loss facilities: Those that would have a high loss associated with them, such as nuclear power plants, large dams, large universities, and military installations. (None exist in Clarke County)
- Vulnerable population centers: housing and other facilities that normally contain vulnerable populations, such as small children, elderly, disabled, or those that need other medical care. They might include nursing homes, senior apartments, childcare facilities, preschools, group homes, and mobile home parks.
- Historical and cultural resources: Those are historic and cultural facilities, landmarks, and other assets that create a sense of place and are important to the quality of life in the community.

Rural Clarke County Assets at Risk

The following table shows the potential properties and populations affected by the various hazards considered in this plan in the unincorporated part of the county.

Figure 3.6: Rural Clarke County Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	1,500	$198,100,000	3,400	100%
Commercial	10	$3,000,000	35	100%
Industrial	0	$0	0	100%
Ag Structures and Land	500 buildings; 248,000 acres	$164,300,000	75	100%
Taxable Infrastructure	10	$57,500,000	10	100%
Government/Institutional	15	$200,000,000	100	100%
Totals	2,035	$622,900,000	3,620	100%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

As this table shows, 3,400 residents live in rural areas and nearly 300 people are in or using other rural area assets at a given time. The total valuation of the rural area assets in approximately 2,035 properties exceeds $622 million dollars, it is estimated.

The following table shows the current list of locally identified critical assets in the rural part of the county.

Figure 3.7: Rural Clarke County Critical Assets

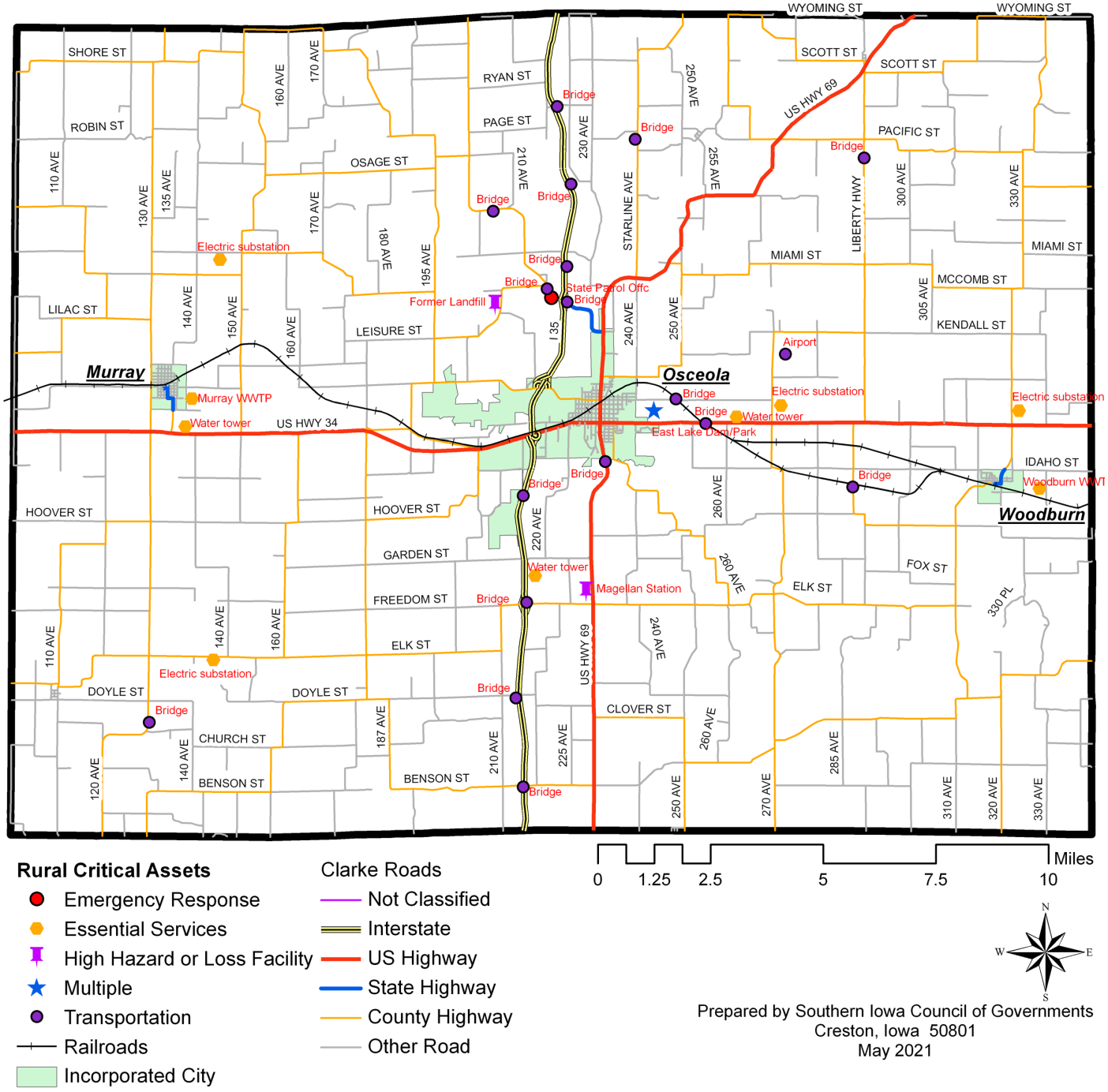
Facility	Location	Primary Type	Size	Replacement Value	Contents Value	Functional Use Value ($)	Displacement Cost ($/day)	Occupancy, Capacity (#)
BNSF bridge over 288th St.	3 mi W of Woodburn	Trans.	n/a	$5 M	$0	$25,000	$25,000	50 trains per day
BNSF bridge over 300th St.	2 mi W of Woodburn	Trans.	n/a	$5 M	$0	$25,000	$25,000	50 trains per day
BNSF bridge over Kansas St.	1 mi E of Osceola	Trans.	n/a	$5 M	$0	$25,000	$25,000	50 trains per day
BNSF Railroad	Crosses county	Trans.	n/a	$25 M	$0	$5 M	$100 K	50 trains daily

Facility	Location	Primary Type	Size	Replacement Value	Contents Value	Functional Use Value ($)	Displacement Cost ($/day)	Occupancy, Capacity (#)
Former Clarke County Landfill	2 mi NW of Osceola	Hazardous facility	25 acres	$5 M	$500 K	$1 M	$5,000	10
Clarke REC system and substations	Throughout county	Utility	n/a	$50 M	$2 M	$1 M	$25,000	0 plus workers
Clarke County Secondary Road buildings	Various locations	Essential facility	20,000 SF	$10 M	$5 M	$5 M	$10,000	25
East Lake Park and Dam	½ mi E of Osceola	Vulnerable population	50 acres	$8 M	$3 M	$50,000	$500	100
H48 bridge over I-35	6 mi S of Osceola	Trans.	n/a	$5	$3 M	$10,000	$1,000	1,000 vpd
H50 bridge over I-35	8 mi S of Osceola	Trans.	n/a	$5	$3 M	$10,000	$1,000	1,000 vpd
I-35 bridge over S. Squaw Cr.	2 mi N of Osceola	Trans.	n/a	$6 M	$0	$25,000	$10,000	30,000 vpd
I-35 bridge over Squaw Cr.	4 mi N of Osceola	Trans.	n/a	$6 M	$0	$25,000	$10,000	30,000 vpd
I-35 bridge over White Breast Cr.	1 mi S of Osceola	Trans.	n/a	$6 M	$0	$25,000	$10,000	30,000 vpd
I-35 Exit 29 bridge	4 mi. S of Osceola	Trans.	n/a	$4 M	$0	$10,000	$1,000	1,000 vpd
I-35 Exit 36 bridge	2 mi N of Osceola	Trans.	n/a	$4 M	$0	$10,000	$1,000	2,000 vpd
Iowa State Patrol office	2 mi NW of Osceola	Trans.	5,000 SF	$1 M	$1 M	$1 M	$5,000	50
Magellan Pipeline and Station	4 mi S of Osceola	Utility	10,000 SF	$5 M	$1 M	$50,000	$10,000	5
Natural gas pipeline	Crosses county	Utility	n/a	$5 M	$500 K	$25,000	$25,000	n/a
Osceola Airport	4 mi E of Osceola	Trans.	100 acres	$6 M	$1 M	$100 K	$1,000	25
R15 bridge over Long Cr.	Doyle Twp.	Trans.	n/a	$3 M	$0	$10,000	$1,000	1,000 vpd
R35 bridge over S. Squaw Cr.	2 mi NW of Osceola	Trans.	n/a	$3 M	$0	$10,000	$1,000	1,000 vpd
R35 bridge over Squaw Cr.	4 mi NW of Osceola	Trans.	n/a	$3 M	$0	$10,000	$1,000	1,000 vpd
R45 bridge over Squaw Cr.	6 mi N of Osceola	Trans.	n/a	$3 M	$0	$10,000	$1,000	1,000 vpd
R59 bridge over Otter Cr.	Liberty Twp.	Trans.	n/a	$3 M	$0	$10,000	$1,000	1,000 vpd
Robin St. bridge over I-35	6 mi N of Osceola	Trans.	n/a	$3 M	$0	$10,000	$1,000	1,000 vpd
SIRWA water system and towers	Throughout county	Utility	n/a	$25 M	$2 M	$250 K	$25,000	0 plus workers
US 34 bridge over BNSF railroad	1 mi E of Osceola	Trans.	n/a	$4 M	$0	$10,000	$1,000	10,000 vpd
US 69 bridge over White Breast Cr.	100 yards S of Osceola	Trans.	n/a	$3 M	$0	$10,000	$1,000	3,000 vpd
Woodburn Sewer treatment lagoons	SE corner of city	Utilities	40 acres	$2 M	$0	$100 K	$5,000	0

Sources: planning team, FEMA Understanding Your Risks, Clarke County Assessor's data, IDOT

The map on the following page shows the rural Clarke County critical assets as listed in the above table.

Figure 3.8: Rural Clarke County Critical Assets Map



Murray Assets at Risk

The following table shows the potential properties and populations affected by the various hazards considered in this plan.

Figure 3.9: Murray Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	350	$17,000,000	700	100%
Commercial	10	$1,500,000	25	100%
Industrial	1	$300,000	10	100%
Ag Structures and Land	1 building; 250 acres	$200,000	1	100%
Taxable Infrastructure	2	$2,700,000	1	100%

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Government/Institutional	10	$20,000,000	325	100%
Totals	374	$41,700,000	1,062	100%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

Any hazard that can affect all people and property in Murray can affect an estimated 374 structures, 250 acres of farmland, $41.7 million in property value, and 1,062 persons. These are rough estimates and vary by time of day. The following is the current list of critical assets in Murray identified by the planning team.

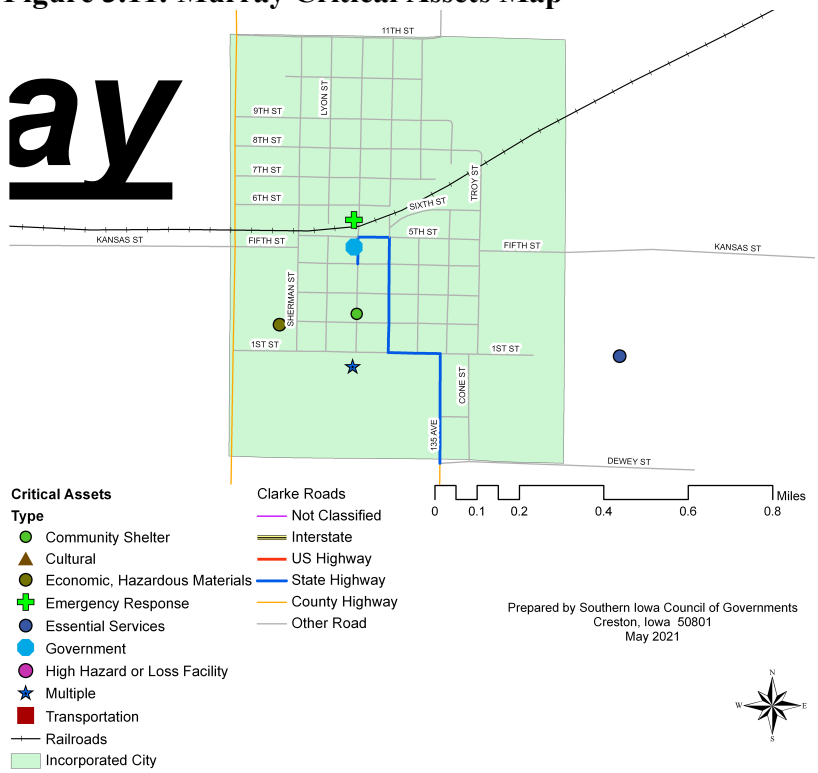
Figure 3.10: Murray Critical Assets

Facility	Location	Primary Type	Size	Replacement Value	Contents Value	Functional Use Value ($)	Displacement Cost ($/day)	Occupancy, Capacity (#)
BNSF Railroad	Crosses city	Trans.	n/a	$500 K	$0	$5 M	$25,000	50 trains
Church of Christ	S part of town	Cultural	5,000 SF	$500 K	$200 K	$50,000	$100	200
City hall	Center of town	Essential facility	2,000 SF	$200 K	$25 K	$50 K	$500	20
Fire station	Center of town	Essential facility	2,000 SF	$500 K	$750 K	$25,000	$5,000	20
Murray Schools	SW part of town	Essential facility	50,000 SF	$10 M	$8 M	$10 M	$50,000	500
Murray wastewater lagoons	E edge of Murray	Utility	50 acres	$2 M	$0	$100 K	$10,000	n/a
Murray wastewater pipes	Throughout Murray	Vulnerable population	n/a	$2 M	$0	$100 K	$10,000	n/a
Vacant former Dekko Mfg Bldg	SE part of town	Economic	30,000	$3 M	$1 M	$5,000	$0 (vacant)	100
Casey's Store	SW part of town	Economic	5,000	$2 M	$1 M	$5,000	$5,000	25

Sources: planning team, FEMA Understanding Your Risks, Clarke County Assessor's data, IDOT

The following map shows Murray's critical assets as listed in the above table.

Figure 3.11: Murray Critical Assets Map



Osceola Assets at Risk

The following table shows the potential properties and populations affected by the various hazards considered in this plan.

Figure 3.12: Osceola Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	2,200	$169,300,000	4,900	100%
Commercial	300	$79,100,000	1,300	100%
Industrial	20	$24,300,000	1,225	100%
Ag Structures and Land	4 buildings; 500 acres	$3,200,000	2	100%
Taxable Infrastructure	8	$18,300,000	15	100%
Government/Institutional	75	$160,000,000	2,250	100%
Totals	2,607	$454,200,000	9,692	100%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

Any hazard that can affect all people and property in Osceola can affect an estimated 2,607 structures, 500 acres of farmland, $454 million in property value, and 9,692 persons. These are rough estimates and vary by time of day. The following is the current list of critical assets in Osceola as identified by the planning team.

Figure 3.13: Osceola Critical Assets

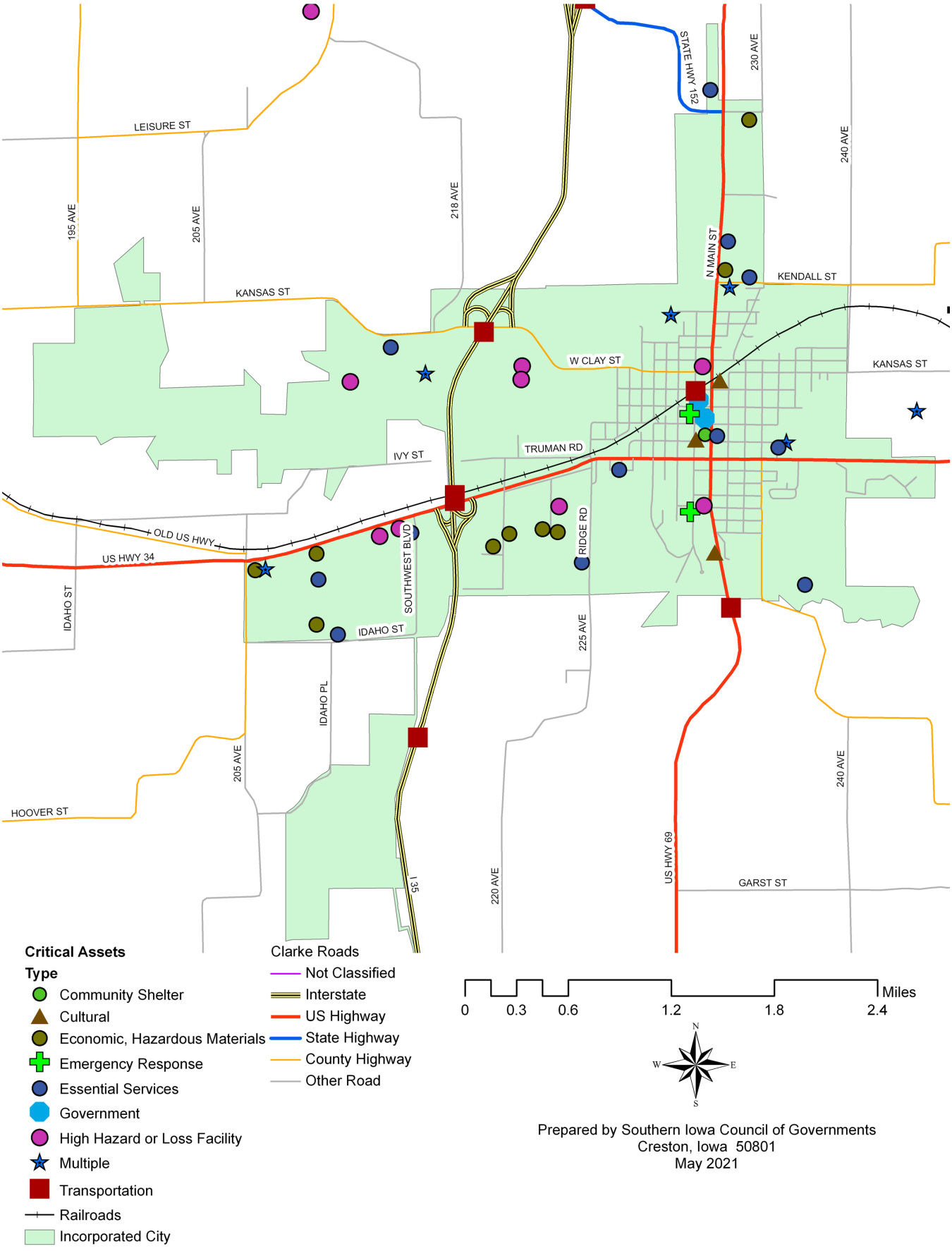
Facility	Location	Primary Type	Size	Replacement Value	Contents Value	Functional Use Value ($)	Displacement Cost ($/day)	Occupancy, Capacity (#)
Alliant Energy Service Center	1415 Eddy Saylor Dr.	Utilities	13,979 SF	$2 M	$2 M	$500 K	$2,500	100
Amtrak Station, Historic Depot	N. Main St.	Trans.	3,000 SF	$1.4 M	$250 K	$50,000	$500	100
Altec Industries	1001 Furnas Dr.	Economic	135,971 SF	$6 M	$7.5 M	$5 M	$25,000	250
BNSF/I-35 bridge	West part of city	Trans.	n/a	$3 M	$0	$5 M	$25,000	50 trains
BNSF Railroad	Crosses city	Trans.	n/a	$1 M	$0	$5 M	$25,000	50 trains
Boyt Harness Co.	1 Boyt Drive	Economic	35,169 SF	$2 M	$2 M	$2 M	$10,000	50
Clarke Co. Courthouse	Osceola Square	Essential facility	20,000 SF	$25 M	$5 M	$10 M	$20,000	200
Clarke Co. Fairgrounds	2070 US Hwy 34	Cultural facility	Multiple bldgs.; 43 ac.	$6 M	$5 M	$250 K	$1,000	1,000
Clarke Co. Historical Museum	South Main St.	Cultural facility	5,000 SF	$600 K	$500 K	$50 K	$1,000	50
Clarke Co. Hospital	800 S. Fillmore	Essential facility	84,000 SF	$110 M	$15 M	$20 M	$100 K	500
Clarke Co. Law Center	Townline Road	Essential facility	10,000 SF	$15 M	$6 M	$1 M	$10,000	100
Clarke Electric Coop	1103 N. Main	Essential facility	26,506 SF	$2 M	$3 M	$2 M	$10,000	50
Clarke Elementary School	215 Dewey St.	Vulnerable pop.	60,000 SF plus land	$25 M	$7 M	$12 M	$25,000	750
Clarke Jr./Sr. High School	800 N. Jackson	Vulnerable pop.	80,000 SF plus land	$40 M	$10 M	$18 M	$35,000	750
Downtown Historic District	Osceola Square	Cultural, economic	50 buildings	$15 M	$10 M	$10 M	$5,000	250
Electric substations	2 (West and North Ind. Parks)	Utilities	2 acres each	$5 M	$0	$100 K	$50,000	2
Fareway Store	Downtown	Economic	24,278 SF	$6 M	$6 M	$1.5 M	$10,000	150
Full Harvest Housing	801 S. Fillmore St.	Vulnerable pop.	22,293 SF	$2.5 M	$1 M	$1.5 M	$15,000	100
Homestead of Osceola	334 NW View Dr.	Vulnerable pop.	20,000 SF	$6 M	$5 M	$2 M	$25,000	100
Hy-Vee food store	W. McLane St.	Economic	27,632 SF	$6 M	$6 M	$1.5 M	$10,000	150

Facility	Location	Primary Type	Size	Replacement Value	Contents Value	Functional Use Value ($)	Displacement Cost ($/day)	Occupancy, Capacity (#)
I-35 Exit 34 bridge	NW part of city	Trans.	n/a	$4 M	$0	$25,000	$5,000	3,000 vpd
Lakeside Casino and Hotel	NW part of city	Economic	70,000 SF	$50 M	$20 M	$5 M	$50,000	750
Majona/Iowa Steel	1525 Eddy Saylor	Economic	46,646 SF	$1.5 M	$1.5 M	$2.5 M	$10,000	50
Methodist Church (shelter, kitchen)	Near downtown	Essential facility	5,000 SF	$500 K	$500 K	$50,000	$1,000	200
Miller Industries	North Main,	Economic	23,160 SF	$6 M	$7.5 M	$10 M	$25,000	250
Mosaic, Inc. office	405 E. McLane	Vulnerable pop.	10,000 SF	$1 M	$500 K	$1 M	$10,000	50
Mueller Industries	Tieken Dr.	Economic	212,800 SF	$3 M	$7.5 M	$10 M	$25,000	250
Natural gas border station	N edge of city	Utilities	1 acre	$1.5 M	$0	$2 M	$25,000	2
North Main Manor	N. Main Street	Vulnerable pop.	16,422 SF	$2 M	$1 M	$2 M	$25,000	100
Osceola City Hall	115 N. Fillmore	Essential facility	3,000 SF	$4 M	$500 K	$4 M	$5,000	50
Osceola Fire Station	Osceola Square	Essential facility	6,000 SF	$6 M	$2 M	$200 K	$5,000	25
Osceola Library	300 S. Fillmore	Cultural	5,000 SF	$5 M	$1 M	$250 K	$5,000	50
Osceola Foods	Warren Dr.	Economic	590,842 SF	$60 M	$15 M	$20 M	$250 K	750
Osceola WTF	NW edge of city	Utilities	2,500 SF	$30 M	$3 M	$2 M	$50,000	25
Osceola Street Dept.	East part of city	Essential facility	10,000 SF	$10 M	$5 M	$2 M	$10,000	25
Osceola WWTF	SE edge of city	Utilities	2,500 SF, 75 ac.	$40 M	$1 M	$2 M	$50,000	25
Pipeline	Crosses city	Utilities	n/a	$1.5 M	$0	$2 M	$25,000	n/a
RR underpasses – Lincoln-Fillmore St.	Central Osceola	Trans.	n/a	$3 M each	$0	$25,000	$1,000	500 vpd
Salford – MacLander Inc.	Furnas Dr.	Economic	55,434 SF	$2 M	$2 M	$2 M	$10,000	50
Simco Mfg	Furnas Dr.	Economic	26,300 SF	$5 M	$7.5 M	$2 M	$10,000	50
Southern Hills Specialty Care	NW part of town	Vulnerable pop.	50,000 SF	$6 M	$3.5 M	$2 M	$25,000	100
Southwestern Community College	2520 College Drive	Vulnerable pop.	10,000 SF	$3 M	$3 M	$1 M	$10,000	100
Swine Graphics	W. McLane	Economic	40,000 SF	$1 M	$500 K	$500 K	$5,000	50
US Hwy 34 bridge over I-35 (4 lanes)	West part of city	Trans.	n/a	$6 M	$0	$25,000	$15,000	10,000 vpd
The Village Childcare Center	2500 College Drive	Vulnerable pop.	17,185 SF	$3 M	$3 M	$500 K	$15,000	100
Valley of the Moon Commercial Poults	Leisure Dr.	Economic	176,448 SF	$15 M	$10 M	$5 M	$15,000	100
Wal-Mart store	West part of city	Economic	99,594 SF	$8 M	$8 M	$3 M	$15,000	250
Water towers	3 (Jeffrey's Dr., Washington St.)	Utilities	1 acre each	$1 M each	$50,000	$50,000	$5,000	n/a
Wastewater collection pipes	Throughout city	Utilities	n/a	$25 M	$10,000	$250 K	$50,000	n/a
West Lake and Dam	W edge of town	High loss	500 acres	$12 M	$3 M	$50,000	$10,000	200

Sources: planning team, FEMA Understanding Your Risks, Clarke County Assessor's data, IDOT

The map on the next page shows Osceola's critical assets as listed in the above table.

Figure 3.14: Osceola Critical Assets Map



Woodburn Assets at Risk

The following table shows the potential properties and populations affected by the various hazards considered in this plan.

Figure 3.15: Woodburn Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	90	$2,600,000	200	100%
Commercial	5	$100,000	8	100%
Industrial	0	$0	0	100%
Ag Structures and Land	1 building; 100 acres	$100,000	1	100%
Taxable Infrastructure	3	$1,400,000	4	100%
Government/Institutional	6	$4,000,000	7	100%
Totals	105	$8,200,000	220	100%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

Any hazard that can affect all people and property in Woodburn can affect an estimated 105 structures, 100 acres of farmland, $8.2 million in property value, and 220 persons. These are rough estimates and vary by time of day. The following is the current list of critical assets in Woodburn identified by the planning team.

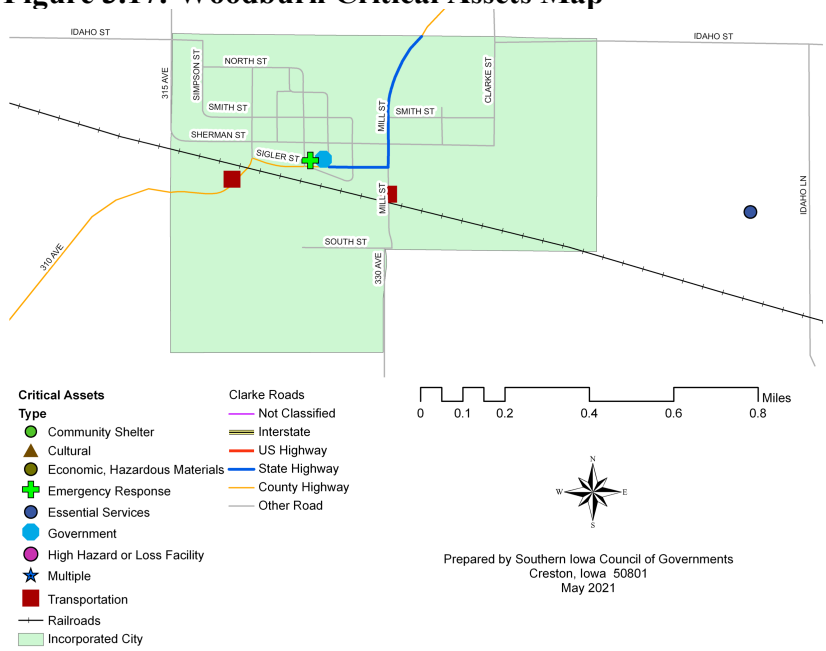
Figure 3.16: Woodburn Critical Assets

Facility	Location	Primary Type	Size	Replacement Value	Contents Value	Functional Use Value ($)	Displacement Cost ($/day)	Occupancy, Capacity (#)
BNSF Railroad	Crosses city	Trans.	n/a	$500 K	$0	$5 M	$25,000	50 trains
City hall/fire station	Downtown	Essential facility	$3,200 SF	$500 K	$1 M	$100 K	$5,000	40
Griffith St. Bridge	SW part of town	Trans.	n/a	$3 M	$0	$15,000	$1,000	500 vpd
Mill St. Bridge	SW part of town	Trans.	n/a	$3 M	$0	$15,000	$1,000	500 vpd
Sewer pipes	Throughout town	Utilities	n/a	$2 M	$0	$100 K	$5,000	0

Sources: planning team, FEMA Understanding Your Risks, Clarke County Assessor's data, IDOT

The following map shows Woodburn's critical assets as listed in the above table.

Figure 3.17: Woodburn Critical Assets Map



The online survey of hazards asked a question about the reasons why the above assets are at risk. Fourteen people responded. The top answer from the choices given was "has direct and immediate impact on ability to respond to hazards," which was chosen by ten respondents. Five each selected "age of structure, deteriorating condition, lack of recent investment" and "high exposure." No other option, such as "high population contained on or in property," received more than two votes.

3.3: Development Since Adoption of the Previous Plan

As part of the online community survey kicking off the project, 14 people answered a question about development in their jurisdiction in the past five years. Most of the respondents lived or served rural Clarke County or Osceola. All 14 indicated new housing construction (a dozen or more units) occurred, five mentioned at least five new businesses started, six mentioned large public infrastructure investments, and four indicated a significant increase in property values (10%).

Compared to the county's total existing development, modest development has occurred since the previous plan was adopted in 2014. The total net increase in assets during this time is approximately 3%, almost entirely in Osceola and townships north of Osceola toward Des Moines. Importantly, compared to other parts of the nation and even Iowa, Clarke County has fared well through the Great Recession and the COVID downtown. Some new homes and other buildings have been built. These new assets, for the most part, are constructed to modern standards and designed to withstand typical weather conditions and are well insured. There have been no major FEMA funded mitigation projects to date, except for regional rural electric line retrofits via the local REC. No new habitable construction has occurred in SFHAs. In fact, mitigation efforts in lowland and flood prone areas have reduced flood risk. Using non-FEMA grants and local funds, watershed protection projects, such as terraces, grassed waterways, grade stabilization ponds, shoreline stabilization efforts, and other developments have occurred in various locations with the intent of improving water quality and reducing the threat and magnitude of flooding.

3.4: Future Land Use and Development

This part of the plan addresses the following Stafford Act requirements:

Section 201.6(c)(2)(ii)A: The plan should describe vulnerability in terms of the types and numbers of existing and *future* buildings, infrastructure, and critical facilities located in the identified hazard areas.
Section 201.6(c)(2)(ii)C: Vulnerability will be described in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

FEMA requires that local mitigation plans consider future development and population growth when considering mitigation strategies. As indicated in Chapter 2, the population is expected to grow slowly overall but not evenly throughout the county. Population growth will be notable in Osceola and in some townships north of Osceola along main roads, where people can commute to Des Moines and other employment centers. Development planners should consider how new housing developments might affect future mitigation needs and strategies in the future in these areas. Generally, other areas will sustain stagnant populations with very minimal new development. The bulk of development occurring outside of the corporate areas of the cities is likely to be single-family homes, typically on larger lots surrounded by farmland and open space. Homes in subdivisions are possible and likely only in Osceola and on a small scale in Murray. It is very unlikely that there will be substantial new development of commercial or industrial facilities in the rural part of the county or anywhere outside of Osceola. Some land annexation is possible by cities of the county, but the amount of land annexed is likely to be modest and should not require an amendment to this plan.

The number of assets is likely to increase at the same pace or more rapidly, since average household sizes continue to decline and new construction to replace older buildings may not mean the demolition of older

buildings. When commodity prices rise, more land that was not farmed (CRP, forested, or pastured land) in the past may be converted to grow corn and soybeans. The opposite is occurring right now with low commodity prices. Some rural areas and small towns are likely to see declines in total numbers of assets, buildings, and values. Other land uses, such as institutional, educational, government, and utilities, are more difficult to project. These developments will depend on available funding but it is anticipated that growth will be limited in most parts of the county, with Osceola as the county seat receiving most of the investment.

As part of the online community survey kicking off the project, 15 people answered a question about projected development in their jurisdiction in the next five years. Most of the respondents lived or served rural Clarke County or Osceola. Ten indicated new housing construction (a dozen or more units), eight mentioned at least five new businesses, nine mentioned large public infrastructure investments, and seven indicated a significant increase in property values (10%). Additionally, five indicated at least a dozen or more new wind turbines or solar collector sites will be built.

Overall, the net growth (+) or decline (-) in assets is likely to be as follows over the five-year life of the plan.

Figure 3.18: Projected Changes in Land Use over Next Five Years

Structure/Land Use	Rural	Murray	Osceola	Woodburn	County
Residential	+50	+4	+75	-1	+128
Commercial	+1	0	+5	-1	+5
Industrial	0	0	0	0	0
Ag Structures	+15	0	0	0	+15
Ag Land (acres) *	-1,000	0	-250	0	-1,250
Taxable Infrastructure	+1	0	+1	0	+2
Government/Institutional	+2	0	+2	0	+4
Totals	+69	+4	+83	-2	+154

** In rural areas: through conversion of marginal land (pasture, forest, CRP, channeled waterways, as land values increase)*

Of course, the above table assumes there are no city boundary changes in the next five years, such as due to annexation. New development will be very minor compared to the current composition of the county; therefore, development will not likely affect the risks in the county in a significant way. The exception may in property values as these inflate and fluctuate over time. In other words, it is not likely that new buildings and population will create appreciable new risks that would not have occurred had the development not occurred.

Planning team members were asked to describe what new risks they could envision in the future due to new development. Some stated that the risks are no more significant than in other areas. The rural area (unincorporated Clarke County) and Osceola have zoning, which regulates development, but neither area has significant development (building design) standards that consider mitigation. Murray and Woodburn have no meaningful land use and development regulations. This means that it is almost impossible to project where and when development may occur and similarly impossible to enact some mitigation priorities and ideas in the location, siting, sizing, and building techniques of new development.

With the approval of FEMA FIRM maps in the past few years, most jurisdictions with SFHAs for 1%-chance events have joined the NFIP and have flood regulations that prohibit development in SFHAs. There are no policies for development of safe rooms and earthquake building codes or for wildland interface areas, which could be greater issues if new development occurs. With proper implementation of the mitigation plan, however, future development will not be in the risk area of any high-risk hazards except for hazards that can affect the entire county.

3.5: Hazard Profiles and Vulnerability

The hazard profile is a complicated part of the hazard mitigation plan. It is essentially a thorough analysis of each hazard included in the hazard mitigation plan. When completed, it provides a reasonable picture of what hazards are the most destructive to the planning area and each jurisdiction and what kind of damages are most likely to occur.

The hazard profile addresses the following information:

- Hazards to be profiled and why
- Hazard profile methodology
- Detailed analysis of each hazard
- Description of its effect on the assets of the county
- Loss estimation for hazards where data is available
- Summary and vulnerability assessment, including listing of hazards by level of risk by jurisdiction

Hazards to Be Profiled

Another change in this plan update is the revision of which hazards are profiled. Part of this is because the 2018 State plan condensed the hazards into a fewer number, where similar hazards were combined. After reviewing other FEMA approved plans, considering readability and brevity, this plan update excludes some hazards from profiling that have nominal impacts on the county or that are just not as important when funds and staff are limited. In other words, the profile attempts to focus resources where it is more likely to make a greater impact. The planning team feels this accomplishes the goals of the plan and the Stafford Act requirements because the information related to hazard risks is not compromised by these actions. The following table shows the hazards that are eliminated and how and why this occurred.

Figure 3.19: Hazards Eliminated from the Profile Process

Hazard	Reason for Omission/Combination
Earthquake	Planning area is located in Seismic Zone 1, the second lowest in the U.S. (Sources: USGS, IDNR, State Mitigation Plan). While very minor earthquakes have occurred regionally, no damage has ever been recorded in the planning area. During the kickoff meeting, members filling out the Historical Occurrences of Hazard Events worksheet identified no knowledge of events and little concern.
Landslide	Most of them occur in remote areas along streams and do not affect human development. Minor landslides along grade cuts for highways, bridges, and railroads have caused minimal damage and are mitigated easily without extensive planning and outside resources. This is no history of significant landslides in the planning area. (Sources: Iowa Map Book, State Mitigation Plan) During the kickoff meeting, members filling out the Historical Occurrences of Hazard Events worksheet identified no knowledge of events and little concern.
Sinkhole	Minor sinkholes with no significant damage have been rare. The only way to mitigate these kinds of sinkholes is to properly compact soils during excavation and construction activities and to fill holes that occur. The risks to people and structures are limited. The Iowa DNR karst topography data also indicates no hazards in the planning area (http://programs.iowadnr.gov/maps/coalmines/). During the kickoff meeting, most members filling out the Historical Occurrences of Hazard Events worksheet identified no knowledge of events and little concern.
Animal/plant/crop diseases	Not a natural hazard, so it is not required. The planning team is focused on hazards that have immediate damages. While animal/plant/crop disease occurs, there are other organizations involved in addressing that hazard, mostly on a scale beyond the county (such as State, Federal, and university officials), and much of this hazard is also addressed by crop insurance and existing mitigation measures. During the kickoff meeting, most members filling out the Historical Occurrences of Hazard Events worksheet identified no knowledge of events and little concern or concern mostly with deer impacting traveling vehicles.
Pandemic human disease	Not a natural hazard, so it is not required. The planning team is focused on hazards with physical damages. As COVID-19 taught us, most of the mitigation is directed from beyond the county (State and Federal). The County and jurisdictions in the county lack the resources to remain on strong footing for this hazard and to implement interim measures in the absence of a pandemic.
Radiological incident	Not a natural hazard, so it is not required. While there are small and occasional shipments of radiological materials across the county, they are well regulated by state and federal agencies and not a focus of local mitigation efforts. The mitigation efforts implemented for hazardous materials and transportation incidents will

Hazard	Reason for Omission/Combination
	also mitigate this hazard and represent the level of mitigation needed to be performed at the local level.
Terrorism	Not a natural hazard, so it is not required. While terrorism is an issue, it has not occurred beyond threats and very minor arson incidents. The planning team lacks the local resources to take sustained actions. Like some other non-natural hazards, most of the sustained actions would be undertaken by officials beyond the county (State and Federal). Schools are already taking all the actions normally suggested, such as ALICE training and security improvements. During the kickoff meeting, members filling out the Historical Occurrences of Hazard Events worksheet identified no knowledge of events.

At the conclusion of their review, the planning team selected the following hazards to profile as hazards that may present substantial risk to the planning area. This includes 10 natural hazards and 4 other hazards.

Figure 3.20: List of Hazards to be Profiled

Natural Hazards			Other Hazards
Dam/Levee Failure	Flood – flash	Severe winter storm	Hazardous materials incident
Drought	Flood – river	Thunderstorm, hail, lightning	Infrastructure failure
Expansive soils	Grass and wildland fire	Tornado/windstorm	Transportation incident
Extreme heat			

Hazard Profile Methodology

The hazard profile is a more detailed investigation of each identified hazard to determine more precisely the potential impact each hazard could have on each jurisdiction. Data from various sources is used to determine how each hazard affects the county and its jurisdictions. This profile evaluates the relative impact of each potential hazard for each jurisdiction through several evaluation criteria. The profile is completed in order to rank the relative risk each hazard has on each jurisdiction, which will then enable the planning team to best develop goals, objectives, and mitigation actions for each jurisdiction later in this document.

This profiling is not new to communities in Clarke County. The previous two hazard mitigation plans included a hazard profile. This process has also been used with success in surrounding counties.

Note that each of the following profiles covers each jurisdiction. Within each profile for each hazard is a description of whether and how different communities have different risks to hazards. The following risk assessment was conducted on a planning area wide basis rather than analyzing each hazard for each individual jurisdiction. Unique conditions within the participating jurisdictions are noted in each hazard profile. For example, flooding will likely impact jurisdictions with Special Flood Hazard Areas (SFHAs) more than those without SFHAs. Unless otherwise stated in the risk assessment, the partnering organizations and other non-incorporated jurisdictions not specifically profiled will have the same risk factors as that of the underlying jurisdiction in which the organizations and assets are located. School districts and the hospital are profiled in terms of how hazards impact assets on their properties.

This part of the plan addresses the following Stafford Act requirement:

Section 201.6(c)(2)(i): [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

Explanation of Hazard Scoring Criteria

The following tables provide explanation of the scoring criteria. There are six overall criteria in which each hazard is scored, along with additional scores for one of the seven: severity of impact. While severity of impact is not necessarily a higher weighted score, it is complex and there are many factors related to the kinds of damages and their impacts. For this reason, the overall hazard score by jurisdiction is a sum of all the criteria. All criteria were rated on a scale of one (1) to nine (9), except the various severity of impact scores, which are rated on a scale of one (1) to five (5).

Plan Update Changes in Profile Hazard Scoring

In this update, the planning team took a completely different approach to hazard scoring compared to previous plans. First, the historical occurrence factor was discussed but is no longer being scored. Past history does not result in future loss. However, historical incidence provides useful data about future probability and risk of loss, as reflected throughout this profile. The scoring system overall is quite different, to make it true to the real risk factors.

Each planning team member attending the first and second community meetings helped score the assessment criteria, with some individualized data and some team discussion results.

The forms used for these discussions are found in *Appendix B*.

Following the meetings, the planning consultant completed research to confirm, and in some cases modify, the scores for each jurisdiction. These scores are found in this plan. The sum of the scores for each hazard for each jurisdiction were then added and ranked by community. Following the profile, the remaining part of this chapter details the results of this analysis.

It was important for the assessment team to score each hazard as a single event. Only impacts from that particular hazard were to be considered in the analysis. The planning team profiled hazards without consideration of secondary or cascading impacts and events.

Future Probability

The probability score reflects the estimated frequency of the hazard occurrence in the future. Often the historical occurrence can be extrapolated into the future, but sometimes this is not accurate. If a hazard or its impacts have been mitigated, the future occurrence will most likely be less than the historical occurrence. The opposite can also be true. There may be new hazards that present themselves to the community. For example, a new industry that produces a hazardous material may move into the community where, before, the hazard did not exist.

Figure 3.21: Future Probability Scoring Criteria

Score	Description
1	Extremely rare: Less than 1% probability in the next year
2	Very Unlikely: Between 2% and 5% probability in the next year
3	Unlikely: Between 6% and 10% probability in the next year
4	Possible: Between 11% and 25% probability in the next year
5	Probable: Between 26% and 50% probability in the next year
6	Likely: Between 51% and 75% probability in the next year
7	Highly Likely: 76% and 90% probability in the next year
8	Often: Between 91% and 100% probability in the next year
9	Regularly: Most years this hazard will occur multiple times

Vulnerability of the Population

The vulnerability score represents adverse impacts to citizens, visitors, and emergency responders. It is important to consider only adverse effects as vulnerability. Many hazards, even those that are widespread, occur which do not significantly impact people, while others will have a direct impact on any person in the area of the hazard event.

Figure 3.22: Vulnerability of the Population Scoring Criteria

Score	Description
1	Indirect: Impacts exist but do not directly affect the lives of any people
2	Temporary: Quality of life is diminished temporarily – hazard in the area raises awareness/causes preventative action
3	Negligible: Less than 1% of the total population of the jurisdiction

Score	Description
4	Limited: 1% to 10% of the total population of the jurisdiction
5	Moderate: 11% to 25% of the total population of the jurisdiction
6	Significant: 26% to 50% of the population of the jurisdiction
7	Critical: 51% to 75% of the population of the jurisdiction
8	Severe: 76% to 90% of the population of the jurisdiction
9	Catastrophic: More than 90% of the total population of the jurisdiction

Maximum Area of Extent

The maximum geographic extent is the percentage of the jurisdiction impacted by the hazard. As an example, a snowstorm will likely impact the entire community, whereas a hazardous materials incident or flash flood may cover only a few city blocks or farms.

Figure 3.23: Maximum Area of Extent Scoring Criteria

Score	Description
1	Indirect: Impacts exist but do not directly affect land, property, or an identifiable area
2	Random: Specific points randomly impacted, such as individual computers at scattered locations
3	Negligible: Less than 1% of the total area of the jurisdiction
4	Limited: 1% to 10% of the total area of the jurisdiction
5	Moderate: 11% to 25% of the total area of the jurisdiction
6	Large: 26% to 50% of the area of the jurisdiction
7	Significant: 51% to 75% of the area of the jurisdiction
8	Widespread: 76% to 90% of the area of the jurisdiction
9	Total: More than 90% of the total area of the jurisdiction

Severity of Impact

The nine criteria used to score the severity of impact, as follows, are similar to those used by the Emergency Management Accreditation Program (EMAP) standards. The EMAP standards for a risk assessment require inclusion of a consequence analysis for the hazards that have potential impact on the planning area. The EMAP process considers the impact of each hazard on the following:

- General public
- First responders
- Continuity of government operations
- Property, facilities, and infrastructure
- Environment
- Economic conditions
- Public confidence in the jurisdiction's governance

Notice how these are similar to the following nine scoring criteria that are analyzed in the "severity of impact" section of each hazard profile.

The rating of 1-5 rather than 1-9 is in place because the planning team did not want to give the total score for severity of impact too much influence over the overall score compared to other criteria, such as future probability.

Severity of Impact – Health and Safety of the Public

Many hazards directly affect health and safety of the public, and protection of the public is a primary goal.

Figure 3.24: Severity of Impact Health and Safety of the Public Scoring Criteria

Score	Description
1	Negligible: No direct risk to health and safety
2	Limited: A few people may suffer minor injuries or become sick or lack food/water; fatalities are very unlikely

Score	Description
3	Moderate: Minor injuries are likely; major injuries and sickness are possible; fatalities are unlikely
4	Critical: Multiple injuries and sickness are probable; fatalities are likely
5	Catastrophic: Widespread fatalities are very likely; Federal and State emergency response will be necessary

Severity of Impact – Health and Safety of Response Personnel

Many hazards directly affect health and safety of those that respond to hazards, either because they are exposed to the original hazard or to resulting hazards and other risks associated with exposure.

Figure 3.25: Severity of Impact Health and Safety of Response Personnel Scoring Criteria

Score	Description
1	Negligible: No direct risk to health and safety; no response needed or response will occur after incident is over
2	Limited: Responders can be injured or made sick due to exposure but fatalities are unlikely
3	Moderate: Injury and sickness are likely and risk is high; fatalities are possible
4	Critical: Multiple injuries are probable; exposure can make many ill; fatalities are likely; secondary impacts such as radiation and explosions can cause adverse effects to a large part of the response community
5	Catastrophic: Widespread fatalities are very likely; Federal and State emergency response will be necessary

Severity of Impact – Continuity of Government Operations, Utilities, and Related Services

Many hazards have a direct impact on continuity of governments due to the impact on staffing, financial resources, and availability of reliable equipment and infrastructure. Utilities can become unreliable or even lost. Other necessary services can be compromised, and basic needs can go unmet or the public can become unprotected from crime and other risks.

Figure 3.26: Severity of Impact Continuity of Government Scoring Criteria

Score	Description
1	Negligible: Will not have a direct impact of any nature on public facilities, services, and infrastructure.
2	Limited: Services can be temporarily disrupted only if hazard directly impacts the central system/building; non-lifeline systems would be impacted for a few hours to one day
3	Moderate: Non-lifeline systems nonfunctional for days; lifeline systems such as electricity and water out for up to 6 hours
4	Critical: Lifeline systems out for 6 to 24 hours; government officials unable to serve for days; risk to life as a result of essential services being down
5	Catastrophic: Lifeline systems out for at least one day; multiple systems disrupted; complete shutdown of essential facilities for at least a day and many for weeks or more; government unable to operate and local officials unable to make decisions that will require Federal response

Severity of Impact – Property, Facilities, and Infrastructure

Property and infrastructure protection is vital to recovery. Most hazards affect properties, even if no people are injured or killed.

Figure 3.27: Severity of Impact Property, Facilities, and Infrastructure Scoring Criteria

Score	Description
1	Negligible: Will not have a direct impact of any nature on buildings, structures, and other infrastructure or will cause such little damaged that insurance can easily cover
2	Limited: Modern buildings and structures can be modestly damaged; weak buildings heavily damaged; sections of roads and utilities damaged but operable
3	Moderate: Key infrastructure and buildings can be moderately damaged – structurally insecure
4	Critical: Buildings are uninhabitable and some buildings destroyed; key facilities and infrastructure is not useful for days; detours needed on key roads
5	Catastrophic: Widespread destruction to strong buildings and infrastructure that will require Federal response

Severity of Impact – Delivery of Services

The public, non-profit, and private sectors deliver important services to the public and businesses in a community. The loss of these affects quality of life and hinders response and recovery.

Figure 3.28: Severity of Impact Delivery of Services Scoring Criteria

Score	Description
1	Negligible: Hazard will not result in any impact on delivery of services physically or via computers and technology
2	Limited: Services are disrupted temporarily both physically and electronically
3	Moderate: Detours will directly impact quality of life for many; deliveries delayed hours to days; Internet unavailable
4	Critical: Services are shut down for days; Internet unavailable for days; deliveries slowed by days
5	Catastrophic: Entire way of life is severely disrupted that will require Federal response

Severity of Impact – Environmental Impact

In a built environment, all kinds of hazards can cause undesirable short- and long-term environmental impacts.

Figure 3.29: Severity of Impact Environmental Impact Scoring Criteria

Score	Description
1	Negligible: No notable impact to the human or natural environment
2	Limited: Temporary impacts that will be cleaned immediately or by the natural environment
3	Moderate: Temporary impacts to the environment which can be cleaned up by local and regional personnel in days
4	Critical: Long-term environmental mitigation needed
5	Catastrophic: Severe damage that may alter wildlife populations and local ecology that will require Federal response

Severity of Impact – Economic and Financial Conditions

Economic and financial impacts of a more general nature can occur as a secondary effect of damage to property, equipment, and infrastructure and of death, injury, illness, and displacement of people.

Figure 3.30: Severity of Impact Economic and Financial Conditions Scoring Criteria

Score	Description
1	Negligible: No direct economic impact
2	Limited: Temporary local slowing of economic activity; a few small businesses temporarily damaged
3	Moderate: Large businesses temporarily damaged; small businesses closed or relocated
4	Critical: Large businesses closed; entire corridors of businesses significantly impacted
5	Catastrophic: Widespread economic losses that affect the regional quality of life that will require Federal response

Severity of Impact – Regulatory and Contractual Obligations

Another secondary impact of a hazard event can be the long-term loss of services so that contracts are broken and quality of life is directly impacted. Regulations may be temporarily ignored, which increases risks to those affected by the regulations. The confusion resulting from the upheaval in a community can raise tempers and distract people from what they are obligated to do.

Figure 3.31: Severity of Impact Regulatory and Contractual Obligations Scoring Criteria

Score	Description
1	Negligible: No direct impact on obligations
2	Limited: Regulations are no longer followed and obligations are not met temporarily
3	Moderate: Vital services and further physical losses directly result from temporary failures
4	Critical: Vital services and severe physical losses result over months and years; lawsuits likely; people financially ruined
5	Catastrophic: Widespread losses result that severely damage local way of life; communities financially ruined; Federal response

Severity of Impact – Reputation of the Entity

Hazard events today are highly visible and people all over the world can learn about them. If the response, cleanup, or other activity is performed poorly, or previous promised mitigation efforts are proved insufficient by an event, local, state, regional, and even federal reputations can be damaged.

Figure 3.32: Severity of Impact Reputation of the Entity Scoring Criteria

Score	Description
1	Negligible: No direct impact on reputation
2	Limited: Reputation of jurisdiction is damaged temporarily or relating to a service provider not directly affiliated with the jurisdiction
3	Moderate: Reputation damage is more than temporary or compromises services in the area temporarily
4	Damaging: Reputation of jurisdiction is severely damaged and trust/confidence is broken for some time; political ramifications to the jurisdiction are notable
5	Severe: other entities must take over responsibility or service/program is entirely terminated

Speed of Onset

The speed of onset is quite simply the amount of warning time available before the hazard occurs. This should be taken as an average warning time. Warning time and the speed the incident develops varies greatly by hazard and by hazard event. Reduced warning time and time to react can worsen the magnitude of damage.

Figure 3.33: Speed of Onset Scoring Criteria

Score	Description
1	More than 2 days warning time
2	1 to 2 days warning time
3	13 to 24 hours warning time
4	7 to 12 hours warning time
5	2 to 6 hours warning time
6	1 to 2 hours warning time
7	31 minutes to 1 hour warning time
8	1 minute to 30 minutes warning time
9	No or virtually no warning (seconds)

Duration of Event

The duration of event is the length of time a typical event affects an area, not counting the cascading events, response, or recovery times. The duration will be from the genesis to the termination of the event in a given area, or the time when warning is sounded or damage begins until an all-clear signal or direct damage ends, not including cleanup, recovery, etc.

Figure 3.34: Duration of Event Scoring Criteria

Score	Description
1	A few seconds to a minute
2	1 minute to 30 minutes
3	31 minutes to 1 hour
4	1 to 6 hours
5	7 to 12 hours
6	13 to 24 hours
7	25 to 36 hours
8	37 hours to 1 week
9	More than one week

Loss Estimation Process

The loss estimation phase includes: 1) the descriptions of loss estimation techniques, 2) the losses for each hazard event, 3) and the estimated losses for each year by hazard by jurisdiction. The chapter also considers future losses due to possible new development in the county.

To complete this process, the planning team considers various data sources**.** The team uses several loss formulas based on the likely damages that each asset may receive from each type of event. The following formulas can be used:

Structures: structure replacement value X percent damaged = loss to structure
Contents: contents replacement value X percent damaged = loss to contents
Functional/use: functional downtime cost (average daily operating budget X days) + displacement cost (displacement costs per day X days displaced) = functional loss
Total estimated losses to asset: structure loss + contents and inventory loss + functional loss = total
Human loss: value of a human life, as defined by FEMA, plus the value of a severe injuries, as defined by FEMA, X the number of injuries and fatalities = total human loss

Plan Update Changes to the Loss Estimation Process
The planning team looked at more outside resources and considered hazard-specific data in each estimation. Also, the hazard loss estimate is outlined within each hazard profile rather than a separate chapter. The overall assessment of annual losses by jurisdiction is outlined later in this chapter for comparative purposes. Like the previous plan, there is no estimate of losses by structure, as this data is not available.

Dam and Levee Failure Profile
Type: Technological

Definition: The uncontrolled release of water resulting from a structural failure in a dam, wall, dike, berm, or area of elevated soil that causes flooding.

Dam and Levee Failure Description:
Dams are constructed for a variety of uses, including flood control, erosion control, water supply impoundment, hydroelectric power generation, and recreation. Flooding, operating error, poor construction, lack of maintenance, damage due to burrowing animals, vandalism, terrorism, and earthquakes can cause dam failure. Dams are classified into three categories based on the potential risk to people and property should a failure occur: High Hazard - If the dam was to fail, lives would be lost and extensive property damage could result; Moderate Hazard - Failure could result in loss of life and significant property damage; and Low Hazard - Failure results in minimal property damage only. The classification may change over time due to development downstream from the dam since its construction. Older dams may not have been built to the standards of its new classification. Dam hazard potential classifications have nothing to do with the material condition of a dam, only the potential for death or destruction due to the size of the dam, the size of the impoundment, and the characteristics of the area downstream of the dam. The Iowa Department of Natural Resources tracks all dams in the state of Iowa with a height of at least 25 feet or a total storage of at least 50 acre feet of water. The inventory excludes all dams less than 6 feet high regardless of storage capacity and dams less than 15 acre feet of storage regardless of height. The county has two lakes with dams that have been given a moderate or significant hazard class and two given a high hazard class by the State of Iowa. A further 33 dams are low hazard dams for a total of 37. The following table shows the current high and significant risk dams in the county.

Figure 3.35: High and Moderate Hazard Dam Information

Lake and Dam	Location	Height	Acre-Feet Storage	Classification
Arbor Valley Lake	Southwest edge of Osceola, outlet flows east into county	58 ft.	2,593	High
East Lake	Just east of Osceola in Clarke County	41 ft.	257	Significant
West Lake	West edge of Osceola, outlet flows northeast into county	34 ft.	9,675	Significant
Grade Lake	Southern part of Osceola, outlet flows south into county	44 ft.	865	High

Source: State of Iowa Hazard Mitigation Viewer, Dam and Levee Failure tab, https://iowahsemd.maps.arcgis.com/apps/MapSeries/index.html?appid=581c59432cb24779af37161c492309fa, 3/30/21

Levees are man-made structures designed to control water and protect structure and property in normally flood-prone areas. These can include berms and dikes. These structures can fail when flooding is too severe, they are improperly designed and built, or when they are not maintained. According to the State of Iowa Hazard Mitigation Viewer's Dam and Levee tab, there are no National Levee Database (NLD) levees or

other recognized levees in the county, nor are there any major levees in upstream counties, so this hazard is not a major concern.

Dam and Levee Failure Historical Occurrence:
There have been no notable or recorded dam failures in Clarke County. Dam failures can occur in rural Clarke County and Osceola due to dams in those areas. Small farm pond failures have occurred, affecting low hazard dams and causing very localized flooding. The four moderate and high hazard dams have experienced no failures nor do they show signs that one is likely in the future.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. Two indicated it happened once or twice in the last five years, 11 responded that it has not occurred, and five responded they did not know.

Dam and Levee Failure Future Probability:
With increased attention to sound design, quality construction, and continued maintenance and inspection, dam failure probability can be reduced, which is the case for the largest dams located within the county. The four moderate/high risk dams and any other public dams in the county are inspected regularly and the IDNR is contacted if evidence comes about that makes officials question their safety. Other private dams are small (a few acres at most) and do not pose any significant hazard to other property (private or public) outside of the dam owner's property. The planning team estimates less than 1% chance of occurrence in the next year involving the listed dams or dams upstream of Clarke County that could result in waters flowing through the rural parts of the county. No property within cities, except Osceola, and schools are at risk due to the direct effects, although washing out of roads and power lines, and loss of water supplies can have an indirect effect. A planned new water source lake in rural northwest Clarke County could have an impact on future probability, but that dam, if built, will be fully engineered.

The overall rating the community gave for this hazard's future probability in a survey was: "extremely rare." When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. Three indicated it is more likely, eight indicated no change in likelihood, three indicated less likely, and four indicated they were unsure.

Score for Rural Clarke County: 1	Score for Murray: 0	Score for Osceola: 1	Score for Woodburn: 0
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

Dam and Levee Failure Vulnerability to the Population:
Iowa has 4,173 dams on the state's dam registry, of with 59 are located in Clarke County (Iowa DNR, 3/30/21). Yet, the bulk of these are very small low-hazard dams, and only four are significant or high-hazard dams. No dams are considered a direct risk to a significant population in the immediate area below the dam. People and property along streams are most vulnerable to failures of these dams. Based on the topographical characteristics of these dams and outflow areas, it is possible that some bridges, buildings, and agricultural land could be impacted. Roads could be closed, including Interstate 35 north and south of Osceola, and a few homes could possibly be impacted. If West Lake Dam fails, it could have a direct impact on the City of Osceola water supply, which is also sold to rural residents, so a significant part of the county's population could be vulnerable to these effects. Temporarily, water can be provided by SIRWA from other regional plants until the Osceola water plant is put back online.

Score for Rural Clarke County: 4	Score for Murray: 0	Score for Osceola: 4	Score for Woodburn: 0
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

Dam and Levee Failure Area of Extent:

The area impacted following a dam failure would be limited to those areas in and near the floodplain. People and property outside the floodplain could also be impacted depending on the proximity to the dam and the height above the normal stream level. No formal study of dam failure inundation has been performed for Clarke County, so an estimate is based only on the area topography. In Clarke County, only 1-2 percent of the area would be impacted directly. Areas indirectly cut off from emergency services by the resulting flow of water could be larger. There is no means to accurately map the risk areas at this time. Indirectly, all occupied properties in Osceola and, to a lesser degree, other parts of the planning area would be affected if West Lake failure eliminates public water supplies.

Score for Rural Clarke County: 4	Score for Murray: 0	Score for Osceola: 4	Score for Woodburn: 0
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

Dam and Levee Failure Severity of Impact:

Dam failure severity will depend on the size of the impoundment, how rapidly it occurs, the extent of failure, and land uses below the dam. The following table shows the relative risks of the worst-case realistic scenario for the size of dams in the county.

Figure 3.36: Dam and Levee Failure Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	Up to 10 estimated persons could be injured or drowned if they live below stream or are driving below the dam when the dam breaks or if they are on the dam or in a boat close to the dam.	4
Health and safety of responders	Limited unless a further break occurs that widens the floodwater flow while responders are in the area; also, communications can be lost.	2
Continuity of operations	The loss of each lake would have impacts on continuation of recreation and wildlife services. West Lake's failure would disrupt water treatment operations for hours to months and would require SIRWA backup.	6
Property, facilities, infrastructure	Failure of each of the dams would result mostly in crop and livestock grazing land flooding and road and bridge damage or loss. Damage to roads and the Osceola water plant is possible. If West Lake fails, the water plant would be severely damaged, with water loss from several hours to days, depending on when SIRWA could provide enough water from other sources. If Grade and East Lakes fail, major highways (US 34 and 69) could be damaged or destroyed.	3
Delivery of services	Damage to roads and the water plant would disrupt the delivery of freight, traffic, and all potable drinking water in the Osceola area and much of the county.	2
Environmental impacts	Fish populations and vegetation in the lakes would be harmed. Downstream flash flooding would harm vegetation and wildlife and may cause storage facilities below to fail, which may dump more contamination into the waterway.	2
Economic/financial conditions	Loss of the lakes themselves represents lost tourism and recreation spending. West Lake in particular is home to dozens of annual fishing tournaments. It is also home to Lakeside Casino and Resort. Millions of dollars in revenues would be lost if the lake is not restored rapidly. East Lake and Grade Lake would have less recreational economic impacts, although East Lake has a campground. Closure and detour of roads in the impacted area, including I-35 and US 69 and 34 would result in extensive costly detours to gravel roads to get in and out of Osceola from all directions. Tens to hundreds of acres of farmland would be submerged and livestock could be lost.	4
Regulatory/contractual obligations	Osceola Waterworks would not be able to meet its obligated water supply production with the failure of West Lake.	2
Reputation	If any rescue is botched or if funds allocated to improve dams are not spent property, leading to the dam failure, the impact could be severe; otherwise, limited.	2

The overall rating the community gave for this hazard's magnitude in a survey was: "moderate."

Score for Rural Clarke County: 27	Score for Murray: 0	Score for Osceola: 27	Score for Woodburn: 0
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

Dam and Levee Failure Speed of Onset:

A dam and levee failure can be immediate and catastrophic, leaving little or no time to warn those downstream of the imminent hazard. With maintenance and monitoring, weak areas and possible failure points can be identified, allowing time for evacuation and securing of the dam. Most dams are only inspected periodically, thus allowing problems to go undetected until a failure occurs. A sudden total failure of the dams in Clarke County is unlikely, but a failure can build over minutes and complete within a few hours.

Score for Rural Clarke County: 8	Score for Murray: 0	Score for Osceola: 8	Score for Woodburn: 0
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

Dam and Levee Failure Duration of Event:

A dam failure may start slowly and take a moderate period of time to complete its destruction. The event could last from a few hours to days before all the water is released. The longer duration of event would likely result in less damage and fatalities because the initial torrent of water after the incident begins will be less. However, the long duration can also mean that responders cannot access the area until it is too late to rescue people and survey property and infrastructure. The score the planning team has used here factors the time required for enough water to be released so that responders can reach the site, based on the size of dams and impoundments in the county.

Score for Rural Clarke County: 6	Score for Murray: 0	Score for Osceola: 6	Score for Woodburn: 0
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

Dam and Levee Failure Total Scores:

The following total scores for dam and levee failure indicate low to moderate risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 50	Score for Murray: 0	Score for Osceola: 50	Score for Woodburn: 0
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

Dam and Levee Failure Vulnerability/Assets at Risk:

This vulnerability assessment is based on the high and moderate hazard dams in the planning area. Only assets in rural Clarke County and parts of Osceola would be at direct risk. Only small percentage of the assets in these areas would be at risk, as outlined below, compared to the full lists of assets in Section 3.2.

Figure 3.37: Rural Clarke County Dam and Levee Failure Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	5	$250,000	10	0.1%
Commercial	0	$0	0	0%
Industrial	0	$0	0	0%
Ag Structures and Land	10 buildings; 5,000 acres	$5,000,000	2	2%
Taxable Infrastructure	1	$3,000,000	1	2%
Government/Institutional	5	$40,000,000	20	20%
Totals	21	$48,250,000	33	6%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

As this table shows, an estimated 33 residents live or will be located in rural areas that are at risk of inundation of other loss when a dam failure occurs in Clarke County. Based on data available, there is no direct risk due to dam failures occurring in other upstream counties. The total valuation at risk of 21 properties exceeds $48 million dollars, it is estimated. Only a small number of occupied properties are known to be at risk. No analysis was done to determine the extent of risk to occupied properties, such as the

location of inundation versus the home situation on a lot or number of vehicles that may be on impacted roadways at a given time of a dam failure.

The following critical assets in the county, as outlined in Section 3.2, could be impacted by this hazard because they are in or partly within the potential inundation areas:

- East Lake Park and Dam
- I-35 bridge over South Squaw Creek
- R35 bridge over South Squaw Creek
- R35 bridge over Squaw Creek
- US 69 bridge over White Breast Creek
- I-35 bridge over White Breast Creek
- Approximately a dozen other bridges in the county's secondary roads system downstream from the various lakes
- Approximately five miles of rural roads and highways, county roads, I-35, and US 34 and 69

Within Osceola, very little value and few critical assets are likely to be impacted other than the impoundments themselves. A handful of people within the boundaries of each city could be impacted, but this impact would most likely be indirect. Again, the main critical asset impacted could be the Osceola Water Plant, which is directly below the West Lake Dam.

Dam and Levee Failure Loss Estimation:
The main losses due to a dam failure in Clarke County would be quality of life and economic, unless the failure is a sudden complete failure of the entire dam. Based on the topography below local dams and the volume of water, a complete and sudden full failure where there is a wall of water suddenly released downstream would be required to cause significant damage more than immediately below the dam. It is possible in this situation that the above list of assets would be damaged. People would be greatly inconvenienced and businesses would be hindered if roads and bridges were flooded near Osceola and if water supplies had to be diverted to SIRWA's other sources. Downstream from most of the county's dams within a few miles are secondary roads, farmland, and bridges. Anything more than about a mile from the dam would likely suffer the same loss as during a flood event (see river flood profile). The farther the water reaches from the dam, the less severe the physical/structural loss would be. Physical losses from a total failure may reach over $5 million dollars to crops and livestock lost, damage to docks and boats, bridges damaged or removed, roads washed away, and utilities damaged.

In any type of dam failure where the water drains from the lake, the loss would be significant for the local economy, because all the significant hazard dams are part of park and recreation areas that host fishing, camping, and other activities or are on private lakes that support high-value homes and watercraft. While the local economy is diverse, recreation and tourism are significant elements, and the economic loss could top $1 million very easily.

Future Development and Dam and Levee Failure:
Future development located downstream from dams in floodplains or inundation zones would increase vulnerability. However, such development is unlikely, except perhaps road and bridge upgrades that must be located in the hazard area. In part because zoning is in place, it is unlikely that private development would occur downstream within a few miles of a dam or anywhere in a floodplain.

Drought Profile
Type: Natural

Definition: A period of prolonged abnormally low precipitation producing severe dry conditions.

Drought Description:
There are four types of drought conditions that are relevant to Iowa: Meteorological drought, which refers to precipitation deficiency; hydrological drought, which refers to declining surface water and groundwater supplies; agricultural drought, which refers to soil moisture deficiencies, and socioeconomic drought, which refers to when physical water shortages begin to affect people. Droughts can be spotty or widespread and last from weeks to a period of years. A prolonged drought can have serious economic impact on a community. Increased demand for water and electricity may result in shortages of resources. Moreover, food shortages may occur if agricultural production is damaged or destroyed by a loss of crops or livestock. While droughts are generally associated with extreme heat, droughts can and do occur during cooler months.

Drought Historical Occurrence:
Drought has been a significant part of life in rural Iowa, including Clarke County, for all of modern history. Because Iowa is an agricultural community and rain/snow fluctuations can be great, drought conditions are normal. At least one part of Iowa is in mild drought conditions most of the time. According to the National Centers for Environmental Information (NCEI), Iowa had 14 periods of drought from 1995-2017. During that period, there was $4.612 billion in crop damage resulting from drought periods and over $645 million in property damage.

According to the NCEI, there have been 16 droughts from 1999 (none reported before that year) through December 2021. While damage and loss are not reported by county for this hazard, the events that affected Clarke County caused no deaths and injuries but significant property and crop damage, $12.65 million and $97.65 million respectively, regionally. Drought years reported to the NCEI include 1999, 2000, 2001, 2003, 2012, 2013, 2017, and 2018. Most occurred in or involved the month of August. While some may have been more severe than others, agricultural areas were impacted more heavily than the metropolitan areas where impacts were indirect. The most common forms of drought historically in Iowa are agricultural and meteorological drought as a result of either low soil moisture or a decline in recorded precipitation.

More prolonged droughts occurred around 1998 and the early part of the last decade (2001-2006). Southern Iowa suffered from a mild but prolonged drought event from 2001-2006 that nearly drained all water supplies, even with regional water in place in the last decade. Most or all of Iowa experienced severe drought conditions throughout 2012 and into 2013. Prolonged hot and dry weather in summer 2012 and limited rain and snow during the spring, fall and winter have caused extreme drought in some areas. Water source lakes and streams were critically low. Heavy rain beginning in March 2013 has lessened the drought severity in all of Iowa and eliminated drought conditions in much of Iowa, including Clarke County. The planning team states that drought seems to be an annual event. After a few wetter years, drought has been an issue in 2019 and 2020 during the growing season. A mild to moderate drought has persisted most of the past two years through the early spring of 2021. One survey respondent stated that annual or biannual dry spells create treatment issues at the water plant and concerns for local industries.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. Three indicated it occurs most years, 11 indicated it happened once or twice in the last five years, two responded that it has not occurred, and two responded they did not know.

In summary, droughts have been in effect about 40% to 50% of the time, with severe droughts relatively rare.

Drought Future Probability:
Drought is part of normal climate fluctuations and can last for years at a time. Research and observations of the El Nino/La Nina climate events are resulting in more predictable climate forecasts. Based on the

evidence that drought periods seem to occur in cyclical patterns and that all of Iowa is in a drought about 10-14.9% of the time, it can be assumed that any given area of Iowa is at least this likely to have a disaster in a given year. The planning committee estimates that in a given year Clarke County has a 10% to 19% chance of experiencing a severe drought event (-3.0 to -3.9 PDSI) or worse in a given year. The chance of a minor or moderate drought is even higher.

The overall rating the community gave for this hazard's future probability in a survey was: "probable." When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. Eight indicated it is more likely, six indicated no change in likelihood, one indicated less likely, and three indicated they were unsure.

Score for Rural Clarke County: 5	Score for Murray: 5	Score for Osceola: 5	Score for Woodburn: 5
Score for Clarke Schools: 5	Score for Murray Schools: 5	Score for SWCC: 5	Score for hospital: 5

Drought Vulnerability to the Population:

Being a rural county with mainly surface water supplies, Clarke is likely to suffer heavily from an extended drought, both directly and indirectly. In 2006 and again in 2012/13, regional water supplies from some of the regional water source lakes were dangerously low. In the 1980s, before surface lakes were prevalent, many in the county were sick due to drinking from severely low water supply wells. Agriculture, agribusiness, and consumers (if the drought lasted long enough or impacted a large area) would be impacted. Fire suppression can also become a problem due to the dryness of the vegetation and possible lack of water for fire suppression. Farmers would be most impacted, but all county residents are susceptible. Schools and hospitals may suffer short water supplies and increased vulnerably populations due to dehydration. Particular groups most directly impacted include seniors, handicapped persons, and diabetics.

Score for Rural Clarke County: 7	Score for Murray: 5	Score for Osceola: 5	Score for Woodburn: 5
Score for Clarke Schools: 5	Score for Murray Schools: 4	Score for SWCC: 4	Score for hospital: 4

Drought Area of Extent:

A drought would likely affect most of Iowa if not the Midwest as a whole. While not all properties will be negatively impacted, the drought would occur countywide and in all jurisdiction at a given time.

Score for Rural Clarke County: 9	Score for Murray: 9	Score for Osceola: 9	Score for Woodburn: 9
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Drought Severity of Impact:

The most commonly used indicator of drought and drought severity is the Palmer Drought Severity Index (PDSI) published jointly by NOAA and the United States Department of Agriculture. The PDSI measures the departure of water supply (in terms of precipitation and stored soil moisture) from demand (the amount of water required to recharge soil and keep rivers, lakes and reservoirs at normal levels). The result is a scale from +4 to -4, ranging from an extremely moist spell to extreme drought. By relating the PDSI number to a regional index, one can compile data that reflects long-term wet or dry tendencies. The following table illustrates the PDSI.

Figure 3.38: PDSI Index Description

Index Classification	Index Description	Index Classification	Index Description
4.0 or more	Extremely wet	-0.5 to -0.99	Incipient dry spell
3.0 to 3.99	Very wet	-1.0 to -1.99	Mild drought
2.0 to 2.99	Moderately wet	-2.0 to -2.99	Moderate drought
1.0 to 1.99	Slightly wet	-3.0 to -3.99	Severe drought
0.5 to 0.99	Incipient wet spell	-4.0 or less	Extreme drought
0.49 to -0.49	Near normal		

Regional indicators such as the PSDI are limited in that they respond slowly to deteriorating conditions. On the other hand, observing surface conditions and groundwater measurements may provide only a snapshot of a very small area. Therefore, the use of a variety of drought indicators is essential for effective assessment of drought conditions. Other climatic factors such as high temperatures, prolonged high winds/and low relative humidity can aggravate the severity of a drought. Severity depends on duration, intensity, geographic extent and the demands made by human activities and vegetation of regional water supplies. The following table illustrates the potential impacts of drought.

Figure 3.39: Drought Impacts by Severity Classification

			Ranges				
Category	Description	Possible Impacts	Palmer Drought Index	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Short and Long-term Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-1.0 to -1.9	21-30	21-30	-0.5 to -0.7	21-30
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-2.0 to -2.9	11-20	11-20	-0.8 to -1.2	11-20
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-3.0 to -3.9	6-10	6-10	-1.3 to -1.5	6-10
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-4.0 to -4.9	3-5	3-5	-1.6 to -1.9	3-5
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less	0-2	0-2	-2.0 or less	0-2

Source: Iowa Hazard Mitigation Plan, 2018; http://www.weatherwizkids.com/wp-content/uploads/2015/02/drought-classification.jpg

The following table shows the relative risks of an extreme drought.

Figure 3.40: Drought Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	Health can be compromised due to the lack of quality water. While the bottled water industry can mitigate some of these issues temporarily, running water is necessary. The planning team indicates that the Jordan Aquifer is reported to be very unpleasant and unsafe to drink. Funds are too limited for any other alternative to surface water. Lake sources can shrink and result in the inability to dilute chemicals entering water sources. Wildfires are also increasingly likely. Hospitals indicate a high number of people needing treatment for dehydration taxes their service capacity.	2
Health and safety of responders	Limited unless firefighters are fighting a fire or other hazard and run out of water.	1
Continuity of operations	This impact would be minimal and not easily assessed. Some facilities and services may be unable to operate once the drought was severe enough.	3
Property, facilities, infrastructure	Extreme dry weather can cause lakes to dry up, pipes to heave, and roads and bridges to sustain damage, especially if the drought causes expansive (or contractive) soils. Again, crops and livestock could be lost.	2
Delivery of services	Except for delivery of surface water for humans, pets, and livestock, few services would be impacted. Large industry that requires large volumes of water would not be able to operate.	3
Environmental impacts	Fish populations and vegetation in the lakes and streams can be harmed. Sensitive plants and crops would be harmed. Mass vegetative death could impact wildlife negatively or cause	3

Severity Criteria	Discussion	Score
	greater risk of landslides, erosion, and other soil loss hazards. Land quality can harmed by overgrazing during drought. Water quality can become degraded and can cause a large nitrate concentration in the rivers. Low stream flow will be negative impacts on riparian habitats and aquatic species.	
Economic/financial conditions	Drought can lead to large and damaging impacts to the agricultural economy. Because of Iowa's reliance on the agricultural economy, the economic and financial impacts would certainly ripple out into other sectors. Rural areas can be especially affected by long-term drought. In 2012 alone crop damages from drought were $4.992 billion in Iowa. If restrictions were put on manufacturers that use large amounts of water, the local economy would be severely impacted. Several manufacturers in Osceola are heavily water-dependent.	County, Osc. 4 Others: 3
Regulatory/contractual obligations	Area water suppliers would not be able to meet its obligated water supply production with the drop in lake supplies. Regulations in the agricultural sector can be and are often adjusted to provide some lenience for adverse conditions for livestock and crop loss.	3
Reputation	Local jurisdictions can suffer reputation damage if they do not provide source water to residents or respond in a satisfactory manner to provide an alternative supply.	2

The overall rating the community gave for this hazard's magnitude in a survey was: "critica1."

Score for Rural Clarke County: 23	Score for Murray: 22	Score for Osceola: 23	Score for Woodburn: 22
Score for Clarke Schools: 22	Score for Murray Schools: 22	Score for SWCC: 22	Score for hospital: 22

Drought Speed of Onset:

Drought warning is based on a complex interaction of many different variables, water uses, and consumer needs that make prediction difficult. Drought warning is directly related to the ability to predict the occurrence of atmospheric conditions that produce the physical aspects of drought, primarily precipitation and temperature. In fact, an area may already be in a drought before it is even recognized. However, the weather that results in a drought, such as prolonged dry weather, requires weeks or months to produce drought conditions.

Score for Rural Clarke County: 1	Score for Murray: 1	Score for Osceola: 1	Score for Woodburn: 1
Score for Clarke Schools: 1	Score for Murray Schools: 1	Score for SWCC: 1	Score for hospital: 1

Drought Duration of Event:

A drought, especially a severe drought, almost always lasts for weeks before adequate rainfall occurs to alleviate the drought conditions.

Score for Rural Clarke County: 9	Score for Murray: 9	Score for Osceola: 9	Score for Woodburn: 9
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Drought Total Scores:

The following total scores for drought indicate moderate risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 54	Score for Murray: 51	Score for Osceola: 52	Score for Woodburn: 51
Score for Clarke Schools: 51	Score for Murray Schools: 51	Score for SWCC: 51	Score for hospital: 51

Drought Vulnerability/Assets at Risk:

While all structures, property, and people in the county would be at risk, the greatest risk of this hazard is economic. Buildings, infrastructure, and critical facilities, with rare exception, are not directly vulnerable to this hazard, although shrinking clay soils can cause secondary hazards to buildings and utilities (see expansive soils profile). However, virtually all assets in the county, as outlined in Section 3.2, could suffer secondary effects of the economic loss, namely to crops and livestock. However, the secondary effect of water rationing, soil loss, soil expansion/contraction, and reduction of recreational lake water levels could

impact not just the economy but also structures and people in all parts of the county. In a long severe drought, all people would be adversely affected to some degree.

All critical assets in the county, as outlined in Section 3.2, could be impacted by this hazard, although, again, it would be a secondary effect in most cases.

Drought Loss Estimation:
With over 75% of the land in the planning area being used for agriculture, the exposure to drought is very high. Aside from agricultural impacts, other losses related to drought include increased costs of fire suppression and damage to roads and structural foundations due to the shrink dynamic of soils (see expansive soils profile) during excessively dry soils. According to the USDA's Risk Management Agency, payments for drought crop losses top any other cause for insurance claims in total losses in Clarke County. From 2016 through 2020 (five full years), the total paid insurance claim was $6,763,552.06 or $1.35 million annually. Farmers suffer the most because wells run dry, crops wilt and die, and forage for livestock becomes scarce and costly. Public health can be compromised due to the loss of water supply. Even with the regional water supplies in place, thousands of residents throughout the county, nearly all those living in the county, would likely suffer some level of risk to their health. Dozens both in town and in rural areas would likely suffer from sickness or other health problems during any drought event.

According to the 2013 Iowa Hazard Mitigation Plan, drought was ranked 2nd of eight hazards in annualized losses based on data spanning 18 years (this data was not found in the 2018 update). Although losses from this hazard reach millions of dollars each time drought occurs, much of it is mitigated by crop insurance. However, losses to public health, industrial and business disruption, fire capabilities, tourism loss, and inconvenience are not covered. FEMA has developed standard loss of use estimates in conjunction with their benefit-cost analysis methodologies to estimate the cost of lost utilities on a per-person, per-use basis. If Osceola, for example, would have to purchase potable water based on FEMA's potable water cost of $93 per person per day, the potential cost would be approximately $465,000 per day.

In the past nearly five years (2016-2020), there have been over $11.3 million in claims for crop insurance in Clarke County, an average of $2.26 million per year. Over 30% of crop insurance claims during this period in terms of dollars were as a result of drought. According to the 2013 Iowa Crop Profile from the USDA's Risk Management Agency, 90.5% of insurable crops in Iowa are insured with USDA crop insurance. Based on insured loss data for droughts that exceed $6.76 million for the past five years, it can be stated that approximately $710,000 in uninsured losses occurred over that time for an average of $142,000 per year. This is a total of an estimated $1.49 million in drought losses per year. Based on the 2017 Census of Agriculture total crops sold of $19,445,000, an estimated 8% of crop value is lost due to drought.

Future Development and Drought:
Increases in the amount of land used for crops and in new development resulting in new residents in the planning area both would result in an increase risk, simply because exposure is greater. Commodity prices will affect the economic cost per incident.

Expansive Soils Profile
Type: Natural

Definition: Soils and soft rock that tend to swell or shrink excessively due to changes in moisture content.

Expansive Soils Description:
The effects of expansive soils are most prevalent in regions of moderate to high precipitation, where prolonged periods of drought are followed by long periods of rainfall. The hazard occurs in many parts of

the Southern, Central, and Western United States, including most areas of Iowa. Recent estimates put the annual damage from expansive soils as high as $7 billion nationwide. However, because the hazard develops gradually and seldom presents a threat to life, expansive soils have received limited attention, despite their costly effects.

Expansive Soils Historical Occurrence:
In Clarke County, high clay soils mean that buildings with weak foundations and basements can be and have been affected by shrinking and swelling soils. Historical events have been isolated and have normally impacted areas of less than 20 feet in diameter. The planning team notes that foundations of homes and some rural bridges have been damaged. The planning team indicates that frost boils have erupted under roads in early spring thaws, causing damage to those roads and to vehicles driving over them. Numerous frost boils occurred in all jurisdictions of the county in April 2008 after a long and wet winter. Other spring thaws since then have resulted in the same issues. Numerous rural bridges have experienced soil loss on bridge approaches. Numerous homes have suffered from cracked and broken basement walls over the course of time. This is an actually pretty common hazard in a small scale and likely is very under-reported or only reported to a property owner's insurance company.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. One indicated it happens most years, three indicated it happened once or twice in the last five years, seven responded that it has not occurred, and seven responded they did not know.

Expansive Soils Future Probability:
Probability and frequency analyses have not been prepared because of the nature of occurrence of this hazard. This is consistent with other geological hazards that occur slowly over time. The probability is much higher, likely multiple times per year, for an individual building suffering from expansive soils than for a widespread incidence affecting multiple properties and requiring a public response. Only on occasion, such as once every five years, will an expansive soils event occur in widespread areas of the county.

While members of the committee varied greatly on their interpretation of future probability, the consensus of the committee anticipates a 5-25% probability in a given year of finding one or more expansive soils incidents that impact critical infrastructure, such as cause road closures or damage essential pipelines. House and other building foundations will continue to be subjected to this hazard due to Iowa's constantly changing weather conditions and contrasting seasons every year, but that issue is mostly mitigated by property insurance and improved construction processes. Awareness of this hazard in the past ten years has resulted in mitigation through better construction practices, soil testing before construction, and use of proper fill and drainage techniques around buildings and structures.

When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. None indicated it is more likely, nine indicated no change in likelihood, two indicated less likely, and seven indicated they were unsure.

While varying by jurisdiction, overall there is a moderate chance in a year of damaging expansive soils.

Score for Rural Clarke County: 8	Score for Murray: 3	Score for Osceola: 4	Score for Woodburn: 3
Score for Clarke Schools: 2	Score for Murray Schools: 2	Score for SWCC: 2	Score for hospital: 2

Expansive Soils Vulnerability to the Population:
Information on clay soils is limited for most properties, but Clarke County residents are accustomed to minor incidents resulting in bowing basement walls and cracking foundations. There is very little risk to human life in most cases. Impacts commonly involve swelling clays beneath areas covered by buildings and slabs

of concrete and asphalt, such as those used in construction of highways, walkways, and airport runways. Most major new construction projects, such as government buildings and roads, involve extensive soil testing. Despite some minor variations by community, the committee believes the overall impact is pretty low overall. Minor road and foundation issues can impact hundreds of people mostly in the way of inconveniences and home repair costs, which are usually insurable. The planning team indicates that the hazard causes "long-term damage rather than an immediate impact." Damaged or broken electrical facilities and water, sewer, or gas lines can impact a larger population. When organizations build large buildings, the design must often include structural fill to address the expansive nature of the local soils.

Score for Rural Clarke County: 3	Score for Murray: 4	Score for Osceola: 4	Score for Woodburn: 4
Score for Clarke Schools: 5	Score for Murray Schools: 5	Score for SWCC: 5	Score for hospital: 5

Expansive Soils Area of Extent:

According to the map in the 2018 State of Iowa Hazard Mitigation Plan from "Swelling Clays Map of the Conterminous United States," all of Clarke County is in the "part of unit (generally less than 50%) consists of clay having slight to moderate swelling potential." Those who live in the area would agree that this category understates the shrink/swell potential, as evidenced in the common occurrence of damaged roads, sidewalks, driveways, basement walls, and building foundations. The amount of clay in area soils countywide is high, and often it shrinks and swells as a result of rain, drought, and ground frost. Nonetheless, the hazard is not entirely widespread because there are variations in soils and, in areas where development has not occurred, these soils do not produce risk. Most occurrences in Clarke County will be very limited in size and have no widespread significance.

Score for Rural Clarke County: 2	Score for Murray: 2	Score for Osceola: 2	Score for Woodburn: 2
Score for Clarke Schools: 2	Score for Murray Schools: 2	Score for SWCC: 2	Score for hospital: 2

Expansive Soils Severity of Impact:

The severity of expansive soils depends primarily on what structures and assets are located in the soils that expand. Often expansion and contraction will not cause any damage. Other times the result will be broken pipes, large cracks in roads and foundations, sinkholes, and other hazards. The cascading impacts can be significant if large populations and key assets are in the path of hazards such as hazardous materials leaks. The table below shows the relative risks of a typical expansive soils event.

Figure 3.41: Expansive Soils Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	Very little to no impact is projected directly. Natural gas or plumbing leaks in homes and buildings present risk in rare cases when undetected or addressed quickly enough. Cracks in basement walls can allow radon, which is a poisonous gas common to Iowa, to enter homes.	2
Health and safety of responders	Usually no response will be necessary, but when critical public infrastructure or pipelines are damaged, emergency response might be necessary.	1
Continuity of operations	Road detours may result, causing inconvenience. Water, sewer, and power facilities may be damaged, causing inconvenience, possible sickness, and possible fires, and other issues. Continuity on a wide scale is not likely to be disrupted.	2
Property, facilities, infrastructure	The most extensive damage from expansive soils occurs to highways and streets. Houses and one-story commercial buildings are more apt to be damaged by the expansion of swelling than are multi-story buildings, which usually are heavy enough to counter swelling pressures. The most obvious manifestations of damage to buildings are sticking doors, uneven floors, and cracked foundations, floors, walls, ceilings, and windows. Major lifeline systems can be affected, including water and sewer lines, gas pipelines, and high voltage power lines.	3
Delivery of services	Delivery of services should not be impacted. Life threatening impacts from the loss of services would not be likely.	1
Environmental impacts	No direct or long-term effect on the environment unless a hazardous material is leaked following pipeline failure or similar damages.	2
Economic/financial	Economic and financial impacts would be limited, resulting from disruption of the flow of	2

conditions	goods and services. Business disruption would likely be very short if any. Loss of infrastructure could cause greater concerns.	
Regulatory/contractual obligations	The jurisdiction would have to repair the roads and surfaces impacted.	2
Reputation	No foreseeable impacts on the reputation of the entity unless the problem is ignored and allowed to worsen, such as potholes continuing to expand. Damage caused in ROW areas can be controversial related to property owner rights and responsibilities.	2

Score for Rural Clarke County: 17	Score for Murray: 17	Score for Osceola: 17	Score for Woodburn: 17
Score for Clarke Schools: 17	Score for Murray Schools: 17	Score for SWCC: 17	Score for hospital: 17

Expansive Soils Speed of Onset:

Soil issues in Clarke County, including frost boils and foundation cracking, would occur rather slowly but could escape notice until suddenly significant damage has occurred. We would have some warning that events could occur soon due to prolonged weather patterns, such as excessive rain and winter weather. These signs might help us understand that expansive soils will likely cause damage but it will not provide details on where they will occur and which assets are affected. Underground pipes might be subject to slowly occurring events that are undetected until suddenly the pipe breaks. These sudden occurrences result in the greatest damage for which mitigation is necessary.

Score for Rural Clarke County: 5	Score for Murray: 5	Score for Osceola: 5	Score for Woodburn: 5
Score for Clarke Schools: 5	Score for Murray Schools: 5	Score for SWCC: 5	Score for hospital: 5

Expansive Soils Duration of Event:

An expansive soils incident will typically last from a few minutes to days or even weeks. If not corrected, the event can continue to occur and the damage can grow perpetually. Mitigation is most urgent for the most rapidly occurring events but long-term shifts in foundations and road cracking can be significant hazards also.

Score for Rural Clarke County: 9	Score for Murray: 9	Score for Osceola: 9	Score for Woodburn: 9
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Expansive Soils Total Scores:

The following total scores for expansive soils indicate low to moderate risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 44	Score for Murray: 40	Score for Osceola: 41	Score for Woodburn: 40
Score for Clarke Schools: 40	Score for Murray Schools: 40	Score for SWCC: 40	Score for hospital: 40

Expansive Soils Vulnerability/Assets at Risk:

Expansive soils are found throughout the county, but short of a site-by-site analysis of soil data, it is difficult to ascertain which specific properties and assets are at risk and which ones are not. For this reason, the analysis considers that all structures, property, and people, as outlined in Section 3.2, could be at risk. In reality, most structures and properties that do not have basements or that are well built will not experience damage due to this hazard.

All critical assets in the county, as outlined in Section 3.2, could be impacted by this hazard, although the damage to any individual building may be minor and most events or incidents will be of a localized nature, affecting only one or a few structures or portions of structures.

Expansive Soils Loss Estimation:

The losses due to this hazard depend mostly on the location in relation to structures and assets, the type of soil, the quality of construction, and how widespread the hazard is. Sometimes, the conditions, such as

prolonged heavy rain, a severe frost followed by rapid thaw, or severe drought, can be widespread and impact dozens or even hundreds of properties, cracking foundations, tipping utility poles, buckling roads, and snapping pipelines. In these extreme events, the effects can be sudden and can cause injuries or, although rare, even death. The greatest likelihood of loss is to foundations of structures, with dozens damaged each incident at an average cost of $5,000 to the average structure. Physical losses throughout the planning area may exceed $500,000 per year in years when incidents are widespread.

Future Development and Expansive Soils:
An increase in the amount of land used for new structures will increase risk simply because exposure is greater. Depending on the type and quality of construction of modern buildings, the risk could vary compared to existing development.

Extreme Heat Profile
Type: Natural

Definition: Summertime weather that is substantially hotter and/or more humid than average for a location at that time of year.

Extreme Heat Description:
In Iowa, extreme heat events (EHE) result from a prolonged period of excessive heat and humidity. Because how hot the temperature feels depends on the interaction of multiple meteorological variables (e.g., temperature, humidity, wind, cloud cover), extreme heat criteria typically shift by location and time of year. In other words, Boston, Philadelphia, Miami, Dallas, Chicago, San Diego, and Seattle are likely to have different criteria at any point in the summer to reflect different local standards for unusually hot summertime weather. In addition, these criteria are likely to change for each city over the summer. Excessive heat is the leading cause of weather fatalities in the nation (through 2009), edging flooding and hurricanes by a small margin. Heat fatality data may actually be under-representative because it might be difficult to see the role of heat in the death of people days or months after the event. Many people do not realize how deadly a heat wave can be. In contrast to the visible, destructive, and violent nature of floods, hurricanes, and tornadoes, a heat wave is a silent killer. Heat kills by overloading the human body's capacity to cool itself. In a normal year, about 117 Americans die as a direct result of excessive heat. In a heat wave in 1980, more than 1,250 people died nationwide.

Extreme Heat Historical Occurrence:
Even though the NCEI has reported only three EHE events, almost every summer there has been at least one EHE as identified by the planning team using the State plan's definition. The week of July 18, 2011 sustained a weeklong excessive heat warning with most of the week seeing 110-degree-plus heat indexes during the day and 90-plus heat indexes at night. In 2012-2014, Clarke County experienced at least one day over 100 degrees. It was over 95 degrees for two straight weeks in 2012 and there were at least 12 days that exceeded 100 degrees that summer. The extreme heat affected people, livestock, and crops. Many elderly people suffered during these events. The County and entities within the county have opened cooling shelters each summer the past few years.

According to the National Centers for Environmental Information, 3 extreme heat events were reported in Clarke County, between 01/01/1995 and 12/31/2021. These events occurred in 2011, 2016, and 2019. No deaths or injuries were reported during these hazard events. Property damage was $135,000. No crop damage was reported, but the planning team recognizes that crop damage does occur due to extreme heat.

Clearly, not all extreme heat events, as defined in this plan, are reported in the NCEI database. Perhaps this is because widespread damages and deaths attributed directly to the event are reported in only a few cases.

The planning team indicates that high heat combined with humidity cause damage in some form (lost productivity, increased fire risk, sickness and death, infrastructure problems) almost every summer and sometimes for days at a time during spells in a given summer. The Clarke County planning team indicates that the incidence of extreme heat is an at-least bi-annual event and has occurred at least 12 times in the past 25 years, most recently in 2020 as the result of a few days where the heat index exceeded 105 degrees. Clarke County, being in southern Iowa, is typically slightly hotter than the state average.

Seventeen persons responded to the online survey question about past occurrences of this hazard. One indicated it happens more than once per year, eight indicated it happened most years, six indicated it happened once or twice in the last five years, one responded that it has not occurred, and one responded they were unsure.

From 2006 through end of 2020, there were 11 NWS excessive heat warnings, and 7 excessive heat watches, and 50 heat advisories issued for Clarke County for heat-related events (*http://mesonet.agron.iastate.edu/vtec/search.php#byugc/IA/IAC001/20110101/20160318*).

The history of extreme heat can be measured in one way by looking at past high temperature records. The Iowa State University Department of Agronomy (*http://mesonet.agron.iastate.edu/request/coop/fe.phtml*) maintains records from the NWS weather station at Osceola. These records include daily highs from January 1, 1893 through today (March 31, 2021). The recorded high temperature was 106 degrees F (three occasions). There have been 126 days where the temperature reached or exceeded 100 degrees, most recently on July 13, 2018.

Extreme Heat Future Probability:
Extreme heat is likely in any given summer, sometimes on multiple occasions. If temperature extremes continue to become more common in this region, the likelihood for extreme heat increases. The planning team estimates extreme heat will have a 60-75% chance of occurring in the next year. However, the probability will depend greatly on severity, as the following chart shows.

Figure 3.42: Extreme Heat Probability by Level of Severity

Heat Condition	Probability in Planning Area	Relative Severity
Heat index of 130 degrees F or higher	Very rare (1% chance)	Catastrophic
Heat index of 105 to 129 degrees F	Common (50%+ chance)	Critical
Heat index of 90 to 104 degrees F	Several times to regularly	Limited
Het index of less than 90 degrees F	Most late spring and summer days	Negligible

For planning purposes, this probability assessment considers the conditions of a heat index of 105 to 129 degrees F.

When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. Eight indicated it is more likely, seven indicated no change in likelihood, none indicated less likely, and three indicated they were unsure.

Score for Rural Clarke County: 8	Score for Murray: 8	Score for Osceola: 8	Score for Woodburn: 8
Score for Clarke Schools: 8	Score for Murray Schools: 8	Score for SWCC: 8	Score for hospital: 8

Extreme Heat Vulnerability to the Population:
Extreme heat events are known to be among the greatest cause of natural hazard death and illness to humans and pets. Recent information released by the NOAA Office of Climate, Water, and Weather Services states extreme heat America's greatest non-severe weather related killer. Elderly persons, small children, chronic invalids, those on certain medications or drugs (especially tranquilizers and anticholinergics), and persons

with weight and alcohol problems are particularly susceptible to heat reactions. The planning team mentions the high population of elderly people in the county. Healthy individuals working outdoors in the sun and heat are vulnerable. Low-income individuals and inner city dwellers can also be susceptible without access to air-conditioned rooms. While no reported deaths have been attributed directly to extreme heat in Clarke County, illnesses have occurred and the stress of heat is certainly a factor in deaths of the elderly. Currently, there are designated cooling shelters, namely certain school buildings and community halls, as defined in the community profile chapter (Chapter 2).

Indirect effects of extreme heat will impact more people through loss of productivity in business, reduced water supplies, inability to participate in the outdoors, higher utility costs, and reduced agricultural productivity. However, not all people will be affected directly. In the general population the risk is greater than in schools and the hospital, because schools either have air conditioning or they close on extremely hot days and because the hospital has air conditioning.

Score for Rural Clarke County: 5	Score for Murray: 5	Score for Osceola: 5	Score for Woodburn: 5
Score for Clarke Schools: 3	Score for Murray Schools: 3	Score for SWCC: 3	Score for hospital: 3

Extreme Heat Area of Extent:
All of Clarke County would be subjected to the extreme heat with vary rare exceptions.

Score for Rural Clarke County: 9	Score for Murray: 9	Score for Osceola: 9	Score for Woodburn: 9
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Extreme Heat Severity of Impact:
Heat severity of impact relates to more than just the actual temperature. High humidity, which often accompanies heat in Iowa, can increase the harmful effects. Other factors include exposure, wind, and activity. The heat index devised by the NWS combines air temperature and relative humidity to measure how hot it really feels. For example, if the air temperature is 102 degrees and the relative humidity is 55% then it feels like 130 degrees; 28 degrees hotter than the actual ambient temperature. To find the heat index from the figure below, find the air temperature along the top of the table and the relative humidity along the left side. Where the two intersect is the Heat Index for any given time of day. The new Mean Heat Index is a measure of how hot the temperatures actually feel to a person over the course of a full 24 hours. It differs from the traditional heat index in that it is an average from the hottest and coolest times of each day. Exposure to full sunshine can increase the heat index by at least 15 degrees.

Figure 3.43: Heat Index Chart

NWS Heat Index — Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution — Extreme Caution — Danger — Extreme Danger

The National Weather Service can issue a Heat Advisory or Excessive Heat Warning:

- Heat Advisory: A heat index of 100°F or higher is expected for a period of 3 hours or more. A heat advisory shall be continued through the overnight hours, following a day with excessive heat, if the heat index is not expected to fall below 75°F. A heat advisory can be issued for a heat index less than 100°F when the cumulative effect of successive days of near advisory heat leads to potentially life-threatening conditions.
- Excessive Heat Warning: A heat index of 105°F or higher is expected for a period of 3 hours or more. An excessive heat warning shall be continued through the overnight hours, following a day with excessive heat, if the heat index is not expected to fall below 75°F. An excessive heat warning can be issued for a heat index less than 105°F when the cumulative effect of successive days of near warning heat leads to life threatening conditions.

While no reported deaths have been attributed directly to extreme heat in Clarke County, illnesses have occurred, and many people can suffer in many ways. In addition to the human toll are possible impacts such as electrical infrastructure damage and failure, highway damage, crop damage, water shortages, livestock deaths, fish kills, and lost productivity among outdoor-oriented businesses.

As referenced in the probability section, events in the critical stage are typical and are used for the basis of the severity assessment. The following table shows the relative risks of a typical extreme heat event.

Figure 3.44: Extreme Heat Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	While heat-related illness and death can occur due to exposure to intense heat in just one afternoon, heat stress on the body has a cumulative effect. The persistence of a heat wave increases the danger. Excessive heat can lead to illnesses and other stresses on people with prolonged exposure to these conditions. Many people do not realize how deadly a heat wave can be. In contrast to the visible, destructive, and violent nature of floods, hurricanes, and tornadoes, a heat wave is a silent killer. Heat kills by overloading the human body's capacity to cool itself. Excessive heat is the leading cause of weather fatalities in the nation (through 2009). In a normal year, about 117 Americans succumb to the bodily stresses of summer heat. In a heat wave in 1980, more than 1,250 people died nationwide.	2 Schools, hospital 4 Others
Health and safety of responders	Response personnel could suffer heat stroke and dehydration working in extreme heat conditions. Firefighters in heavy gear are at the greatest risk.	4
Continuity of operations	Operations can be hindered due to heat impacts on workers and utility systems. All electric utility systems and Southern Iowa Rural Water report damages and strains on their capabilities. Some schools close for the day during extreme events.	2
Property, facilities, infrastructure	Transportation impacts include the loss of lift for aircrafts, softening of asphalt roads, buckling of highways and railways, and stress on automobiles and trucks (increase in mechanical failures). A 2011 article states that, in a typical year, Iowa DOT maintenance equipment operators spend 2,000 to 4,000 hours making temporary repairs of pavement blowups and another 6,000 hours replacing these pavement sections, costing an average of $400,000 annually. Power lines and facilities can fail.	2
Delivery of services	Electric transmission systems are impacted when power lines sag in high temperatures. High demand for electricity also outstrips supply, causing electric companies to have rolling black outs. The demand for water also increases sharply during periods of extreme heat. This can contribute to fire suppression problems for area fire departments.	3
Environmental impacts	No direct long-term effect on the environment. Livestock and other animals are adversely impacted by extreme heat. High temperatures at the wrong time inhibit crop yields and cause fish kills.	2
Economic/financial conditions	Economic costs in transportation, agriculture, production, energy, and infrastructure are high. Lost productivity, due to conditions that make work outside or in a poorly ventilated building intolerable, can impact many other economic sectors indirectly. Extreme heat can pose a threat to livestock and crops. High temperatures have been shown to reduce summer milk production, impair immunological and digestive function of animals, and increase mortality of livestock. In July 2011, according to The Iowa Cattlemen's Association approximately 4,000 cattle died due	3

Severity Criteria	Discussion	Score
	to extreme heat. In 1995, livestock-related economic losses due to heat stress were estimated to be $31 million in Iowa.	
Regulatory/contractual obligations	Rural water and electric companies may have trouble providing contracted supplies and meeting sewer discharge regulations. Farmers and other producers may not produce what is required by contracts.	3
Reputation	None if response is adequate and timely.	1

Score for Rural Clarke County: 24	Score for Murray: 24	Score for Osceola: 24	Score for Woodburn: 24
Score for Clarke Schools: 22	Score for Murray Schools: 22	Score for SWCC: 22	Score for hospital: 22

Extreme Heat Speed of Onset:
As with other weather phenomena, periods of extreme heat are predictable within a few degrees within 3 days or so. Variations in local conditions can affect the actual temperature within a matter of hours or even minutes. The NWS will initiate alert procedures when the heat index is expected to exceed 105 degrees Fahrenheit for at least two consecutive days.

Score for Rural Clarke County: 2	Score for Murray: 2	Score for Osceola: 2	Score for Woodburn: 2
Score for Clarke Schools: 2	Score for Murray Schools: 2	Score for SWCC: 2	Score for hospital: 2

Extreme Heat Duration of Event:
An extreme heat event typically lasts for the afternoon and evening of a given day or consecutive days but can be all day long for a few days or even a week before cooler air arrives to an area.

Score for Rural Clarke County: 7	Score for Murray: 7	Score for Osceola: 7	Score for Woodburn: 7
Score for Clarke Schools: 7	Score for Murray Schools: 7	Score for SWCC: 7	Score for hospital: 7

Extreme Heat Total Scores:
The following total scores for extreme heat indicate moderate to high risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 55	Score for Murray: 55	Score for Osceola: 55	Score for Woodburn: 55
Score for Clarke Schools: 51	Score for Murray Schools: 51	Score for SWCC: 51	Score for hospital: 51

Extreme Heat Vulnerability/Assets at Risk:
Virtually all structures, property, and people in the county, as outlined in Section 3.2, could suffer from the effects of extreme heat. While the heat itself will rarely damage buildings, it can damage infrastructure that supports buildings. Power lines, towers, roads, and bridges are at the most risk among structures. Contents losses are likely to be minor, even compared to structural losses. The greatest risk is to human health and life due to exposure to heat on the body. Additionally, because of the reduced productivity due to the effects of heat on humans and infrastructure failures, economic losses could be severe in some sectors.

All critical assets in the county, as outlined in Section 3.2, could be impacted by this hazard, although, again, it would be a secondary effect in most cases, as outlined in the above paragraph.

Extreme Heat Loss Estimation:
The most significant losses due to extreme heat are to human health, exposed infrastructure, crops and livestock, and economic impacts due to reduced productivity. Rarely do buildings suffer loss, although power lines and other infrastructure can fail at the cost of millions of dollars.

The loss due to human life and health are significant due to extreme heat. Despite this risk, it is difficult to attribute to extreme heat a death that appears to be due to natural causes. People over the age of 65, which

make up well over 2,000 residents, people who are outside and cannot get indoors, and those with old homes and no air conditioning are all at greater risk than the general population. In a typical extreme heat event, it is estimated that death is possible, severe illness requiring hospitalization is very likely, and multiple minor illnesses are very likely. Because extreme heat is a silent killer and is more common in a given location than a tornado or other killer, this hazard is one of the most likely to cause death in a given year.

According to the USDA's Risk Management Agency, the insured payments in Clarke County for damages to crops as a result of heat from 2016-2020 totaled $4,042.05, or much less than 1% of all insured loss from three claims. Assuming about 90.5% of insurable cropland is insured, the actual loss is approximately $4,500 years or $1,000 annually.

Extreme heat also puts strain on electrical infrastructure, where wires and poles are exposed to the heat while having to generate and convey immense amounts of energy to power air conditioning during extreme heat events. Roads, especially asphalt, and bridges are also damaged due to expansion and buckling. Loss figures for these are not available. Metal buildings and towers, if built poorly, can also suffer damage or weakening that is not visible at the time but that may show up during future hazard events.

Economic losses can be severe, as certain factories and businesses are closed because of the heat. People who are not in good physical condition cannot be productive when they are hot. In Clarke County, tens of thousands of dollars in lost productivity are likely due to each extreme heat event. Further, thousands of dollars are spent each year to provide cooling for local businesses during extreme heat events. The intense industries that dominate Osceola's economy are compromised during extreme heat events.

Future Development and Extreme Heat:
The threat could decline as older homes are replaced with newer structures over time, but any population growth also means more people will be exposed. The population of the community continues to age as well.

Flood, Flash Profile
Type: Natural

Definition: Any event when water levels rise at an extremely fast rate with little or no warning.

Flash Flood Description:
Flash flooding results from intense rainfall over a brief period, sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil, or impermeable surfaces. Most flash flooding is caused by slow-moving thunderstorms or thunderstorms repeatedly moving over the same area. Flash flooding is an extremely dangerous form of flooding which can reach full peak in only a few minutes and allows little or no time for protective measures to be taken by those in its path. Flash flood waters can move at very fast speeds and can roll boulders, tear out trees, scour channels, destroy buildings, and obliterate bridges. Flash flooding often results in higher loss of life, both human and animal, than slower developing river and stream flooding.

Flash flooding can also be caused by inadequate or improper drainage systems including storm sewers, culverts, and drainage ditches. These systems are usually designed to carry up to a specific amount of water (design capacity). When heavy rainfall causes the design capacity of the systems to be exceeded, water will begin to back up and fill low-lying areas near system inlets and along open ditches. This is most common in urban areas. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization increases runoff two to six times over what would occur on natural terrain.

Flash Flood Historical Occurrence:

Flash flooding occurs more regularly and does more damage than river flooding in Clarke County due to the topographic location of the county. There are few large streams, and most potential flood hazard areas are located where little development is at risk.

Floods are the most common and widespread of all-natural disasters except fire. In Iowa, as much as 21" of rain has fallen in a 24-hour period. Extreme rain events in 2008, 2009, 2010, 2011, and 2015 have occurred in Clarke County. The main problem resulting from these rains was flash flooding – both urban and small stream events. Culverts, bridges, roads, and other infrastructure have been damaged in the rural areas. Towns with older storm sewer systems have been overwhelmed, and small un-served towns cannot control water. In 2018, Murray began a ditch and underground piping system to begin to address storm water. While the town is relatively flat, standing and flowing water has damaged roads. The City's goal is in part to replace roads in the coming years, and dealing with storm water is vital to make that project successful. Part of the motivation for this work was an extreme rain in the summer of 2015 that left feet of water in yards and basements. One photo from the event was of a guy in a rowboat moving through his neighborhood. In early 2021, Osceola received grants totaling over $2 million to invest in considerable green and traditional storm water infrastructure to address flooding in the downtown and streams in the city. One of the main problems is feet of water flooding a railroad underpass north of downtown, which is the only emergency vehicle crossing of the town when trains block the other crossings. Water can sit for hours after a rain before finally flowing through storm drains. Many of the bridge closings reported in Clarke County in recent years have been due to small stream rather than large river flood events. One survey respondent stated that regular heavy rain events flood low-lying areas and create potential sewer bypass events.

The NCEI reports 14 flash flood events from 2006 through the end of 2020, resulting in 1 injury and $1.33 million in property damage and $192,000 in crop damage. All jurisdictions have been impacted.

The county's planning team believes that flash flooding is actually much more common and destructive. Dozens of smaller (more localized) events happen in the county during any wet year, many of which are not reported to authorities. The local hazard mitigation planning team provides the following as a summary of past flash flooding events by community.

Figure 3.45: Planning Team Flash Flood Reported Historical Data

Jurisdiction	Years/Events	Impact
Rural	1992, 8/93, 6/95, 6/2008, 2009-11 are just some of the times when flash flooding was widespread and/or caused injuries; at least 16 damaging events in the past 25 years.	According to the planning team, a child drowned years ago due to the vehicle being swept off a rural road in the county. In 1992, the team reported, 2 persons drowned when a driver put a car into a flash flood area and the bridge was washed out. Somewhere in the county almost every year one or more culverts and/or secondary roadways are damaged by flash flooding in a localized area. Most flash flooding has had minimal impact on property, however, and farmland is most exposed. Clarke Community Schools reports that flash flooding has affected bus routes in rural areas. Several people reported flash flooding of southern Clarke County and US Highway 69 in the 2019-20 timeframe.
Murray	At least one incident at Murray Schools is reported.	Old building at Murray Schools has suffered flash flood damage. This building not in a SFHA. Heavy rains have caused basement flooding and foundation cracking to many homes. Sewer backups have impacted only a few homes (less than 10%). The City about 2008 completed ditch work to address previous flooding damages. The same was done in other areas of town in 2018-19.
Osceola	Infrastructure damage due to flooding; lots of impermeable surfaces with few outlets for excessive rainwater.	At least one sewer lift station has been washed out, resulting in FEMA PA. The City has a significant storm water inflow and infiltration problem in its sewer system, which is likely to cost $5 million to repair. Illegal storm water bypasses have occurred. Downtown areas have had standing water for days and street and building deterioration has resulted. Storm water systems and streets have been damaged by large flows in various parts of town. Heavy rains have caused basement flooding and foundation cracking to many homes. Sewer backups have impacted many homes (10%).

Jurisdiction	Years/Events	Impact
Woodburn	2010 flooding that included some flash flooding.	Heavy rains have caused basement flooding and foundation cracking to many homes. Woodburn received $8,600 in FEMA PA funding in 2010 for street repair. Sewer lines are relatively new SIRWA is in place to manage and maintain them. Several people reported flash flooding in Woodburn area in the 2019-20 timeframe.

Dozens of smaller (more localized) events happen in the county during any wet year, many of which are not reported to state and federal authorities. They may damage a few blocks of street, a few basements, and the wastewater system, but do not result in a federal response in most cases.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. Five indicated it happens most years, seven indicated it happened once or twice in the last five years, three responded that it has not occurred, and three responded they did not know.

From 2006 through end of 2020, there were 45 NWS flash flood warnings and 103 watches issued for Clarke County for flash flood events (https://mesonet.agron.iastate.edu/vtec/search.php#byugc/IAZ083). As previously described, flash flooding can be caused by intense rainfall over a brief period. The following table shows the top 30 rainfall events, as reported in 24-hour calendar day periods from 1937 through December 31, 2020, at the Osceola weather station.

Figure 3.46: Heavy Rain Days at Osceola Weather Station

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
9/15/1992	8.80	8/26/1944	4.29	8/23/2014	3.60
11/17/1952	6.20	8/16/2014	4.24	9/13/2008	3.57
8/26/1987	6.02	7/28/2008	4.03	7/31/1999	3.56
7/4/1981	6.01	6/17/1990	4.01	4/18/2013	3.52
8/26/1977	6.00	8/27/2009	3.89	9/10/2014	3.52
8/19/1993	5.35	9/1/2018	3.87	4/15/2012	3.50
8/14/2006	4.87	8/6/1959	3.80	4/14/2014	3.48
6/8/1981	4.83	7/27/1967	3.75	5/12/2014	3.44
7/5/1993	4.77	8/24/1946	3.63	5/12/2011	3.42
5/9/1950	4.65	9/8/2001	3.61	8/6/1938	3.38

Source: Iowa State University Department of Agronomy, http://mesonet.agron.iastate.edu/request/coop/fe.phtml

As can be seen, the largest daily rainfall totals are spread throughout the history of records, although a few years had multiple days: 1981, 1993, 2008, and 2014 (4 days).

Flash Flood Future Probability:

As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization increases runoff 2 to 6 times over what would occur on natural terrain. While Clarke County is rural, there are areas within Osceola in particular containing significant expanses of impervious surfaces. As more development occurs in the watersheds, the amount of runoff produced also increases. Unless measures are taken to reduce the amount of runoff (or slow its movement), flash floods will continue to occur and possibly increase. Often, aging storm sewer systems are not designed to carry the capacity currently needed to handle the increased storm runoff in certain areas. Rural areas may have more events because of the amount of area on which they can occur, but developed areas are more likely to have flash flooding during less significant rainfalls. Either way, evidence suggests that extreme rain events are becoming more commonplace. Because of this, with existing mitigation efforts or lack thereof, the future probability is likely to be higher than past history.

However, some mitigation measures are occurring to reduce these risks. Through partnerships between farmers and conservation officials, BMPs for storm water control in rural areas are occurring. The Clarke

County Secondary Roads Department continues to make improvements to culverts and bridges that might reduce the likelihood of flooding and damage when flooding occurs. Efforts underway or recently completed in Murray and Osceola will have an impact on key problem areas of those communities.

According to Karl, T.R., J. M. Melillo, and T. C. Peterson, *2009: Global Climate Change Impacts in the United States*, 2009, "One of the clearest trends in the United States observational record is an increasing frequency and intensity of heavy precipitation events… Over the last century there was a 50% increase in the frequency of days with precipitation over 101.6 mm (four inches) in the Upper Midwestern U.S.; this trend is statistically significant". Research has also shown that in Iowa the trend is more heavy rain in the spring and less in the fall.

The overall rating the community gave for this hazard's future probability in a survey was: "likely." When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. Seven indicated it is more likely, eight indicated no change in likelihood, two indicated less likely, and one indicated they were unsure.

Score for Rural Clarke County: 7	Score for Murray: 6	Score for Osceola: 6	Score for Woodburn: 6
Score for Clarke Schools: 4	Score for Murray Schools: 4	Score for SWCC: 3	Score for hospital: 3

Flash Flood Vulnerability to the Population:

Certainly, many buildings and much infrastructure can be damaged by flash floods that include urban small stream flooding, ditch flooding, basement flooding, and clogged storm water control systems. Due to aging infrastructure and lack of use of storm water control BMPs, much of the population can be impacted secondarily through inefficient sewer system flow and rapidly deteriorating streets. Closed roads, even if only temporarily, can disrupt the lives of people who otherwise are not impacted by floodwater.

The following table shows the warnings and other alerts that address the risks to people.

Figure 3.47: Flash Food Risk Chart

Product	What It Means	You Should...
Hazardous Weather Outlook	Will there be any threat of flash flooding in the next several days?	If there is a threat of flash flooding, check back later for updated forecasts and possible watches and warnings. Latest Hazardous Weather Outlook
Flash Flood Watch	There is a threat of flash flooding within the next 48 hours, either as a result of heavy rain, ice jams, or the threat of a dam break.	Monitor weather conditions closely, especially if you live in an area prone to flash flooding.
Flash Flood Warning	There is an immediate threat for flash flooding in the warned area, especially in low-lying and poor drainage areas. These warnings are updated frequently with Flash Flood Statements.	If you live in an area susceptible to flash flooding, be prepared to evacuate and head to higher ground. Be very cautious when driving in the warned area, especially at night or while it is still raining. You may not be able to see a flooded road until it is too late!
A *Flash Flood Emergency* may be declared when a severe threat to human life and catastrophic damage from a flash flood is imminent or ongoing. The declaration of a *Flash Flood Emergency* would typically be found in either a Flash Flood Warning or Flash Flood Statement. People are strongly encouraged to avoid the geographic area of concern in a *Flash Flood Emergency*. The *Flash Flood Emergency* wording is used very rarely and is reserved for exceptionally rare and hazardous events.		
Areal Flood Warning	The threat of flash flooding is over, but there is still significant standing water in the affected area.	Areal flood warnings will typically list locations and roads impacted by the flooding. Try to avoid these locations until the water has receded.

Source: http://www.floodsafety.noaa.gov/products.shtml

People who are at the greatest risk of injury, death, and property loss are those close to waterways and in low-lying areas inside and outside of mapped SFHAs. Those downstream from dams, levees, and retention basins are also at risk. People and property in areas with insufficient storm sewers and other drainage infrastructure can also be put at risk because the drains cannot rid the area of the runoff quickly enough. Nearly half of all flash flood fatalities are auto-related. Motorists often try to traverse water-covered roads and bridges and are swept away by the current. Six inches of swiftly moving water can knock persons off their feet and only two feet of water can float a full-sized automobile. Recreational vehicles and mobile homes located in low-lying areas can also be swept away.

The risk depends on the jurisdiction. For example, areas like the downtown area of Osceola, schools, and the hospital have impervious surfaces in key areas (roofs, walkways, and streets) that limit the ability to take in storm water. Schools and the hospital have modern storm water facilities, unlike small towns and rural areas. The planning team indicates that the topography and rainfall trends make notable areas susceptible to flash flooding events. The scores are based on direct impacts: actual flooding on property and damage due to flooding in areas that directly impact safety and health of those outside of flood areas. Although the risks vary by jurisdiction, it is estimated 20 to 25% of any population is truly vulnerable to losses in a single event, somewhat less in rural areas because the population is spread out and surfaces are less impervious.

Score for Rural Clarke County: 5	Score for Murray: 6	Score for Osceola: 6	Score for Woodburn: 6
Score for Clarke Schools: 4	Score for Murray Schools: 4	Score for SWCC: 3	Score for hospital: 3

Flash Flood Area of Extent:

Areas in a floodplain, downstream from a dam or levee, or in low-lying areas can certainly be impacted. People and property located in areas with narrow stream channels, saturated soil, or on land with large amounts of impermeable surfaces are likely to be impacted in the event of a significant rainfall. Unlike areas impacted by a river/stream flood, flash floods can impact areas a good distance from the stream itself. Streets can become swift moving rivers, and basements can become deathtraps because flash floods can fill them with water in minutes. Rural areas, due to their expanse, would be less impacted by the heaviest rain in a storm. Cities, schools, and the hospital would have a greater percentage of land impacted by excessive rain events because of the impervious surfaces and smaller area under which a single storm can target. The scores are based on total area that is subjected to damage as a result of the event.

Score for Rural Clarke County: 5	Score for Murray: 6	Score for Osceola: 6	Score for Woodburn: 6
Score for Clarke Schools: 7	Score for Murray Schools: 7	Score for SWCC: 7	Score for hospital: 7

Flash Flood Severity of Impact:

Due to the location of Clarke County away from large rivers associated with flooding, people can sometimes be naïve or forgetful that flash flooding is a real risk and it can occur with little warning. People are at risk when they may not be aware of the risk at a given location. The following table shows the relative risks of a typical observed flash flood event.

Figure 3.48: Flash Flood Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	Flash floods are the #2 weather-related killer in the United States. This is likely in part because flash floods can quickly inundate areas thought to be safe. Flash flooding is a serious risk to people trapped in flooding areas and to those subjected to unforeseen flood impacts, such as flooding basements that cause mold growth.	3
Health and safety of responders	Rescuers are at significant risk when attempting to work in swift moving floodwaters associated with flash flooding. Special training in swift water rescue exists, and most are trained. However, sometimes equipment is lacking. A regional water rescue team, based in a nearby county, is in place to address some of this concern.	3
Continuity of operations	Damage to infrastructure, detours as a result of damaged or covered roadways, and continuous	3

Severity Criteria	Discussion	Score
	duration of precipitation can result in delays in projects and in facility operation for hours to perhaps days in rare instances.	
Property, facilities, infrastructure	Personal property can be extensively damaged and destroyed by swift moving water. Facilities and infrastructure can be scoured around and degrading its structural integrity. Because flash flood water is off premises quickly, damages related to standing water are often limited, but the current associated with flash floods causes abrasive type damages such as erosion and undercutting. Roads, culverts, and bridges in Clarke County have been heavily damaged. A large part of the County budget is designated to address secondary road damages related to this hazard: washouts, damaged and lost bridges, culvert damage, etc.	4
Delivery of services	Flash flooding's impacts on roads and other infrastructure can delay the delivery of essential services, including emergency response. It can immobilize normal function of sewer and water systems that are urgently needed in modern society.	3
Environmental impacts	Destruction of homes, illnesses, transportation accidents, and contamination of water supplies are very possible. Materials swept away by floodwaters can contaminate and leave a lasting impact on the environment.	3
Economic/financial conditions	Most impacts are indirect due to disruption of business and damage to infrastructure on which industry and services rely. Damaged to large buildings and to foundations can have a lasting impact on business. Extensive uninsured losses can have a great impact on local financial security.	3
Regulatory/contractual obligations	Impacts are likely to be temporary in most cases and likely indirect. The exceptions are when roads are closed for an excessive length of time or service providers fail to meet basic needs.	2
Reputation	Flash floods can be damaging to the reputation of the community if proper notification and warning are not given. Often times the victim will blame development, deteriorated infrastructure, or other changes in the community as the cause of the flooding on their property.	2

Score for Rural Clarke County: 26	Score for Murray: 26	Score for Osceola: 26	Score for Woodburn: 26
Score for Clarke Schools: 26	Score for Murray Schools: 26	Score for SWCC: 26	Score for hospital: 26

Flash Flood Speed of Onset:

Flash floods are somewhat unpredictable, but there are factors related to speed of onset: soil type, soil covering/surfacing, topography, wetness of soil before the event, and direction of the water's or storm's origination. As the name implies, flash floods occur within a few minutes or hours of excessive rainfall, a dam or levee failure, or a sudden release of water held by an ice jam. Warnings may not always be possible for these sudden events. Predictability of flash floods depends primarily on the data available on the causal rain. Individual basins react differently to precipitation events. Weather surveillance radar is being used to improve monitoring capabilities of intense rainfall. Knowledge of the watershed characteristics, modeling, monitoring, and warning systems increase the predictability of flash floods. Depending on the location in the watershed, warning times can be increased. However, estimations for flash flood events are difficult at best.

Score for Rural Clarke County: 7	Score for Murray: 7	Score for Osceola: 7	Score for Woodburn: 7
Score for Clarke Schools: 7	Score for Murray Schools: 7	Score for SWCC: 7	Score for hospital: 7

Flash Flood Duration of Event:

Flash floods are usually brief but can last several hours, usually not more than 6 hours.

Score for Rural Clarke County: 4	Score for Murray: 4	Score for Osceola: 4	Score for Woodburn: 4
Score for Clarke Schools: 4	Score for Murray Schools: 4	Score for SWCC: 4	Score for hospital: 4

Flash Flood Total Scores:

The following total scores for flash flood indicate moderate to high risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 54	Score for Murray: 55	Score for Osceola: 55	Score for Woodburn: 55
Score for Clarke Schools: 52	Score for Murray Schools: 52	Score for SWCC: 50	Score for hospital: 50

Flash Flood Vulnerability/Assets at Risk:
Virtually all structures, property, and people in the county, as outlined in Section 3.2, are susceptible to flash flooding. While the planning team does not believe all property is likely to be damaged and that it is a localized hazard, there is no definitive conclusion as to what properties are exempt from its effects. For this reason, the planning team has identified all properties and assets as potentially at risk. In reality, the properties most at risk include those on slopes, lower elevations, and at or near impervious surfaces. Almost anything can flood when there is enough rainfall in a short amount of time.

All critical assets in the county, as outlined in Section 3.2, could be impacted by this hazard. Exceptions may include a few assets that are above the ground and would likely not be damaged, including:

- Major overhead power lines anchored by heavy and deeply drilled poles
- Wind turbines
- Water towers

Flash Flood Loss Estimation:
The most significant losses include foundations and basements of structures on sloping and low-lying areas, not necessarily in a Special Flood Hazard Area (SFHA, see river flood profile), and infrastructure in the same area, namely streets, culverts, and bridges. Underground infrastructure, such as pipelines, can be damaged by scouring of flash flooding water, and overloaded sewer mains can back up into homes and businesses. Areas with large buildings and parking areas, such as in downtown Osceola or in industrial areas of Osceola, are likely to experience more flash flooding damage than other areas. In a given flash flood event, Osceola and the rural area of the county are likely to experience the greatest loss to structures and property, topping hundreds of thousands of dollars. If one Secondary Road bridge is washed away, it can cost $2 million to replace the bridge and create a traffic detour that can last for a year or more.

According to the National Centers for Environmental Information, there have been 14 flash flooding events in Clarke County through 2020. Since 2006, $1.33 million in property losses and $192,000 in crop losses have been reported. Over a 15-year period, total reported losses were $1.52 million, which averages $101,000 per year.

According to www.weather.gov, each year more people die from flash flooding than any other thunderstorm-related hazard. The loss of human life and health are significant due to flash flooding, mostly when people make a bad decision to drive into a flooded area. While rare in rural Iowa, extremely rapid rise of waters and flooding of impervious areas are more common in urban areas, where people get trapped and are killed by the raging torrent. However, it is certainly possible for death and injuries in Clarke County. Fortunately, most people living in the county know where the risk is greatest and avoid those areas close to home when traveling during and after a rain event.

From 2016 to 2020, there were 117 crop insurance claims as a result of "excess moisture/precipitation/rain." The results from these claims is a net $3,139,392.77, which is over 25% of claims from that time period in terms of dollars, exceeding all hazards except drought. Considering that only about 90.5% of covered crop losses are claimed, the real loss over 5 years is approximately $3.45 million or $690,000 per year.

According to the State's Hazard Mitigation Viewer's Flood Tab, as of April 1, 2021, there have been the following flash flood statistics:

- Number and annual loss from flash flood events impacting property: 20; $68,189
- Number and annual loss from flash flood events impacting crops: 10; $10,241
- Total annual loss reported for flash floods: $78,430

Economic losses can be severe, depending on where flash flooding occurs. Flood-caused detours and damage to major employment centers can greatly slow commerce.

Future Development and Flash Flood:
This impact depends mostly on the amount of new development and if mitigation measures are implemented. Mitigating flash flooding in new development is fairly simple with the combination of appropriate water quality practices and regulations, such as building codes and zoning, which force developers to consider hydrology in their building plans. Fortunately, the trend today is to consider these "green" principles and the reduction in impervious surfaces in development planning, often called "low-impact design."

Flood, River Profile
Type: Natural

Definition: A rising or overflowing of a tributary or body of water that covers adjacent land not usually covered by water when the volume of water in a stream exceeds the channel's capacity.

River Flood Description:
River flooding is a natural and expected phenomenon that occurs annually, usually restricted to specific streams, rivers or watershed areas. Floodwaters can be extremely dangerous; the force of six inches of swiftly moving water can knock people off their feet and two feet of water can float a car. Floods can be slow or fast rising but generally develop over a period of days.

River flooding is usually the result of heavy or prolonged rainfall or snowmelt occurring in upstream inland watersheds. Melting snow can combine with rain in the winter and early spring; severe thunderstorms can bring heavy rain in the spring or summer. Intense rainfall over a short period of time, or an ice or debris jam can also cause a river or stream to overflow. River floodwaters can occur quickly and move rapidly, as in a flash flood, or waters can rise slowly over a period of hours or even a few days as they often do where the land is gently sloping or flat. The National Flood Insurance Program (NFIP) defines flooding as a partial or complete inundation of normally dry land areas from:

1. The overland flood of a lake, river, stream, ditch, etc.
2. The unusual and rapid accumulation or runoff of stream waters.
3. Mudflows or the sudden collapse of shoreline land.

Unlike flash floods, river floods occur within defined areas of basins (watersheds) called floodplains. A floodplain is defined as the lowland and relatively flat area adjoining a river or stream. The terms "base flood" and "100-year flood" refer to the area of the floodplain that is subject to one percent or greater chance of flooding in a given year. FEMA has mapped these areas and calls them "Special Flood Hazard Areas." For the purpose of this profile, river flooding only occurs within those mapped areas. Flooding caused by dam failure and flash flooding is profiled in other sections of this chapter.

River Flood Historical Occurrence:
The Floods of 1993 and 2008 are still fresh in the minds of Iowans. Flooding has been a regular and frequent hazard in Iowa. Iowa has been involved in 36 or more Presidential Declarations of a major disaster related to flooding since 1953. Several of those have been from 2008-2011, affecting virtually all of Iowa's counties and sometimes including Clarke County. River floods, mostly of minor nature, have occurred in Clarke County, resulting in relatively modest damage compared to other counties. Many minor events have occurred in Clarke County that did not result in a Presidential declaration. In fact, minor or moderate flooding is nearly an annual event in Clarke County, including 2008, 2009, 2010, and 2011. Major flooding, however, has been rare within the county. The largest waterway, Whitebreast Creek, which flows through the central and eastern part of the county, has done considerable damage to bridges, culverts, and farm fields.

Smaller streams have flooded and impacted adjacent properties, culverts, and bridges. The rural part of the county and the cities of Osceola and Woodburn are susceptible to minor flooding, based on past history and newly completed FIRM maps. Several jurisdictions are identified as having no waterways susceptible to river flooding (although flash flooding can occur): city of Murray, Clarke Community School campus, Murray School campus, SWCC campus, and Clarke County Hospital campus.

Information on past events in Clarke County is incomplete because most flood events reported for Clarke County show the results of the larger flood event. Because flooding does not stop at a county boundary, flood events are reported regionally, and most or all the damages reported might be located outside of Clarke County in some events. The only official source is the NCEI. According to the National Centers for Environmental Information, there have been 41 river flooding events in Clarke County in modern history (since 1996 through 2020) with over $1.881 million in reported property damages and over $20.6 million in crop losses. The majority of Clarke County's historical losses occurred in 2010. Only one flood event was reported in the past five years, which cost $200,000 in property damage. The major event recorded for the county by the NCEI includes $20 million in crop loss. This is estimated loss due to a month of heavy rain that destroyed crops and prevented planting in June 2010 throughout much of Iowa. Likely less than $1 million of the loss occurred in Clarke County.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. Eight indicated it happened once or twice in the last five years, eight responded that it has not occurred, and two responded they did not know.

FEMA declarations involving flooding including Clarke County were made 12 times since 1990. FEMA has funded repairs to bridges and county assets along several rivers and streams. The National Flood Insurance Program (NFIP) Repetitive Loss Properties (RLP) report identifies properties vulnerable to multiple flood losses. Through the end of 2020, there have been no RLPs in Clarke County.

More information on river flooding and how it is addressed in Iowa can be found at http://www.iowadnr.gov/Environmental-Protection/Land-Quality/Flood-Plain-Management. This discusses the IDNR's approach to this hazard.

Plan Update Change to Future Flood Risk

The previous plan included flood risk in the various jurisdictions based on maps in place at that time. With the new official FIRM maps that show hazards in the rural area, Osceola, and Woodburn. These changes are based on the fact that, while flooding can occur outside of a SFHA, such flooding is unlikely based on past history, and, if it occurs, will likely be flash flooding in nature. No municipalities are likely to annex area that includes SFHAs.

River Flood Future Probability:

Minor flooding, not necessarily to the 1% (100-year) flood elevation, is likely to continue in the rural county and the cities that have flood hazard areas. Major flooding requiring Federal response is moderately likely in the next five years. Although Clarke County lacks large rivers, small rivers can cause significant damage to structures that remain in floodplains. The future probability, according to the planning team, will vary greatly by vulnerable jurisdiction. New and better efforts at mitigation in the past few years and planned for the next few years, such as updated flood maps, should reduce the loss of lives and property due to flooding. This is important because the noticeable increase in heavy rain events is likely to increase the prevalence of flooding and make it so 0.2% (500-year) flood events are likely to occur more often.

It is anticipated that minor to moderate floods will be occasional with impacts on developed parts of incorporated areas rarely occurring. The following scores assume that flooding is only occurring in areas with Special Flood Hazard Areas (SFHAs) as mapped by FEMA. This includes Osceola, Woodburn, and the

unincorporated area. Any other flooding that might affect other areas is assumed to be flash flooding and is profiled as such in this section.

When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. One indicated it is more likely, nine indicated no change in likelihood, four indicated less likely, and four indicated they were unsure.

Score for Rural Clarke County: 5	Score for Murray: 0	Score for Osceola: 3	Score for Woodburn: 3
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

River Flood Vulnerability to the Population:

The vulnerability from river flooding is quite delineated to the 1%-chance level and with new mapping efforts to the 0.2%-chance level. Much work in the area of flood hazard mapping, where maps have been completed, has allowed many communities to restrict development in hazardous areas. Clarke County now has countywide FIRMs (Flood Insurance Rate Maps) and an FIS (Flood Insurance Study). These have been attached in *Appendix D*. These maps are the result of collaboration among FEMA, the Iowa DNR, and Clarke County using the Risk MAP process and LiDAR technology through the Iowa Flood Center. Previous to this, only a few of the cities were mapped back in the 1970s (FHBMs), all of which have previously been rescinded, or replaced by the new maps.

Over 90% of the county's flood hazard area (Zone A) is currently used for agriculture, so the greatest impact on private property due to flooding is agricultural land, crops, and potentially livestock and outbuildings. The maps show no occupied structures (homes, businesses, etc.) in flood hazard areas. However, infrastructure, such as bridges and roads, rather than private development, is more likely to be lost. Over 100 bridges are located in flood hazard areas or that cross over waterways that can flood around the base of the bridge. Public properties, such as East Lake Park, the water plant below the West Lake Dam, and even part of the Osceola wastewater plant system, could be damaged by floodwaters. However, even in incorporated areas, there is no evidence that homes or other occupied structures are at risk of flooding.

The National Flood Insurance Program (NFIP) Repetitive Loss Properties (RLP) report identifies properties vulnerable to multiple flood losses. To date there are no repetitive loss properties (RLPs) in Clarke County. Currently, only Woodburn is in the NFIP. The other jurisdictions do not have occupied properties in the floodplain that might have interest in flood insurance.

Figure 3.49: FIRM Participation Information

Community	CID	Initial FHBM * Identified	Initial FIRM ** Identified	Current Effective Map Date	Regular Program Entry Date	Sanction Date
Woodburn	190070	12/20/74	05/01/2011	02/16/2018	05/01/2011	n/a
Osceola	190637	04/23/76	02/16/2018	02/16/2018	n/a	04/23/1977
Clarke County	190856	n/a	02/16/2018	02/16/2018	n/a	02/16/2019

Source: FEMA Community Status Book Report, 4/1/2021, http://www.fema.gov/cis/IA.pdf
**Flood Hazard Boundary Map **Flood Insurance Rate Map (NSFHA) – no SFHA exists*

According to the Iowa DNR Floodplain staff, there have been no ($0) in losses reported by NFIP insurance product purchasers in Clarke County from 1978 through 12/31/2020.

Figure 3.50: Flood Insurance Information

	Insurance Zone A			Insurance Zone B, C, and X		
Community	Policies in Force	# of Claims	$ of Claims	Policies in Force	# of Claims	$ of Claims
Woodburn	1 ($61,200)	0	$0	0	0	$0
Osceola	0	0	0$	0	0	$0
Clarke County	0	0	$0	0	0	$0

Source: FEMA Community Information Service (CIS), provided by Iowa DNR Floodplain Section, 4/1/2021

Woodburn is non-delegated community, which means a State floodplain permit must be issued prior to the community issuing the local permit. Iowa floodplain regulations establish higher standards than the minimum NFIP standards. One example of higher standards is that all new and substantially improved construction must be elevated one foot above base flood elevation. Additional DNR standards have been established for development in the floodway.

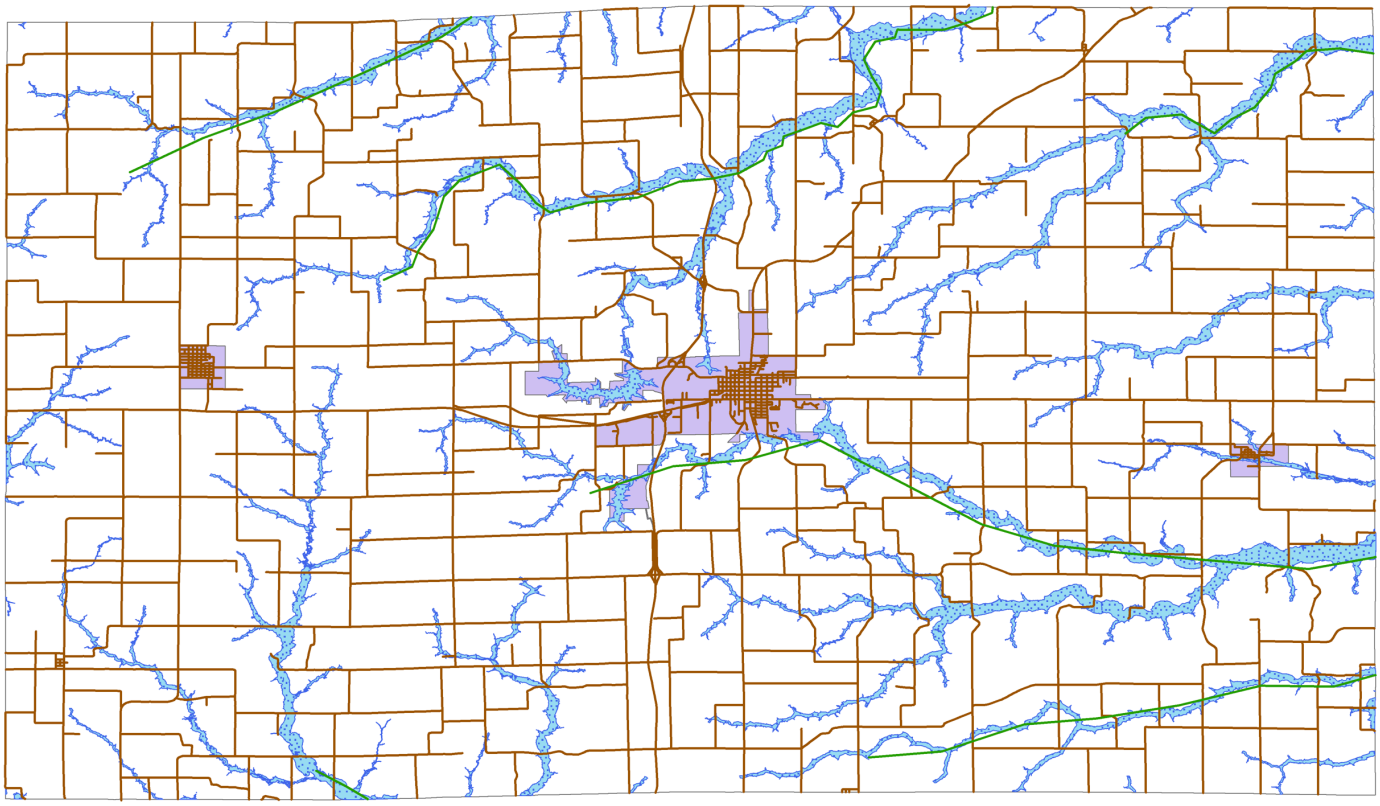
Future flooding is likely to impact some of the 150-plus bridges in Clarke County along with dozens of culverts and numerous gravel and paved county roads that cross low-lying river basins. Thousands of acres of farmland are also likely to be submerged. Generally, however, unless the flooding is the result of dam failure, no residential or occupied buildings are likely to be flooded. Therefore, the impact to the population is likely to be economic and indirect: detours due to road closures, tax increases to fund new bridges, etc. The planning team is concerned that flooding may cut access to homes in some rural areas in the event of emergency.

The ratings below are based on the direct impact to the population, as it is impossible to really measure the indirect impact, which will vary by location and severity of the flood event. Osceola's impact is most likely to be minor temporary disruption of the wastewater treatment facility and water treatment facility operations.

Score for Rural Clarke County: 4	Score for Murray: 0	Score for Osceola: 5	Score for Woodburn: 5
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

River Flood Area of Extent:
Flood mapping helps delineate risk. Fortunately, FIRM maps are now in place. Printed copies of these are in *Appendix D*. The following is an unofficial version of the FIRM map for illustrative purposes.

Figure 3.51: Flood Hazard Areas (Unofficial)



Note from the maps that there are special flood hazard areas (SFHAs) in the following jurisdictions: unincorporated Clarke County, Osceola, and Woodburn. Over 99% of the property in the SFHA is in the unincorporated area. As these maps show, river flooding primarily affects rural agricultural areas. In total, the estimated number of parcels located in the SFHAs of Clarke County would be 250 agricultural parcels in rural areas and 20 agricultural parcels in incorporated cities. As shown here, only about 2% of the county as a whole is in a flood hazard area, while 3 to 5% of both Osceola and 10% of Woodburn are in the area.

It is important to know that there is a difference between being unmapped and having no SFHA:

- Unmapped: If a community is unmapped, there has been no formal effort to determine if or where flood risk areas may be located. The community has no flood map. The "unmapped" community requires a level "a" ordinance. (No parts of the county are "unmapped.")
- No SFHA: If a community was studied and mapped, and it was found that there were no SFHAs within that jurisdiction, FEMA has determined the community has no special flood hazard areas. (Rescinded FHBMs fall within this category.) The NSFHA community does not require an ordinance.

(*Sources: Iowa Flood Center; IHSEMD Regulation "Staircase")*

It is possible (although very difficult) to perform a scenario analysis to determine where flooding could occur in a given storm event, and in most storm events the resulting flooding would not cover the entire planning area's SFHA. However, for the planning team's purposes, simply using the entire SFHA in each jurisdiction is adequate. The following list summarizes the flood hazards impacting each of the jurisdictions in this plan:

- Rural Clarke County: Several small rivers and streams pass through the county, most of them originating in the county. Approximately 2% of the land surface in the unincorporated area is within SFHAs. Most of these areas run from west toward the east.
- City of Osceola: the area of and just beyond the shoreline of West Lake, Q Pond, and Grade Lake and small streams downstream from this lake, composing up to 5% of the area of the city.
- City of Woodburn: the small stream flowing through the city south of downtown near the railroad, composting up to 10% of the city's area.
- Clarke School District: Rural areas within the district have SFHAs, but no land owned by the District or under its responsibility is within those areas.
- Murray School District: Rural areas within the district have SFHAs, but no land owned by the District or under its responsibility is within those areas.

Score for Rural Clarke County: 4	Score for Murray: 0	Score for Osceola: 4	Score for Woodburn: 4
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

River Flood Severity of Impact:

The extent of damage caused by floods is determined by many factors including depth, frequency, velocity, rate of rise, duration and the potential presence of ice and debris. These factors also determine which mitigation methods will work best.

Depth is the primary factor in evaluating the potential for flood damage. Every floodplain is unique in terms of the different levels of flooding that can be expected.

- Very shallow flooding, usually defined as a depth of 1 foot or less, is not life threatening, but can still cause considerable amounts of damage to a building.
- Shallow flooding of 1 to 3 feet in depth can result in significant amounts of damage both to structures and their contents.
- Moderate flooding, depths of 3 to 6 feet, can destroy buildings and threaten lives due to the large flood forces involved.
- Deep flooding, depths exceeding 6 feet, are the most destructive and dangerous.

Frequency, or how often the flooding occurs, is usually the second factor considered. All floodplains are subject to floods of differing depths, with the lower depths occurring more frequently than higher levels. Although historical flood depths provide some indication of the level of risk, there is no certain method to predict future flood levels. A method of estimating flood frequencies has been developed to determine the statistical probability of specific flood levels. For example, the flood that has a 1-percent (1 in 100) probability of being equaled or exceeded in any year is referred to as the 100-year flood event. However, this does not mean that a 100-year event is one that happens every 100 years or that once a 100-year event happens it will not occur again for another 100 years. This is only a statistical tool used to estimate the risk of certain flood levels. The 100-year flood is known as the base flood elevation or BFE. Once a BFE has been established, it is published on a Flood Insurance Rate Map (FIRM). These maps delineate areas of a specific community that are subject to the base flood.

Velocity is the speed at which floodwaters move. Slow moving floodwaters are usually defined as those having a velocity of less than three feet per second and they usually do not present substantial problems. Fast moving floodwaters, those moving over five feet per second, can quickly erode or scour the soil leading to foundation failure or even moving the house off its foundation. Historical flood event information is often the best way to determine potential flood velocities, although it is possible to hydraulically calculate theoretical velocities.

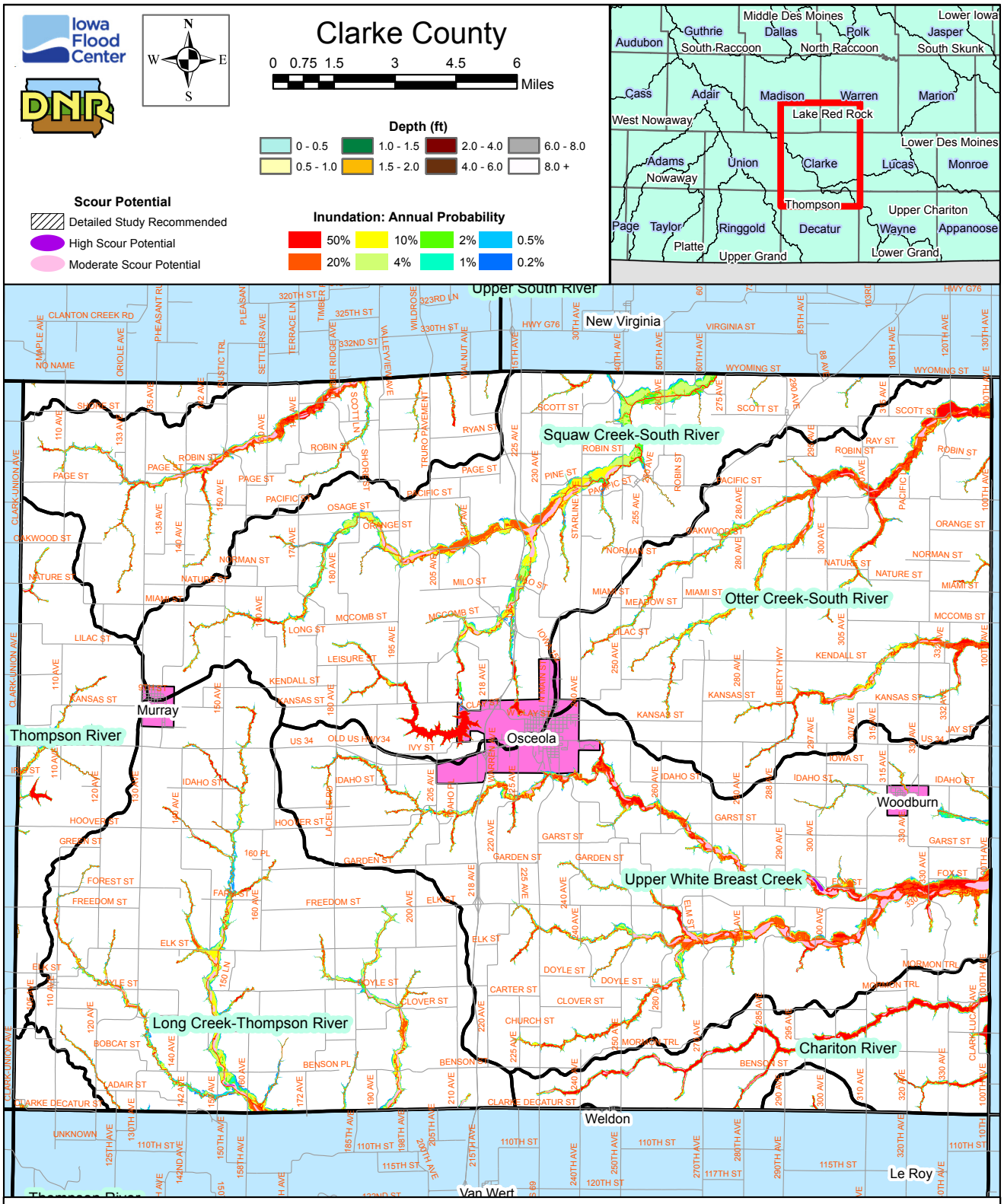
The speed floodwaters rise, or *Rate of Rise*, is the primary factor in determining the amount of warning time. In steep topography or when large amounts of rainfall occur within a short period of time, flash floods can occur. In low, flat areas the warning time can be several hours or even days. The rate of rise is also important because of the effects of hydrostatic pressure. For example, if the water rises quickly, water may not be able to flow into the building fast enough for the pressure inside to rise as quickly as the level outside. When the internal and external pressures (pressure of the water inside the building and the water outside the building) are significantly different, it could cause serious structural damage and even collapse.

The *duration* of the flood is how long it lasts. Often duration is related to rate of rise and rate of fall. Usually water that rises and falls rapidly will recede more rapidly and water that rises and falls slowly will recede more slowly. How long the structural members, interior finishes, service equipment, and building contents are affected by floodwaters is related to how much damage will occur. Duration also determines how long buildings remain uninhabitable.

Ice and/or debris can often pose a greater danger than the floodwater itself. For example, ice floes, caused by ice breakup, can often strike a building causing serious damage or the ice may form around a flooded building causing uplift and structural damage. Floodwaters can carry all types of debris, including trees, portions of flood damaged buildings, storage tanks, mobile homes, as well as dirt and other substances such as oil, gasoline, sewage and chemicals. At low velocities the debris can cause damage and pose a health and safety threat; at higher velocities it can destroy structures, including buildings and bridges.

Figure 3.52 (next page) is a scour potential map provided by the Iowa Flood Center. This map provides some insight into severity of flooding.

Figure 3.52: Clarke County Flood Scour Potential



-Scour predictions made for land cover conditions as shown in the 2009 High Resolution Land Cover database and soil conditions as shown in the 2013 USDA NRCS gSSURGO database
-Scour predictions were not made behind levees that appear to protect against the 1% annual flood
-Levees shown may or may not be accredited by FEMA
-Some sections of stream are missing depth and/or inundation maps; this had to be done in areas that incorporated detailed studies or digital conversions as part of the Iowa Floodplain Mapping project.

Source: Iowa Flood Center, retrieved April 2021

Most floods in Clarke County will have modest depth and frequency but, because they are more likely to be flash floods initially, they will likely have a rapid rate of rise and velocity. They will also likely have a short duration compared to other floods in Iowa. The following assessment is based on these characteristics.

Figure 3.53: River Flood Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	Flooding impacts include potential loss of life. River flooding has less risk than flash flooding because of the slower onset of the river flood. In Clarke County, large floods with large areas of deep water are unlikely. Despite this, the risk of death remains. The 2008 floods resulted in 18 fatalities and 106 injuries, the evacuation of approximately 38,000 Iowans and impacting 21,000 housing units (none in Clarke County).	2
Health and safety of responders	Responding to river flooding often includes sandbagging and working in floodwaters. Response personnel should have current tetanus and hepatitis shots. Rescuing victims often requires rescue from boat. Wearing personal protective gear such as life vests at all times can prevent most injuries.	2
Continuity of operations	Operations could be disrupted from direct impacts if facilities are in the floodplain and indirectly from loss of critical services (such as electricity) to maintain operations. Back-up power and other services can eliminate the impact to operations. Water and wastewater treatment plants are often located in floodplains because they must either take or deposit water into a waterway. This is the case in Osceola. Osceola's water plant is located in a potential flood area if West Lake Dam fails. Other operational elements can be damaged in other communities and the rural area.	2
Property, facilities, infrastructure	Facilities and infrastructure can be scoured around, which degrades its structural integrity. Most losses in Clarke County have been limited to bridges and serving rural areas; some have been destroyed. Because a large area can be impacted, flood damages could be severe.	County: 3; cities: 2
Delivery of services	Damage and disruption of communications, transportation, electric service, and community services are likely in severe cases. Water and wastewater treatment facilities are located in or near the floodplain and are at some risk of flooding and eventually being taken offline.	3
Environmental impacts	Hazards of fire, health and transportation accidents, and contamination of water supplies are likely effects of flooding situations. In Clarke County, hazardous materials facilities are not in flood hazard areas.	3
Economic/financial conditions	Crop and livestock losses and interruption of businesses either from direct flooding or loss of the delivery of critical services can have damaging impacts on the local economy. The magnitude and location of flooding in the county, however, is not likely to have a long-term impact on the overall economy. Counties covered in the 2011 disasters ranged from the western border due to flooding on the Missouri River to eastern counties along the Mississippi River. Crop losses in Iowa alone from Missouri River flooding were an estimated $162 million.	2
Regulatory/contractual obligations	None are known – unlikely to be significant to the population.	1
Reputation	The jurisdiction should pay careful attention to disclosing flood risk in the community. Participation in the National Flood Insurance Program and providing accurate and up to date flood insurance rate maps should mitigate this concern.	1

Score for Rural Clarke County: 19	Score for Murray: 0	Score for Osceola: 18	Score for Woodburn: 18
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

River Flood Speed of Onset:

Gages along streams and rain gages throughout the state provide for an early flood warning system. River flooding usually develops over the course of several hours or even days depending on the basin characteristics and the position of the particular reach of the stream. The National Weather Service provides flood forecasts for Iowa. Flood warnings are issued over emergency radio and television messages as well as the NOAA Weather Radio. People in the paths of river floods may have time to take appropriate actions to limit harm to themselves and their property. The planning team recognizes that Clarke County is the source or is near the source for several rivers and streams, so in most cases flooding originates in the county rather than approaches the county from farther upstream. Therefore, the speed of onset is often much quicker than

areas like Des Moines, Davenport, and Ottumwa, where larger rivers may take on a flood from hundreds of miles upstream. Towns with SFHAs in this county are at or near the very upper reach of the river, so they will occur relatively quickly.

Score for Rural Clarke County: 6	Score for Murray: 0	Score for Osceola: 6	Score for Woodburn: 6
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

River Flood Duration of Event:

River floods can last for days to even one week in a given area of a river. Most flooding in Clarke County will be of a shorter duration because the streams generally originate in or near the county and will flow through the county before going to downstream locations like Ottumwa or northern Missouri. Typically, the river floods in the county are much briefer as a result, although there can be exceptions if rain persists for days or there is an exceptional snowmelt over several days. Osceola and Woodburn are near or at the very upper reach of the streams, so floods will be relatively brief.

Score for Rural Clarke County: 5	Score for Murray: 0	Score for Osceola: 4	Score for Woodburn: 4
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

River Flood Total Scores:

The following total scores for river flood indicate low to moderate risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 43	Score for Murray: 0	Score for Osceola: 40	Score for Woodburn: 40
Score for Clarke Schools: 0	Score for Murray Schools: 0	Score for SWCC: 0	Score for hospital: 0

River Flood Vulnerability/Assets at Risk:

With the availability of Digital Flood Insurance Rate Maps (DFIRMs) as well as detailed parcel data with assessed values, analysis is made to quantify the risk to structures, properties, and people. This allows for analysis of actual structures and values by type that fall within the boundaries of the regulatory floodplain (SFHA). At the time this plan update was written, the County's GIS system did not have a flood hazard layer, so the estimates are tentative at best. By the next update the GIS system should have this data.

As stated earlier, about 2% of the rural (unincorporated) area is within a SFHA. Primarily the area within the floodplains is made up of farmland and timber/wildland. Very few inhabited structures are found in this area. Note the following table of rural assets that could be at risk.

Figure 3.54: Rural Clarke County River Flood Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	5	$400,000	12	<1%
Commercial	0	$0	0	0%
Industrial	0	$0	0	0%
Ag Structures and Land	10 buildings; 20,000 acres	$25,000,000	2	8%
Taxable Infrastructure	2	$8,000,000	1	15%
Government/Institutional	5	$40,000,000	20	25%
Totals	22	$73,400,000	35	8%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is believed that about 8% of the assets in the unincorporated part of the county are at risk. As can be seen, most of them are agricultural lands/crops and infrastructure that is necessary in rural areas, such as bridges, roads, culverts, and utilities that must cross over waterways. The cost/value of bridges and culverts, which is a major budget concern for the County, inflate the asset valuation in comparison with the percentage of the planning area that is within SFHAs. For the estimated five residential properties above, these are properties

that are partially in the SFHA but the County GIS maps seem to show the structures themselves are not in the flood hazard area. The following critical assets listed in Section 3.2 are susceptible:

- Clarke REC system (lines that cross through SFHAs)
- East Lake Park and Dam
- I-35 bridge over S. Squaw Creek
- I-35 bridge over Squaw Creek
- I-35 bridge over White Breast Creek
- R15 bridge over Long Creek
- R35 bridge over S. Squaw Creek
- R35 bridge over Squaw Creek
- R45 bridge over Squaw Creek
- R59 bridge over Otter Creek
- SIRWA water mains system (mains that cross through SFHAs)
- US 69 bridge over White Breast Creek

Approximately 250 acres in the west central, southwest, northwest, and southeast parts of Osceola are also at risk. Most of the acres are inclusive of and surrounding West Lake. The following structures and properties are included.

Figure 3.55: Osceola River Flood Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	0	$0	0	0%
Commercial	0	$0	0	0%
Industrial	0	$0	0	--
Ag Structures and Land	0 buildings; 25 acres	$20,000	0	2%
Taxable Infrastructure	1	$50,000	0	0%
Government/Institutional	2	$5,000,000	5	3%
Totals	3	$5,070,000	5	1.2%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is estimated that about 2% of the assets in Osceola are at risk, mostly in the form of agricultural land and low-traffic roadways that can be flooded. The following critical assets listed in Section 3.2 are susceptible:

- Water treatment plant (portions in 0.2% flood zone)
- Wastewater treatment plant (portions, no buildings)
- West Lake and Dam

Approximately 50 acres through the west, central, south central, and southeast parts of Woodburn are also at risk. The following structures and properties are included.

Figure 3.56: Woodburn River Flood Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	2	$75,000	4	2%
Commercial	1	$25,000	2	20%
Industrial	0	$0	0	--
Ag Structures and Land	0 buildings; 20 acres	$15,000	0	15%
Taxable Infrastructure	1	$50,000	1	4%
Government/Institutional	1	$100,000	1	3%
Totals	5	$265,000	8	3%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is believed that approximately 3% of the assets in Woodburn are at risk. Two of the critical assets listed in Section 3.2 are susceptible: two bridges over the stream.

River Flood Loss Estimation:

The potential losses to existing development will be provided for the following categories of losses:

- Building losses – this will include counts and values for buildings exposed to potential damage from the 1-percent annual chance flood for each jurisdiction in the planning area;

- Estimated population displaced;
- Agricultural impacts; and
- Critical facilities and infrastructure at risk.

When estimating potential losses to structures, it is important to remember that, when a flood occurs, it rarely causes total destruction of the properties in the floodplain. As stated in the severity of impacts section of this profile, factors like depth, velocity, and building type are also important. Based on FEMA Flood Insurance Administration (FIA) flood depth-damage curves, the percent of damage is directly related to the flood depth. FEMA's HAZUS flood loss estimation tool and the flood benefit/cost module both use this simplified approach to model flood damage based on building type and flood depth. A damage estimation of 20 percent of the total value was used based on FIA depth-damage curves for a one-story structure with no basement flooded to two feet. While there are several limitations to this model, it does present a methodology to estimate potential damages. This model may include structures within the 1-percent annual chance floodplain that may be elevated above the level of the base flood elevation, according to local floodplain development requirements, and thus mitigate the risk. Additionally, structures with finished basements and commercial properties would likely sustain a higher percentage of damage.

To determine the population that would be impacted and potentially displaced by a 1-percent annual chance flood event, the average household size, as determined by the Census 2015-2019 estimate, was multiplied by the number of residential structures in the 1-percent annual chance floodplain for each jurisdiction. The population impacted is somewhat underestimated since some of the residential structures are multi-family structures. However, data was not available to determine the number of households in each multi-family structure.

The following table outlines this analysis and provides an estimate of losses due to flooding caused by a 1-percent annual chance flood on structures (not including contents).

Figure 3.57: Estimated Loss in Clarke County Due to River Flood

Jurisdiction	Total Improved Value	Improved Value in SFHA	Estimated Loss	Loss Ratio	Residential Properties in SFHA	Average Household Size	Estimated Impacted Population
Rural Clarke County	$622,900,000	$73,400,000	$14,680,000	2.36%	5	2.35	12
City of Osceola *	$454,200,000	$5,070,000	$1,014,000	0.22%	0	2.28	0
City of Woodburn	$8,200,000	$265,000	$53,000	0.65%	2	2.28	5
Totals	$1,085,300,000	$78,735,000	$15,747,000	1.45%	7	--	17

*Sources: Clarke County DFIRM, Clarke County GIS, US Census Bureau, 4/2020 * Includes school, SWCC, and hospital property.*

While flawed, the model provides a rough idea of what could happen. In Clarke County, the clear majority of physical losses will be to county infrastructure, and residential properties are likely to suffer damage but not to the residential structures themselves. In reality no people will likely be displaced by a flood event in the county, but access to rural homes and farms will be impacted, and there is slight risk of people being injured and killed in a river flood event. Recall from the flash flood profile that river flooding is much less likely to cause death and injury than the more sudden and rapid flash flooding.

According to the State's Hazard Mitigation Viewer's Flood Tab, as of April 1, 2021, there have been the following river flood statistics:

- Number and annual loss from river flood events impacting property: 34; $102,593
- Number and annual loss from river flood events impacting crops: 14; $1,119,367
- Total annual loss reported for river floods: $1,221,960

USDA crop insurance claims for excess moisture/precipitation/rain and flood conditions for the five-year period of 2016-2020 show 115 claims, more than for any other individual hazard and over one-third of the total claims during this period. The total amount of claims was $3,139,392.77, which is the highest amount all causes of crop loss, except drought. This averages to $627,878.55 annually. It is likely that much of these losses occurred outside of the SFHA, but data is not available to determine this.

Due on the limited information available about properties, structures, and infrastructure in SFHAs, it is difficult to estimate losses due to a flood event. Likely the greatest losses, based on past history, will be to County-owned infrastructure, namely roads, bridges, and culverts. These will be partially to totally washed-out either through one flood event or the compound impacts of multiple floods. A new bridge over a small stream or river will cost over $1 million dollars. A larger bridge required to address the traffic demands of a major State/US highway would be upwards of $2 million. Culverts for smaller streams are less expensive but can cost over $100,000. There are approximately 100 to 150 bridges and a similar number, if not more, culverts within SFHAs, almost all of them in unincorporated areas.

Economic losses include more than crops. When infrastructure is washed out, vehicles must take costly detours and some businesses that are isolated will lose sales. The functional use value of businesses, organizations, and governments can be diminished to some degree.

Future Development and River Flood:
Any future development in floodplains would increase risk in those areas. For those communities that participate in the National Flood Insurance Program, enforcement of the floodplain management regulations will ensure mitigation by preventing future construction in those areas. However, even if mitigation actions occur, evacuation may still be necessary due to rising waters. In addition, floods that exceed mitigated levels may still cause damages.

Grass and Wildland Fire Profile
Type: Natural

Definition: An uncontrolled fire that threatens life and property in a rural or wooded area.

Grass and Wildland Fire Description:
Grass and wildland fires can occur when conditions are favorable, such as during periods of drought when natural vegetation would be drier and subject to combustibility. In Iowa, landslides and wildfires often happen in similar circumstances. Both tend to occur in forest or sloping grassland areas. For wildfires, Iowa is in “Ag Land” and Model R. These are both “light fuel” according to the US Forestry Service.

Grass and Wildland Fire Historical Occurrence:
Grass and wildland fire is the most common type of fire in Clarke County, and all participating jurisdictions except the Murray Schools and Clarke County Hospital campus can be affected. A part of Osceola has been affected, but by far most grass and wildland fires have occurred in the rural part of Clarke County. Consistent and accurate data is not available for Clarke County, but in total the area fire departments report multiple incidents per year. Most of these are small (less than five acres), impact only ditches and cropland or timberland, and can be handled with local fire department resources. Occasionally, more than one property, aboveground infrastructure, and structures are impacted, and a few times per year an incident occurs that requires more than one fire department to respond. The planning team, in describing the hazard, said it happens “several times a year.” The team mentioned 2019 is a year with many fires and there was a “huge fire east of Osceola.” With local fire departments partnering through mutual aid compacts, it is relatively easy to gain assistance and put out fires before they become a major hazard.

According to the National Interagency Fire Center, there were 1,817 wildfires spanning 33,122 acres and 1,884 prescribed fires spanning 14,079 acres from 2002 through 2012 in Iowa. None of the state's wildland fires reported to the Center has been considered historically significant. Again, grass and wildland fires are localized hazards.

In 2012, seven departments were called to a large wildfire in rural Clarke County where three firefighters needed medical help due to heat exhaustion. There have been no known fatalities due to grass or wildland fires in the county. No significant fires have been reported other than in Osceola and the rural part of the county. The NCEI reports 1 wildfire in Clarke County from 1950 through December 2020. In that incident, which occurred near Osceola in July 2012, over 100 acres were burned with one firefighter injured. Areas burned included pasture, woodland, and corn crops. Fire departments from three counties were called. The crop damage totaled $40,000.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. Four responded that this occurs more than once per year, seven indicated it happens most years, three indicated it happened once or twice in the last five years, three responded that it has not occurred, and one responded they did not know.

Grass and Wildland Fire Future Probability:

There is nearly 100% chance that there will be a grass fire in each county in the state each year; however, the chance of a wildfire that requires more than day-to-day capabilities to handle is much less. Based on State Fire Marshal and National Interagency Fire Center, there is a very low probability of significant wildland fires impacting thousands of acres. Clarke County planning team members indicate wildland fires are increasingly common, mostly with growth of CRP acres and rural acreages, many of which are in wild areas. The risk is much lower within incorporated communities. For wildfires, Iowa is in "Ag Land" and Model R. These are both "light fuel" according to the US Forestry Service. No specific information for the state on critical fire days was found. Based on climate information obtained, it would be suggested that 2 to 7 days per year would be a good level for southern Iowa. In 2 to 7 days/year fire weather frequency and light fuel, the state has a moderate hazard, no matter the slope of the area surveyed. Only in the more densely forested areas with steeper than 40% slopes is the hazard high in Iowa. All participating jurisdictions except the Murray Schools and Clarke County Hospital campus can be affected by wildfire starting or invading the jurisdiction's property. The two jurisdictions above are separated from wildland areas by roads and other development that does not include wildland vegetation.

The overall rating the community gave for this hazard's future probability in a survey was: "likely" to "highly likely." When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. Nine indicated it is more likely, seven indicated no change in likelihood, one indicated less likely, and one indicated they were unsure.

Score for Rural Clarke County: 8	Score for Murray: 2	Score for Osceola: 3	Score for Woodburn: 2
Score for Clarke Schools: 1	Score for Murray Schools: 0	Score for SWCC: 1	Score for hospital: 0

Grass and Wildland Fire Vulnerability to the Population:

People choosing to live in wildland settings are more vulnerable to wildfires, and the value of exposed property is increasing at a faster rate than the population. This is because the few new homes are being built in forested and wildland areas, where the risk is greatest. Compared to forest fires, grass fires are often more easily contained and extinguished before there is damage to people or developed property, although farms, rural developments, and campgrounds are at risk. Fires often burn large portions of field crops in the fall when the crops are dry and the harvesting equipment overheats or throws sparks. This can be quite costly to the farmer in terms of lost production. Forest and cropland fires present a greater threat to firefighters than

the general public. While most rural residents are at risk to fire, very few are at risk due to any one event due to the limited size of the fire. Generally, people can escape the fire but property and crops are damaged.

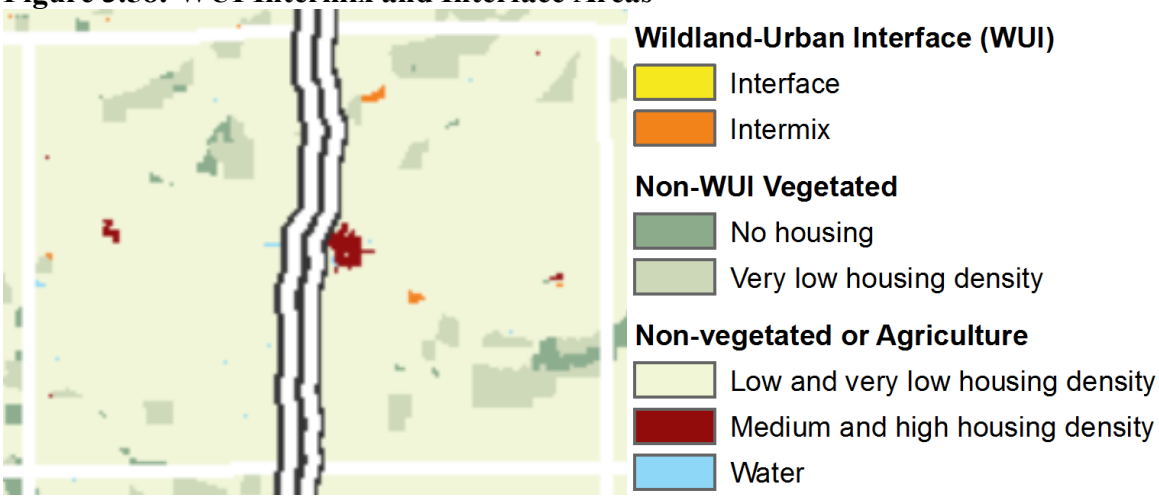
Score for Rural Clarke County: 4	Score for Murray: 5	Score for Osceola: 5	Score for Woodburn: 5
Score for Clarke Schools: 3	Score for Murray Schools: 0	Score for SWCC: 3	Score for hospital: 0

Grass and Wildland Fire Area of Extent:

Iowa is less vulnerable to large-scale wildland fire because of the large percentage of land that is developed. Most grass fires are contained to highway right-of-way and rail right-of-way ditches and are less than a few acres in size. However, larger fires are possible. The extent is dependent upon conditions such as land use/land cover, moisture, and wind. For example, high winds can turn a small flame into a multi-acre grassfire within a matter of minutes or can change fire direction suddenly. Local fires rarely exceed 20 acres but can exceed a few thousand acres in the right locations during dry seasons.

Damaging wildland/grass fires are most likely to occur in the Wildland Urban Interface (WUI). This is the area where houses meet or intermingle with undeveloped wildland vegetation. Within the WUI, there are two specific areas identified: 1) interface and 2) intermix. The interface areas are those that abut wildland vegetation and the intermix areas are those areas that intermingle with wildland areas. As can be seen by the following graphic, Clarke County has very few areas of WUI intermix and no WUI interface areas. WUI areas impact less than 1% of the area of the county.

Figure 3.58: WUI Intermix and Interface Areas



Source: http://silvis.forest.wisc.edu/data/wui-change/, 4/7/21

Score for Rural Clarke County: 3	Score for Murray: 4	Score for Osceola: 4	Score for Woodburn: 4
Score for Clarke Schools: 4	Score for Murray Schools: 0	Score for SWCC: 4	Score for hospital: 0

Grass and Wildland Fire Severity of Impact:

Grass and wildlife fire severity is usually related to environmental factors in the area where the fire is occurring. The conditions that may exacerbate or mitigate the effects of wildfires include:

- Climatic conditions (dry air, high wind, and ambient heat worsen situation)
- Topography (steep slopes increase risk)
- Geography—fuels, hazardous materials areas, open construction areas
- Flammable materials on exteriors of structures
- Narrow roadways
- Inadequate hydrants
- Combustible landscaping

- Development on the interface with the wildland area (adjacent to forests and row crops).

The following table shows the relative risks of a typical observed grass and wildland fire that exceeds normal day-to-day response capabilities.

Figure 3.59: Grass and Wildland Fire Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	Injuries and deaths from fires and from smoke inhalation are possible. Generally, people can escape the fire area.	3
Health and safety of responders	Injuries and deaths from fighting the fire most often occur by natural causes such as heart attack or stroke. Rapidly advancing fires in windy conditions can overtake a firefighter. Other weather conditions can also exacerbate risks due to exposure. The potential lack of water in rural areas (few hydrants and limited tanker capacity) increases risk in remote areas of the county. The risk is actually quite high for responders, but today's first responders are well trained, mostly well equipped, and have modern PPE.	3
Continuity of operations	Most operations would unlikely be disrupted.	1
Property, facilities, infrastructure	Property damage is usually limited to grass, small trees, etc. Occasionally a house or outbuilding can be damaged or destroyed. Major infrastructure, such as bridges and pipes, are unlikely to be damaged. Power lines, poles, and towers are at risk.	3
Delivery of services	Insignificant impacts for the most part. Fire services can be disrupted if equipment is lost.	2
Environmental impacts	Environmental impacts of grass and wildland fires do not deviate much from the burning of the grasses, crops, or other low land cover. If a building or vehicle is burned, it could release damaging chemicals and gases.	3
Economic/financial conditions	The loss of crops could potentially lead to economic hardships within a community in the event of a widespread fire. Typically, if the farmer has insurance, his losses are limited.	2
Regulatory/contractual obligations	None known, unless water supplies are not available as promised.	2
Reputation	Grass fires occur frequently enough that they usually have little impact on reputation.	1

The overall rating the community gave for this hazard's magnitude in a survey was: "limited."

Score for Rural Clarke County: 20	Score for Murray: 20	Score for Osceola: 20	Score for Woodburn: 20
Score for Clarke Schools: 20	Score for Murray Schools: 0	Score for SWCC: 20	Score for hospital: 0

Grass and Wildland Fire Speed of Onset:

Most fires occur without warning and get out of hand in a hurry, perhaps within a few minutes.

Score for Rural Clarke County: 8	Score for Murray: 8	Score for Osceola: 8	Score for Woodburn: 8
Score for Clarke Schools: 8	Score for Murray Schools: 0	Score for SWCC: 8	Score for hospital: 0

Grass and Wildland Fire Duration of Event:

Grass and wildland fires that are likely in Iowa would not be to the size or magnitude of those in Western states, which can last for days or weeks. Usually, a fire can be extinguished in 6 hours. The rating is a bit shorter for fires within towns served by fire departments because the response is more likely to be quicker.

Score for Rural Clarke County: 4	Score for Murray: 3	Score for Osceola: 3	Score for Woodburn: 3
Score for Clarke Schools: 3	Score for Murray Schools: 0	Score for SWCC: 3	Score for hospital: 0

Grass and Wildland Fire Total Scores:

The following total scores for grass and wildland fire indicate low to moderate risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 50	Score for Murray: 42	Score for Osceola: 43	Score for Woodburn: 42
Score for Clarke Schools: 39	Score for Murray Schools: 0	Score for SWCC: 39	Score for hospital: 0

Grass and Wildland Fire Vulnerability/Assets at Risk:

As evidenced by the previous wildland-type fires in the planning area, they have historically been the smaller brush/grass fires that can occur anywhere that has open grassy areas. Most of the assets at risk are located in rural areas. Note the following table of rural assets that could be at risk.

Figure 3.60: Rural Clarke County Grass and Wildland Fire Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	1,400	$185,000,000	3,200	93%
Commercial	10	$3,000,000	35	100%
Industrial	0	$0	0	100%
Ag Structures and Land	500 buildings; 248,000 acres	$164,300,000	75	100%
Taxable Infrastructure	8	$45,000,000	8	80%
Government/Institutional	10	$120,000,000	65	65%
Totals	1,928	$517,300,000	3,383	85%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is believed that about 85% of the assets in the unincorporated part of the county are at risk. The following critical assets listed in Section 3.2 are susceptible:

- Cell towers
- Electrical substations
- Former landfill
- Secondary Roads buildings
- Iowa State Patrol office
- Pipeline surface infrastructure
- Osceola Airport
- Water towers

The fringes of the town of Murray are also at risk. The following structures and properties are included.

Figure 3.61: Murray Grass and Wildland Fire Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	25	$1,200,000	50	7%
Commercial	1	$500,000	10	40%
Industrial	1	$300,000	10	100%
Ag Structures and Land	1 building; 250 acres	$200,000	1	100%
Taxable Infrastructure	1	$2,000,000	1	70%
Government/Institutional	3	$3,000,000	15	15%
Totals	32	$7,200,000	87	12%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is believed that about 12% of the assets in Murray are at risk. Two of the critical assets listed in Section 3.2 are susceptible, due to their location adjacent to wildland and agricultural areas: former Dekko Building and Casey's Store.

The fringes of the town of Osceola are also at risk. The following structures and properties are included.

Figure 3.62: Osceola Grass and Wildland Fire Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	100	$8,000,000	225	7%
Commercial	15	$15,000,000	300	6%
Industrial	10	$15,000,000	800	60%
Ag Structures and Land	4 buildings; 500 acres	$3,200,000	2	100%
Taxable Infrastructure	4	$9,000,000	7	50%
Government/Institutional	10	$20,000,000	300	15%
Totals	143	$70,200,000	1,634	15%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is estimated that about 25% of the assets in Osceola are at risk. The following critical assets listed in Section 3.2 are susceptible:

- Clarke County Fairgrounds
- Clarke County Historical Museum
- Boyt Harness Company
- Clarke County Law Center
- Clarke Electric Coop
- Clarke Elementary School
- Clarke Jr./Sr. High School
- Electric substations
- Homestead of Osceola
- Majona/Iowa Steel
- Natural gas border station
- Osceola Foods
- Osceola WTF
- Osceola WWTF
- Southern Hills Specialty Care
- Southwestern Community College
- Swine Graphics
- The Village Childcare Center
- Valley of the Moon Commercial Poults
- Walmart store

The fringes of the town of Woodburn are also at risk. The following structures and properties are included.

Figure 3.63: Woodburn Grass and Wildland Fire Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	15	$400,000	35	18%
Commercial	2	$50,000	4	50%
Industrial	0	$0	0	100%
Ag Structures and Land	1 building; 100 acres	$100,000	1	100%
Taxable Infrastructure	1	$500,000	2	35%
Government/Institutional	1	$500,000	1	15%
Totals	20	$1,550,000	43	20%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is believed that about 20% of the assets in Woodburn are at risk. None of the critical assets listed in Section 3.2 are susceptible because they are located in the developed part of the city and would very unlikely be impacted by a wildfire on the scale likely to be experienced in this area.

Grass and Wildland Fire Loss Estimation:

Wildfires can be responsible for extensive damage to crops, the environment, and occasionally residential and business facilities. Homes built in rural areas, and particularly in the WUI Interface are most vulnerable, especially where construction is occurring, on hilly land, or if the property owner burns trash and other debris. The vulnerability is exacerbated by the lack of hydrants in those areas and the distance from which fire departments housed in towns must respond.

For the purpose of loss estimation, it is believed that most of the grass and wildland fire loss in Clarke County is to cropland. Buildings and vehicles (usually farm implements) are also vulnerable but most of the time they are not involved, partly due to the low density of development. In the typical wildland fire, 50 acres will be burned, impacting $10,000 in crops. On average perhaps $5,000 in structural loss will be experienced. Per the USDA's crop insurance claim report, no claims have been made for wildland fire loss in the five-year period of 2016-2020.

Injuries and fatalities to civilians and firefighters are certainly possible, although not common. In fact, the planning team estimates a very small probability of either injuries (10%) or fatalities (less than 1%) per incident.

Economic losses can be severe, depending on the size and location of the wildland fire. Most often it will be localized to a few fields, where crops and outbuildings will be lost. If the fire impacts a traveled road, it can result in detours that can be economically costly for businesses and farmers in that area.

The costs to area fire departments to respond to a fire are small compared to some hazard losses, but since most departments are underfunded, a very large fire (by Iowa standards) can drain resources quickly.

Future Development and Grass and Wildland Fire:
Future development in the wildland-urban interface/intermix areas would increase vulnerability. Such development is likely on a very small scale involving a few structures each year in the rural part of the county.

Hazardous Materials Incident Profile
Type: Technological

Definition: An accidental release of flammable or combustible, explosive, toxic, noxious, corrosive, oxidizable, irritant, or radioactive substances or mixtures that can pose a risk to life, health, or property, possibly requiring evacuation.

Hazardous Materials Description:
This profile includes the following hazards from the most recent Clarke County plan: fixed hazardous materials incident, pipeline transportation incident, and transportation hazardous materials incident.

A hazardous substance is one that may cause damage to persons, property, or the environment when released to soil, water, or air. Chemicals are manufactured and used in ever increasing types and quantities. As many as 500,000 products pose physical or health hazards and can be defined as "hazardous chemicals." Each year, over 1,000 new synthetic chemicals are introduced. Under the Emergency Planning and Right to Know Act of 1986, the US Department of Transportation (USDOT) identified 308 specific hazardous chemicals from 20 chemical categories. USEPA sorts hazardous materials (HAZMAT) into the numerous categories as well.

Fixed hazardous materials incidents originate from fixed facilities. This does not mean that all hazardous materials spills originate from regulated facilities that handle them. However, most major spills that affect life and property originate from specific materials handling fixed facilities. The following table shows the current EPA regulated facilities by jurisdiction as of April 2020. *This data is official EPA database results and not necessarily the current building occupant.*

Figure 3.64: List of EPA Regulated Hazardous Materials Handlers

Name	Address/Location	Name	Address/Location
Rural Clarke County			
ADL I – Cactus Family Farms	2700 Idaho St.	Joe Fisher/Long Creek Cattle Company	1562 Benson St.
ADL II – Cactus Family Farms	3050 Kendall St.	Joe Miller	1602 Hoover St.
ADL III Sow Farm – Cactus Family Farms	2952 Kendall St.	Level 3 Communications – Osceola – OscLIAAY	2241 B. US 69 Highway
ADL IV - Cactus Family Farms	2480 Clover St.	Liberty Store	1122 Hwy 69
ADL IV Acclimation – Cactus Family Farms	2418 Clover St.	LIFT, L.L.C.	1447 Hwy 69
ADL V Sow Farm – Cactus Family Farms	1441 Nature St.	Lou Mayfield	3405 Scenic Valley Dr.
Bee Creek Cattle – Home Site	1667 Elk Dr.	Magellan Pipeline Co., LLC – Osceola Pump Station	2245 Hwy 69
Bee Creek Cattle – West Site	2187 160th Pl.	Manatt	Section 1, Township 71, Range 26
BNSF Railway Corporation	MP 356.61, 260th Ave.	Muselman Salvage	RR 4
C & N Cattle Co.	1347 Truro Pavement	Nelson's Mini Stop	Hwy 69 North
Countryside Products – Murray	1905 130th Avenue	Osceola Municipal Airport	1756 270th Ave.
Craig Luce	2320 Lacelle Rd.	Osceola Quarry	RR 1
Darrell Flaherty	1723 Kendall St.	Oswald Ranch	1426 Truro Pavement
Denis Weiser	1436 Starline Ave.	Ottawa Quick Stop	1888 330th St.

Name	Address/Location	Name	Address/Location
Diehl Mobile Home Park	1824 Liberty Hwy	Pig Daddy's Boar Stud Site	210th Street
Don Williams: Clarke County	2897 Garst St.	Pontier Finisher – Cactus Family Farms	1852 297th Ave.
Doug Robins	1438 170th Ave.	Richard Barr	Rte 3
Doug Robins Farm	1738 170th Ave.	Richard German	2440 Kansas St.
Doug Robins Farm Facility	1689 Osage St.	Road Ditch	1-35 South Bound Mile Marker 39
Fastenal Company – Vehicle Accident & Fire	On-ramp from Hwy 152 to I-35 S	Road Ditch	3058 Highway 34 (milemarker #126)
Ferrellgas	1830 130th Street	Robins 1	Osage St.
George Burnett Jr.	1487 130th Ave.	Robins 2	McComb St.
Gerald Pedersen	1801 270th Ave.	Roger Kentner: Clarke County	1426 S. Ridge Rd.
Gregg Voegtlin	8480 SE Vandalia Rd.	Ron Reed	1660 Hwy 152
Hauge's Salvage	1318 225th Ave.	SCCI-Osceola Quarry	1605 218th Ave.
High Prairie Farms	1272 220th Ave.	Schildberg Constr. (Osceola Quarry)	1720 218th Ave.
Hopeville United Methodist Church	Rural	Smyrna Sow Farm	330th Street
Iowa Select – Davis #2	3351 167th St.	Tim Lupkes	2179 Page St.
Iowa Select – Davis Gilt Isol	1054 Kendal St.	Union LP Gas System	1832 130th Ave.
Iowa Select Farms – Davis #1	1024 Kendall St.	Woodburn City of STP (SIRWA)	Idaho Ln. (3/4 mile SE of city)
J-Mar Enterprises, Inc.	I-35 MM 37, E. Side of Hwy	Murray City of STP	Just SE of city (1/4 mile)
JHL Properties, LLP	Idaho Place		
	Murray		
Agriland FS, Inc. – Murray	628 Troy St.	Iowa Select Farms (city of Murray)	500 6th St.
Brown's Service	402 5th St.	Murray City Well #1/Waterworks	6th St.
Casey's General Store #3332	702 1st. St.	Murray Community School	216 Sherman
Clarke Co. Secondary Roads	529 Fourth St.	Rice Spraying	Rte. 15 on West Edge of Town
D.B.A. Mustang Express (Murray)	230 1st St.	Rolling Hills FS, Inc.	NE Corner of Town
Davidson & Sons	211 1st St.	S&W Auto Diesel Inc., FSO	603 Maple St.
Farm Service Co-Humeston	7th & Troy (NW Corner)		
	Osceola		
Agriland Farm Service, Inc.	1994 Old Highway 34	Iowa Dept. Of Transportation	1463 Jeffreys Dr.
Altec Osceola Body Plant	1001 Furnas Dr.	IDOT – office of construction	Hwy 152 Bridge Replacement over I-35 Squaw Creek
Amerigas Propane	2230 N. Main St.	IES Util. Inc. - Osceola FMGP Site	120 E Cass St.
Andrew Auto Supply Aka Napa Auto Parts	129 W. Washington	Iowa Steel Fabrication, LLC	1525 E. Eddy Saylor Parkway
Astoria Industries of Iowa	1001 Furnas Dr.	Iowa Telecom	117 W. Cass
Babson Bros Co.	1000 Tieken Dr.	Iowa-American Foundry	1827 Tieken Dr.
BNSF ROE Enterprises	Delaware and Vale Streets	IP&L Co - Osceola Operating	209 W Washington
Burlington Northern Santa Fe Railway Co	Webster & Main (E. side)	ITC Midwest Osceola North	307 Kendall St
Burlington Northern Railroad	Burlington Northern Railyard	ITC Midwest Osceola West	530 Jimmy Dean Ave
Burlington Northern Santa Fe	600 Block Roosevelt Blvd.	J & J Auto Service-Former Site Of	116-1/2 E McLane St
Carriage House Cabinetry	2318 N. Main St.	Jimmy Dean Manufacturing	Jimmy Dean Avenue
Case Power Equipment-FSO	Hwy 34 W @ I-35	June & Penny's Produce	115 E McLane St
Case Power & Equipment	1420 Southwest Blvd.	KIIC – FM	118 W. Jefferson St.
Casey's	315 W. McLane	Knights Dry Cleaners - Former Site Of	208 S Main St
Casey's General Store	1706 Jeffreys Dr.	Kum & Go #34	202 S. Main St.
Casey's General Store #2320	615 W. McLane	M&M Ag Service, Inc.	1415 N. Main St.
Casey's General Store #1898	114 N. Main St.	Miller Products	1015 N Main
Casey's General Store #3212	400 S. Main St.	Oliver Motors	1120 Jeffreys Dr.
Cathy's Body Shop	2326 N. Main St.	O'Reilly Auto Parts Store 286	721 W. McLane
Chaney Twin Service Inc.	328 S. Main	Osceola 66	102 E. McLane
City of Osceola	604 E. Washington St.	Osceola BP	328 S. Main St.
City of Osceola	City Hall	Osceola City of WTP	2114 W. Clay Street
City Of Osceola STP	1986 Country Club Rd.	Osceola Coal Gas	E. Jefferson and S. Park

Name	Address/Location	Name	Address/Location
Clarke County Maintenance	Highway 69 N.	Osceola Farm & Home	714 W. McLane St.
Clarke County Secondary Roads	1710 N. Main St.	Osceola Foods, Inc.	1027 Warren Avenue
Clarke Community High School	800 N. Jackson St.	Osceola Locker Company	123 ½ North Main St.
Clarke County Courthouse	100 S. Main St.	Osceola North	307 Townline Rd.
Clarke County Hospital	800 Fillmore St.	Osceola Travel Plaza	105 Ariel Cr.
Clarke County Sanitary Landfill	2095 Leisure Dr.	Osceola Veterinary Clinic	1030 North Main Street
Clarke County Sanitary Landfill	2089 Leisure Dr.	Osceola Water Works	2320 W Clay St.
Clarke County Secondary Roads	100 S. Main St.	Osceola WWTP South	Country Club Drive
Clarke County State Bank	139 S. Main St.	Pamida (FSO)	Hwy 34 West
Clarke County Tire	803 W. McLane	Paul Mueller Company	1715 Tieken Drive
Clarke Electric Cooperative	1103 N. Main St.	Pilot Travel Center #131	2010 W. Clay St.
Clarke Rural Water District #1	2544 Kansas St.	Quality Car Wash	701 West McLane St.
Cozad, Jacob	107 W. 3rd Ave.	R & H Auto Sales & Service	920 N Main
Dekko Tech, FSO	3330 W. McLane St.	Ringgold Co. Soil &Water Conservation Dist.	101 S. Main St.
Eastgate Oil	415 E Jefferson	Ruan	1053 Furnas Dr.
Eastgate Oil Co-Osceola	1215 N Main St.	Rueters – Osceola	1827 Tieken Dr.
Eastgate Oil Co Ltd. (Osceola)	715 S. Adams St.	Safety-Kleen Household Hazardous Waste	1710 N Main St.
Eastside Automotive-FSO	714 E McLane	Salford Inc	925 Furnas Drive
Exel Inc.	1035 Warren Ave.	Saylor-Cooley Grain Elevator	116 ½ W. Webster
Farmer's Cooperative Co.	221 Townline Rd.	Schwans Osceola Depot/Home Service, Inc.	215 Townline Rd.
Ferrellgas	1820 N. Main St.	Simco Drilling Equipment Inc	802 S Furnas Dr.
Ferrellgas (Schwans-Osceola)	215 Townline Rd.	SIRWA #3 (Osceola)	115 N. Fillmore St.
Former Sinclair Station	101 E. McLane	Smith Oil Co.	405 E. McLane St.
Friendly Acres Mobile Home Park – STP	1729 Truman Rd.	Special Packaging, Inc., DBA Palleton of Iowa	511 Warren Ave.
Furnas Electric Co.	1000 Furnas Dr.	Sport Wade South	600 Block Roosevelt Blvd.
German Machine Works Inc.	1302 Jeffreys Dr.	Texaco Food Mart	1520 Jeffreys Dr.
Glazebrook Auto Supply Inc.	614 W McLane	Tom & Johns Auto Service	301 Le Ann Dr.
Goodyear Store	Main and Cass Streets	Trager Motor Co	210 W Jefferson
Halls James (Osceola)	1573 Church St.	United Farmers Coop – Osceola	221 Townline Rd.
Hard Water Inn	1510 N. Main St.	Valley Of The Moon Commercial Poults Inc	211 Leisure Dr.
Ideal Ready Mix Co Inc. - Osceola	1911 N Main	Walmart Supercenter 4606	2400 College Dr.
Iowa Dept. Of Transportation	1410 Jeffreys Dr.	Wilkins North Elevator	1705 N. Main St.
		Woodburn	
Clarke Co. Secondary Roads	109 Sherman St.	Cottrell & Sons	510 Sigler St.

Source: EPA EnviroMapper Website, https://iaspub.epa.gov/enviro/fii_map_master.fii_retrieve#TopMap, 4/8/2021; FSO – former site of

Each year, thousands of hazardous materials are transported across the county via semi-truck, aircraft, and trains. Hazardous substances are categorized as toxic, corrosive, flammable, irritant, or explosive. Hazardous materials incidents generally affect a localized area, and the use of planning and zoning can minimize the area of impact. *The scope of this update did not include obtaining data about the types and quantities of hazardous materials transported through the county. Such data should be gathered and included in the next plan update.*

The 1986 Act requires that companies report releases of designated hazardous chemicals to USEPA, even if releases do not result in human exposure. Hence, hazardous materials are greatly regulated, but the sheer volume of data involved can overwhelm local authorities. To identify the extent of the hazard in a particular community, planning personnel and others must determine what types of HAZMAT are stored, handled, processed, or transported and where and how those functions are performed. With limited staffing capabilities this is nearly impossible for Clarke County.

The issue is complicated because some incidents are the result of failure to close valves on the vehicles, resulting in unnoticed releases that are not tied to a reportable event. At other times, events may not be reported if there are no witnesses besides the driver, pilot, or engineer.

Natural hazards may cause transportation HAZMAT events. Heavy rainfall during thunderstorms can cause slippery road conditions resulting in highway carrier accidents. Floods, lightning, fires, and severe winter storms cause pipelines to fail. Snow ice, and high-wind conditions during severe winter storms cause traffic accidents. High velocities and volumes of floodwaters wash out bridges and roads.

Iowa is served by many high-pressure pipelines for residential and industrial uses. An underground pipeline incident can be caused by environmental disruption, accidental damage, or sabotage. Incidents can range from a small slow leak that is not ignited to a large rupture in which the gas is ignited. Inspection and maintenance of the pipeline system along with marked gas line locations and an early warning and response procedure can lessen the risk of those in close proximity to the pipelines. Pipeline transportation facilities are mapped in Chapter 2. Pipelines cross portions of rural areas and access several of the cities in the county, where natural gas is used for heating and other household and business needs.

Hazardous Materials Incident Historical Occurrence:

A high impact occurrence is one defined as an environmental emergency by the EPA. An environmental emergency is a sudden threat to the public health or the wellbeing of the environment, arising from the release or potential release of oil, radioactive materials or hazardous chemicals into the air, land, or water. Locally there have been very few incidences that would meet this definition. Nonetheless, releases do occur and do impact the planning area. According to the Iowa DNR Hazardous Spill Reporting System (https://programs.iowadnr.gov/hazardousspills/Introductory.aspx#&&SearchResult=1), there have been 17 reported spills in Clarke County from 2016 through 2020. The nature of the hazard events (fixed or transportation) was not provided. Osceola is listed as the location for most of them, although some could be located in rural areas.

According to the planning team, almost all fixed facilities incidents have occurred within Osceola, and many of these in industrial areas. Past events have been contained and cleaned within local response capabilities in most cases. Relatively minor events have been reported at the Osceola Foods plant in Osceola and the Co-op in Murray. An alcohol spill occurred near Woodburn (rural area) over ten years ago. A more recent incident involved 55 gallons of a dangerous chemical (unnamed) that occurred in 2019. No major events causing loss of life have been discussed. No events in recent years have resulted in widespread mandatory evacuations. The most common types of substances have been agricultural materials, including stolen anhydrous ammonia, and petroleum. Local gas stations, agricultural facilities, and manufacturing plants are common sites, as well as rural highways.

Transportation hazardous materials incidents seem to occur monthly in Osceola or the rural county. Incidents have not been reported in Murray or Woodburn but can happen. Incidents in the past few years include transported chemicals, such as ammonia, liquid chlorine, and propane, and mobile methamphetamine labs (2 or 3 events). Approximately ten years ago, a semi-truck went off a highway just north of Osceola. There was a plume, and the acids ate the tires off the truck and tied up the site for a week. In late 2007, an event occurred on I-35 that shut down half the Interstate for hours by Exit 36. There have been no widespread evacuations as a result of incidents to date, but road detours are common. Only an average of one incident per year would be defined as a danger to public health and/or safety.

Natural gas service is used in homes and businesses for heat and manufacturing processes in parts of rural Clarke County and all of Osceola. Pipeline transportation incidents of a small scale, with no injuries or

major losses, have occurred in the rural area and Osceola. These have been limited to Osceola and rural areas, where only a portion of the population and properties were affected temporarily with the loss of natural gas.

Clarke County seems to proactive, but the continued mechanization of agriculture means more and larger specialized chemicals and storage facilities. The County and most cities contract with the Southeast Iowa Response Group (SIRG), based in Ottumwa, (75 minutes away) for specialized response and cleanup and the service is used for larger incidents, but this group has been used very sparingly so far.

The Emergency Planning and Right to Know Act of 1986 requires the reporting to the EPA (designated through the IDNR in Iowa) of many kinds of events: Types of releases include:

- Air emissions of gases or particles from a pressure relief valve, smokestack, ruptured reaction vessel, broken pipe or other equipment at a chemical plant or other fixed-site facility; from broken, loose-fitting, or punctured equipment, containers, or cylinders on transportation vehicles; and from solid or liquid discharges onto ground or into water;
- Discharges into bodies of water from damaged ships, barges, underwater pipelines, and trucks or railroad cars that fall into the water;
- Discharges as outflows from sewer or drain outfalls, runoff from spills on land, runoff from water used to control fires, or contaminated groundwater;
- Discharges onto land;
- Solid waste disposal in onsite landfills;
- Injection of wastes into underground wells;
- Transfers of wastewater to public sewage plants;
- Transfers of wastes to offsite facilities for treatment or storage.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. Three indicated it happened once or twice in the last five years, ten responded that it has not occurred, and five responded they did not know.

Hazardous Materials Incident Future Probability:
Combined, fixed and transportation hazardous materials incidents and pipeline transportation incidents are common. However, the percentage of significant or serious incidents that are beyond local capabilities or that threaten life or significant property is relatively low. However, because of the railroad, Interstate highway, two major US highways, and heavy manufacturing, including animal processing, facilities, this is an important hazard for the county to consider.

Fixed HAZMAT events from Tier II sites are possible in or affecting all jurisdictions. There are nearly 200 sites in Clarke County that, because of the volume or toxicity of the materials on site, are designated as Tier II facilities under the Superfund Amendments and Reauthorization Act. Despite increasing safeguards, more and more potentially hazardous materials are being used in commercial, agricultural, and domestic activities. While protection methods are improving, the probability is likely to increase over time in some jurisdictions. Clarke County has numerous agricultural and energy facilities, including bulk plants, LP tanks, and anhydrous ammonia tanks. Fuel leaks can happen in most or all jurisdictions, whether or not they are Tier II facilities. Several manufacturers in Osceola also handle large quantities of hazardous materials.

Current planning is significant to address future probability. Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 requires that each community establish a Local Emergency Planning Committee (LEPC) to be responsible for developing an emergency plan for preparing for and responding to

chemical emergencies in that community. The plan is reviewed by the State Emergency Response Commission (SERC) and publicized throughout the community. It must include the following:

- An identification of local facilities and transportation routes where hazardous materials are present;
- The procedures for immediate response to an incident (including a community-wide evacuation plan);
- A plan for notifying the community that an incident has occurred;
- The names of response coordinators at local facilities;
- A plan for conducting exercises to test the plan.

Clarke County is generally current with LEPC planning and has the correct policies and trained personnel in place.

Transportation incidents that are of a major threat are limited to the I-35, US 34, US 69, the BNSF Railway, and paved county highways. The probability varies by jurisdiction; however, the probability is low in all jurisdictions of a significant event requiring extended road closures, large fires, evacuations, and/or full mobilization of outside response capabilities.

Pipelines are found in the county but are very well monitored. Petroleum and natural gas pipeline accidents occur with some regularity, but they usually have a limited impact and are quickly and adequately handled by pipeline company emergency crews and local and state responders. Pipeline operators are required to coordinate all safety preparedness and response activities with the communities. Planning, training, and exercising of emergency procedures with all involved parties help to limit the occurrence and severity of incidents. This risk is mainly limited to Osceola and parts of the rural county where pipelines travel. In Clarke County, as pipeline use continues to increase and more homes are put on natural gas, the probability of incidents will increase.

Overall, the chance of an incident that threatens life and property is greatest in the Osceola but is low overall. The following is the probability for an incident that requires response beyond local resources and is a direct risk to the public or critical environmental resources, such as streams and waterways.

When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. Four indicated it is more likely, six indicated no change in likelihood, three indicated less likely, and five indicated they were unsure.

Score for Rural Clarke County: 3	Score for Murray: 2	Score for Osceola: 7	Score for Woodburn: 2
Score for Clarke Schools: 1	Score for Murray Schools: 1	Score for SWCC: 1	Score for hospital: 1

Hazardous Materials Incident Vulnerability to the Population:

HAZMAT releases pose short- and long-term toxological threats to humans and to terrestrial and aquatic plants and wildlife. Toxic materials affect people through one of three processes: a) inhalation, b) ingestion, and c) skin contract. People, pets, livestock, and vegetation in close proximity to facilities and transportation corridors producing, storing, or transporting hazardous substances are at higher risk. Populations downstream, downwind, and downhill of a released substance are particularly vulnerable. Depending on the characteristics of the substance released, a larger area may be in danger from explosion, absorption, injection, ingestion, or inhalation. Occupants of areas previously contaminated by a persistent material may also be harmed either directly or through consumption of contaminated food and water.

Tier II Fixed Facilities are required to have an off-site consequence plan that addresses the population of the surrounding area. Responding personnel are required to be trained to HAZMAT Operations Level to

respond to the scene, and those personnel that come into direct contact with the substances released are required to have HAZMAT Technician level training. However, for fixed HAZMAT purposes, risk is most pronounced at reporting facilities, even though they can occur at any "fixed" site. People work in facilities that house chemicals. For the purpose of this plan, for simplicity, direct impacts will occur within a 1,000-foot radius of a facility. Clarke High School, Murray School, and Clarke County Hospital are Tier II facilities, but the impact of the other facilities is mostly to people who are outdoors and can be affected by airborne gases from other locations within 1,000 feet.

Transportation incidents like train derailments, semi-truck spills, and agricultural implement spills are common and can occur where people are located. These are more difficult to regulate, contain, and cleanup because most of the spills occur outdoors and many times they occur in adverse weather conditions such as high winds and snowstorms. People, pets, livestock, and vegetation in close proximity to transportation corridors and populations downstream, downwind, and downhill of a released substance are particularly vulnerable. Depending on the characteristics of the substance released, a larger area may be in danger from explosion, absorption, injection, ingestion, or inhalation. Occupants of areas previously contaminated by a persistent material may also be harmed either directly or through consumption of contaminated food and water. Using a 1,000-foot buffer on paved highways, some areas are populated and some roads have considerable traffic. Some jurisdictions are greatly impacted; others will only see a small part of the population at risk. Through evacuations and sheltering in place, most people are not likely to be directly harmed if warned before the substance(s) reach them.

People and property with pipelines on their land or nearby are the most at risk. People excavating earth near a pipeline are also at risk. Whether the greater hazard is posed to those upwind or downwind from a site depends on the product spilled, for example - natural gas is lighter than air. Private homes and business served by natural gas have smaller diameter pipelines connected to their structure. The underground pipelines cross public streets, roads, highways, and streams. Iowa's natural environment is also vulnerable to contamination from an underground pipeline incident. People can suffer from the loss of gas service to their homes. The greatest potential impact as a percentage of population is the cities that have full gas service, which are Osceola, Clarke Schools, SWCC, and the hospital. It can take days for personnel to go to each house and re-pressurize and re-light facilities for each building. Manufacturers would have to use other fuels to continue operating. Buildings like the schools and hospital use other heating that does not require much pipeline capacity.

The following assessment of the vulnerable population reflects the combined risk of any one event for any one of these forms of hazardous materials.

Score for Rural Clarke County: 5	Score for Murray: 5	Score for Osceola: 7	Score for Woodburn: 4
Score for Clarke Schools: 4	Score for Murray Schools: 3	Score for SWCC: 3	Score for hospital: 4

Hazardous Materials Incident Area of Extent:

Most of the hazardous materials incidents are localized and are quickly contained or stabilized by the highly trained fire departments and hazardous materials teams. To identify the extent of the hazard in a particular community, planning personnel must determine: a) what types of HAZMAT are stored, handled, processed, or transported, and b) where and how those functions are performed. Depending on the characteristic of the hazardous material or the volume of product involved, the affected area can be as small as a room in a building or as large as 5 square miles or more. Many times, additional people outside the immediately affected area are evacuated for precautionary reasons. More widespread effects occur when the product contaminates the municipal water supply or water system such as a river, lake, or aquifer. For direct impact, the planning committee assumes a 1,000-foot radius of the fixed facility, transportation corridor, or major pipeline. This would be a small part of the rural area but a larger part of each directly impacted city or

individual building, campus, or property. Buildings and assets near the traveled routes would be impacted, even if people can be evacuated or taken indoors. The use of planning and zoning, which exists only Osceola, can minimize the area of impact.

Identification and caution signs are posted wherever pipelines pass under roads, streams, fence lines, or at any aboveground utilities. Despite warnings, people excavating earth near a pipeline are at high risk. Because chemicals and gases vary in how they react when a pipeline is severed, people and property with pipelines on their land or nearby are the most at risk. Since pipelines are most common in populated areas, in order to serve residential and industrial needs, the extent could be very high. Private homes and business served by natural gas have smaller diameter pipelines connected to their structure and the threat of failure in terms of explosion risk is low. Underground pipelines cross public streets, roads, highways, and streams. Iowa's natural environment is also vulnerable to contamination from an underground pipeline incident. People can suffer from the loss of gas service to their homes. Osceola has full gas service, so an outage could affect 90% of properties. However, these impacts, in most cases are an inconvenience at best. In the winter, during severe cold, a modest percentage of residents without gas due to the outage could be harmed. Pipelines have automatic shutoff valves installed so that damaged sections can be isolated and the volume of product escaping can be limited.

Score for Rural Clarke County: 4	Score for Murray: 5	Score for Osceola: 6	Score for Woodburn: 5
Score for Clarke Schools: 7	Score for Murray Schools: 7	Score for SWCC: 7	Score for hospital: 7

Hazardous Materials Incident Severity of Impact:

Severity of hazardous materials incidents is difficult to assess. The root cause of the incident can exacerbate conditions. Natural hazards, for example, can cause HAZMAT releases at fixed sites, on transportation systems, in the outdoors, and in pipelines. When a HAZMAT event occurs during a natural disaster, access to facilities may be restricted, water lines for fire suppression may be broken, and response resources (equipment and personnel mainly) may be limited.

The following provides a summary of the severity of impact throughout the county for a major or "environmental emergency" HAZMAT incident resulting from a natural hazard event. This summary is based on a scenario. Keep in mind the magnitude or severity will be greatly impacted by the chemical or gas involved, location, quantity, and capabilities to respond, in addition to the circumstances surrounding the incident (weather, time of day, etc.). Enforcing and/or facilitating either a shelter in place protocol or full evacuation of an area also can hinder response greatly.

Figure 3.65: Hazardous Materials Incident Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	The release of some toxic gases may cause immediate death, disablement, or sickness if absorbed through the skin, injected, ingested, or inhaled. Some chemicals may cause painful and damaging burns to skin if they come in direct contact with your body. Within fixed facilities and in close proximity of outdoor incidents the risks are very high. People evacuating an area are exposed to natural hazards. Release of explosive materials can cause additional fatalities.	3
Health and safety of responders	Specialized training is needed to respond to these types of incidents. If inadequately trained personnel attempt to respond, the impacts could be the same as those for the general public exposed to the toxic materials. Proper training and equipment greatly reduce the risk to responders. Responders would also be exposed to any natural hazards that caused the incident. There are a limited number of trained people. The effort to locate and fix a ruptured pipeline or other source of a leak offers additional great risk to responders.	4
Continuity of operations	None directly unless the incident occurs on or near critical facilities or services (which includes pipelines). Road closures and evacuations can also stall operations. Response agencies may lose equipment and members could be injured or sick and unable to respond. Proper decontamination may be needed before the facilities go back in service.	3

Severity Criteria	Discussion	Score
Property, facilities, infrastructure	Physical damage is usually limited to the immediate property involved. Proper decontamination is needed before the facilities go back in service. Fire and the decontamination process can damage buildings as much or more than the original hazardous material. Pipeline infrastructure can suffer from extensive damage.	3
Delivery of services	Contaminated water resources may be unsafe and unusable for days or longer. Other services can be delayed due to road closures, evacuations, and the cleanup process. Petroleum products may not be delivered or will be delivered in limited quantity.	2
Environmental impacts	Contamination of air, ground, or water may harm fish, wildlife, livestock, and crops. The release of hazardous materials into the environment may cause debilitation, disease, or birth defects over many years. The costs and time involved in cleanup can be months or even years and involve millions of dollars. Pipeline failures can cause the rapid and sudden erosion and contamination of soil.	4
Economic/financial conditions	Loss of livestock and crops, industrial fires and shutdowns, and evacuations may lead to economic hardships within the community. The time required for cleanup and decontamination can ruin a small business and cause hardship for those in the area. Insurance rates and costs may also increase.	3
Regulatory/contractual obligations	None directly, but EPA and related environmental violations can cause regulatory ramifications to the jurisdiction. Affected businesses and organizations may not meet demand from customers.	2
Reputation	Safe and timely response will greatly limit any damage to the jurisdiction's reputation. Proper warning and public information before, during, and after the incident can also limit reputation damage.	2

Score for Rural Clarke County: 26	Score for Murray: 26	Score for Osceola: 26	Score for Woodburn: 26
Score for Clarke Schools: 26	Score for Murray Schools: 26	Score for SWCC: 26	Score for hospital: 26

Hazardous Materials Incident Speed of Onset:

Most of the various kinds of incidents are unplanned accidents due to weather damage, human error, mechanical failure, and the like. The incident can be immediate and, although not common, severe from the start. There may be no warning that an incident is about to occur. Even if reported immediately, people in the area of the release have very little time to be warned and evacuated. During some events, sheltering in-place is the best alternative to evacuation because the material has already affected the area and there is no time to evacuate safely. Public address systems, television, radio, reverse E911, and the NOAA Weather Radios are used to disseminate emergency messages about hazardous materials incidents. Because some jurisdictions are not within the immediate area of a fixed incident, speed of onset in those areas is longer.

Score for Rural Clarke County: 9	Score for Murray: 9	Score for Osceola: 9	Score for Woodburn: 9
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Hazardous Materials Incident Duration of Event:

The incident duration can vary greatly by the type of chemical or gas released, ambient conditions (wind, weather, darkness, etc.), how long it has been released, and the capacity of the local response team(s) to respond adequately in containing the hazard. If you include the process of cleanup so that the public can again enter the area, the duration could be hours to a day or more. Evacuations can delay containment.

Score for Rural Clarke County: 5	Score for Murray: 5	Score for Osceola: 5	Score for Woodburn: 5
Score for Clarke Schools: 5	Score for Murray Schools: 5	Score for SWCC: 5	Score for hospital: 5

Hazardous Materials Incident Total Scores:

The following total scores for hazardous materials incidents indicate moderate to high risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 52	Score for Murray: 52	Score for Osceola: 60	Score for Woodburn: 51
Score for Clarke Schools: 52	Score for Murray Schools: 51	Score for SWCC: 51	Score for hospital: 52

Hazardous Materials Incident Vulnerability/Assets at Risk:

Generally, past hazardous materials incidents were very localized and usually had no effect beyond the immediate area. Nonetheless, government agencies regulate the areas where impact can occur in relation to a fixed facility based on the types of chemicals involved. However, based on past experience and likely future incidents where evacuations or sheltering in place may be needed, the planning team uses a 1,000-foot buffer around fixed facilities and main transportation routes (highways and railroads). Note the following table of rural assets that could be at risk.

Figure 3.66: Rural Clarke County Hazardous Materials Incident Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	200	$25,000,000	500	15%
Commercial	10	$3,000,000	35	100%
Industrial	0	$0	0	100%
Ag Structures and Land	50 buildings; 10,000 acres	$10,300,000	7	8%
Taxable Infrastructure	9	$52,000,000	9	90%
Government/Institutional	14	$185,000,000	95	95%
Totals	283	$275,300,000	646	20%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is believed that about 20% of the assets in the unincorporated part of the county are at risk. The following critical assets listed in Section 3.2 are susceptible:

- All bridges listed
- REC electrical substations
- County Secondary Roads buildings
- BNSF Railroad
- East Lake Park and Dam
- Iowa State Patrol office
- Magellan Pipeline and Station
- Natural gas pipeline
- Osceola Airport
- Woodburn and Murray sewer lagoons

Murray is also subject to hazardous materials from a few fixed facilities, a pipeline that passes near the city, and key transportation routes. At least half of the town is within 1,000 feet of a source of hazardous materials.

Figure 3.67: Murray Hazardous Materials Incident Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	225	$11,000,000	450	65%
Commercial	10	$1,500,000	25	100%
Industrial	1	$300,000	10	100%
Ag Structures and Land	1 buildings; 125 acres	$125,000	1	60%
Taxable Infrastructure	2	$2,700,000	1	100%
Government/Institutional	9	$18,000,000	315	90%
Totals	248	$33,625,000	802	80%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is believed that about 80% of the assets in Murray are at risk. Several of Murray's critical assets identified in Section 3.2 are within 1,000 feet of the major transportation route or a fixed facility. With no natural gas in Murray, there are no pipeline hazards, except to a small part of the city within 1,000 of a passing pipeline northwest of the city.

- Church of Christ
- City Hall
- Fire Station
- BNSF Railroad
- Former Dekko Building
- Casey's Store

Dozens of fixed facilities are located in Osceola, and there are highways and "truck" routes, so the risk within 1,000 feet covers most of the town of Osceola. The following structures and properties are included.

Figure 3.68: Osceola Hazardous Materials Incident Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	1,750	$130,000,000	4,000	80%
Commercial	290	$77,000,000	1,250	97%
Industrial	20	$24,300,000	1,225	100%
Ag Structures and Land	2 buildings; 250 acres	$1,600,000	1	50%
Taxable Infrastructure	7	$17,000,000	13	85%
Government/Institutional	70	$155,000,000	2,150	95%
Totals	2,139	$404,900,000	8,639	87%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is estimated that about 87% of the assets in Osceola are at risk. All the critical assets listed in Section 3.2 are susceptible, with the exception of the water towers.

There is one paved highway used by trucks and farm machinery through Woodburn but no natural gas and only two small Tier II fixed facilities, so the risk within 1,000 feet covers most of the town of Woodburn. The following structures and properties are included.

Figure 3.69: Woodburn Hazardous Materials Incident Structures, Values, and People at Risk

Structure/Land Use	Number of Structures	Estimated Value	Number of People	Estimated %
Residential	70	$2,000,000	150	75%
Commercial	5	$100,000	8	100%
Industrial	0	$0	0	100%
Ag Structures and Land	1 building; 50 acres	$75,000	1	75%
Taxable Infrastructure	2	$1,200,000	3	80%
Government/Institutional	5	$3,500,000	6	85%
Totals	83	$6,875,000	168	75%

Sources: Hazard Mitigation Planning Team, US Census, various local data sources, Iowa Dept. of Management

It is believed that about 75% of the assets in Woodburn are at risk. All critical assets listed in Section 3.2 are susceptible.

Hazardous Materials Incident Loss Estimation:

The impact of this hazard will likely be localized to the immediate area surrounding the incident, but with the lack of other credible data, the planning team used 1,000 feet from locations where the incident is likely to occur, which are regulated fixed facilities, major transportation corridors, and major pipelines. The initial concern will be for people, and then for structures and the environment. The current practice is that the spiller is responsible for the cleanup actions and is to contact local responders and then the Iowa DNR and possibly the EPA to ensure that cleanup is done safely and in accordance with federal and state laws.

The losses would reflect the location, type of substance spilled or released, ambient conditions where it occurs, and response capabilities. It is difficult to determine the potential losses to existing development because of the variable nature of a hazardous materials spill. For example, a toxic airborne chemical or gas in a developed area could make dozens of people sick and kill numerous people. A simple spill of 500 gallons of anhydrous on a cornfield might only require modest soil remediation.

In Clarke County, most incidents will have minor loss in terms of property, simply because the population density is low. However, in the worse-case scenario, based on past history, a factory could be destroyed by fire, one or more vehicles can be destroyed, and surrounding buildings and properties can catch on fire or

suffer damage from chemicals and gases. Typically, up to $100,000 per occurrence in property loss is expected. Depending on the asset, contents losses could be as high.

Economic/functional use losses could be considerable if an entire factory or neighborhood is cordoned off and people cannot enter or leave the area. A mass evacuation would disrupt many people's lives and make it so they cannot contribute to the economy. Businesses that are not even responsible for the incident can be closed for hours or longer. Economic losses due to a typical incident might exceed $100,000.

Rarely do hazardous materials incidents cause the loss of life, but injuries and illnesses are not uncommon. It is reasonable to assume that in the most severe cases that can be expected that one or more persons will be killed by an explosion or by exposure to fumes and gases.

According to the Pipeline and Hazardous Materials Safety Administration in the US DOT, the overall average per-gallon response cost for crude oil, gasoline, and other fuels is $1,270. From January 2016 through December 2020, 4 years, there were 17 spills in Clarke County, according to the Iowa DNR spill reporting system. Based on historical data, using the above cost, the average per year was $40,000 just to clean the hazard.

Future Development and Hazardous Materials Incident:
The number and types of hazardous chemicals stored and, even more so, transported through the county is likely to increase substantially. Population and business growth along major transportation corridors increases the vulnerability to transportation hazardous materials incidents. While the county's population is not likely to grow significantly, any growth is likely to occur in areas where this hazard exists.

Infrastructure Failure Profile
Type: Technological

Definition: An extended interruption, widespread breakdown, or collapse (part or all) of any public or private infrastructure that threatens life and property.

Infrastructure Failure Description:
Infrastructure failure involves numerous types of infrastructure profiled in the previous plan: energy utilities, communications systems, and structural failures and fires. The following paragraphs offer a brief description of the types of infrastructure considered.

Communications involve personal and emergency systems. Emergency 911, law enforcement, fire, EMS, public works, and emergency warning systems are just a few of the vital services which rely on communication systems to effectively protect citizens. Business and industry rely heavily on various communication media as well. Mechanical failure, traffic accidents, power failure, line severance, and weather can affect communication systems and disrupt service. Disruptions and failures can range from localized and temporary to widespread and long-term. If switching stations are affected, outage could be more widespread. Key communications systems are shown in the communications map in Chapter 2.

Energy failure is the loss of power and other energy supplies needed for day-to-day human survival. International events could potentially affect supplies of energy-producing products, while local conditions could affect distribution of electricity, petroleum or natural gas. The magnitude and frequency of energy shortages are associated with international markets. Local and state events such as ice storms can disrupt transportation and distribution systems. If disruptions are long lasting, public shelters may need to be activated to provide shelter from either extreme cold or extreme heat. Stockpiles of energy products eliminate short disruptions, but can also increase the level of risk to the safety of people and property in

proximity to the storage site. Key energy systems and pipelines are shown in applicable maps in Chapter 2.

A road, bridge, or building may collapse due to the failure of the structural components or because the structure was overloaded. Weather events such as heavy snow may cause a roof of a building to collapse under the weight of the snow. Heavy rains and flooding can undercut and wash out a road or bridge. The age of the structure is sometimes independent of the cause of the failure. Enforcement of building codes can better guarantee that structures are designed to hold up under normal conditions. Routine inspection of older structures may alert inspectors to "weak" points. The level of damage and severity of the failure depends on factors such as the size of the building or bridge, the number of occupants of the building, amount of traffic on the road or bridge, and the type and quantity of products stored in the structure.

Structural fires present a great threat to life and property and the potential for much larger economic losses. Modern fire codes and fire suppression requirements in new construction and building renovations, coupled with improved firefighting equipment, training, and techniques, lessen the chance and impact of a major urban fire. Most structural fires occur in residential structures, but the occurrence of a fire in a commercial or industrial facility could affect more people and pose a greater threat to those near the fire or fighting the fire because of the volume or type of the material involved. Fire stations and response facilities are mapped in Chapter 2.

This hazard includes an extended interruption, widespread breakdown, or collapse (part or all) of any public or private infrastructure that threatens life and property. Infrastructure failure can result from hazard incidents, overuse, normal age and deterioration, and even space weather or solar flares. These types of infrastructure are vital to hazard warning, response, cleanup, and recovery. Improving the conditions of infrastructure, making them stronger to withstand the impact of hazards, and modernizing them all can mitigate hazards and can improve local quality of life and the economy. Because Clarke County relies so much on infrastructure to support the various communities and widespread farms and to ensure the dynamic economy can flourish, mitigating their failure is essential beyond the damages caused by natural hazards, such as wind, ice, and tornadoes.

Infrastructure Failure Historical Occurrence:
Most widespread infrastructure failure in Clarke County has been caused by the combination of weather events and system/facility age, the latter making the infrastructure more vulnerable to weather events.

Local communications failure incidents due to weather conditions, equipment failure, excavation incidents, and traffic accidents have been reported, but outages have usually been resolved in a timely manner. Infrastructure is aging in the county, and minor events have occurred in several, mostly rural, locations. A few ice and windstorms have cost communications lines and systems for hours to days over the past twenty years in parts of Clarke County. Emergency communications have improved with the updating to the new narrow-banding requirements and the construction of a modern central law enforcement center that serves as the emergency communications hub. However, much of the outlying infrastructure is aging, and the increased reliance on cellular phones is a problem when tower equipment fails, which happens from time to time due to various weather events. Rural areas have experienced the most E-911 incidents because of the lack of wired systems and distance to wireless facilities. There is only one incident that comes to mind locally. This is the major ice storm of December 2007, which resulted in the power failure throughout the county and subsequent loss of wired and wireless communications for a few days in some locations.

All areas of the county have experienced short-term and most areas have experienced long-term electrical failures. Short-term failures are common and may include loss of power to a neighborhood for a few minutes. The 2007 ice storm produced a prolonged power failure, where many rural residents were without electricity for several days and even city residents were without power for hours to a day or more. High

wind events and heavy snow have also knocked out electricity for hours to a day or more in various areas of the county. Losses, mostly infrastructure and economic, due to the 2007 ice storm were significant but no figures have been discussed in the planning process. Fortunately, back-up power was available at hospitals and critical care facilities. Rural Clarke County had failures to high-voltage power lines across the northern half of the county due to heavy snow in November 2011. Due to the age of facilities and high proportion of lines that are above ground, most areas have random short-term outages even in normal weather conditions. Groups like the Clarke Electric Cooperative are working on line retrofits to prevent the losses such as suffered in the past, totaling in the million so dollars. Gas and other fuel lines that provide energy for the county have also been severed but have been back on-line within a day or two. With no local production capabilities, all power failures have been to facilities in other counties or to power lines and wires as they cross the county. In 2019, the Osceola Water Plant was offline for a long period of time due to a filter system failure.

In the past ten years several rural culverts and bridges failed or were closed due to the threat of failure. In almost all the towns and in the rural area older buildings have collapsed, either slowly over time or suddenly. Most structures are not occupied or are used for storage. According to the planning team, while many buildings have collapsed due to slow deterioration and neglect, none of them have been a hazard. On several occasions in the past twenty years, other structures (not buildings) have failed. Structural failure has occurred in Osceola (I-35/US 34 Interchange) and the rural part of the county (due to flooding) in the form of bridge damage and collapse due to weather and transportation damages.

The county suffers from approximately 10 occupied structure fires each year, most of which are quickly extinguished by on-site personnel or local fire departments. A few fires in the past year have required more than the local fire department capacity. Approximately 3-5 structure fires per year in Clarke County require assistance from fire departments outside the county via Mutual and Automatic Aid Compacts. All jurisdictions have been affected. Osceola and Clarke County have experienced the most structural fires requiring outside intervention. Data from local fire departments varies in quality, but Osceola, which covers the most property and value, reports annually to the State of Iowa. Keep in mind the fire losses they report are for all fires, not just structural fires. In 2018, they reported $351,600 in content losses and $490,901 in property losses for a total of $842,501. There were 11 recorded structural fires. In 2019, the fire losses reported were $58,002 in contents loss, $133,502 in property loss, for a total of $191,504 in losses that includes 12 structural fires. In the past five years, several people have died in structural fires in Clarke County. Most structural fires occur in residential structures, but the occurrence of a fire in a commercial or industrial facility could affect more people and pose a greater threat to those near the fire or fighting the fire because of the volume or type of the material involved. It is believed that larger communities tend to have more fires due to the larger number of structures. There have been 284 deaths in Iowa from fires from 2006 to March of 2013 according to the State Fire Marshall Division. The year 2017 was a record year with structural fire deaths, most of them occurring in rural towns like those found in Clarke County.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. One person responded that this happens more than once a year, two indicated it happens most years, seven indicated it happened once or twice in the last five years, five responded that it has not occurred, and three responded they did not know.

Infrastructure Failure Future Probability:
Although infrastructure failure occurs on a routine basis, events that are life threatening, highly destructive, or otherwise impair the overall economy in the planning area are not as common.

Widespread communications failures are likely to be brief at best due to the extensive redundancy of systems. Local communications failures are likely not to affect large parts of the county. Generally, emergency

communications are affected, but this problem is being mitigated to some degree with new equipment being purchased meeting national and state standards and with a new communications plan. In some places, the infrastructure is adequate and can withstand most hazards, but in other places it is not. Because our society is communications and information oriented, it stands to reason that the probability will increase in failures and the difficulty/expense of storing communications. However, technology and redundancy is improving and should reduce the probability of any given failure to be widespread and prolonged.

The State of Iowa has three strategies to limit the likelihood of an energy shortage: 1) through voluntary and mandatory demand reduction mechanisms; 2) the substitution of alternative energy sources when possible; 3) and state government programs to curtail excessive use, energy supply and demand. The federal government has a strategic petroleum reserve to supplement the fuel supply during energy emergencies. Shortages, especially electrical shortages, can be unpredictable with immediate effects. Natural events, human destruction, price escalation, and national security energy emergencies can cause unavoidable energy shortages. Because Clarke County does not have its own energy supplies to maintain, it becomes more urgent to ensure that utility lines bringing energy into the county are protected. Further, most critical assets lack fixed power generators, although more are adding them due to the lessons learned from recent events. Widespread incidents are less likely in the future, but local areas are still at considerable risk.

The unprecedented growth in technology has resulted in a host of problems related to complex structures, special materials, and severe operational and environmental loads, such as fire, excessive vibrations, explosion, high-energy piping failures, missiles, and earthquakes. With the possible exception of misuse, accidental or environmental loads, the causes of failure may be found in deficiencies of design, detailing, material, workmanship, or inspection. With the aging structures in the country along with problems with new materials discussed above, structural failures will continue to occur. Efforts to inspect and maintain these structures will lessen the probability of a failure, but not guarantee that it will not happen in the future. Internal weaknesses can be hidden from inspectors and not be realized until it is too late. In Clarke County, old bridges, culverts, homes, and abandoned buildings pose a failure risk. These structures are only getting older, and resources to improve them are lacking.

Even with increasing efforts and quality of fire prevention programming nationally and locally, both residential and nonresidential fires will continue to occur. During colder months, clogged chimneys, faulty furnaces and fireplaces, and use of space heaters can increase the probability of structural fires. Based on the current trends for new development and continued fire prevention efforts, the annual probability in any jurisdiction is low to moderate.

Considering the variety of infrastructure and the fact that infrastructure of one kind or another is found in all parts of the county, the probability of an incident with negative consequences (economic loss, health implications, etc.) to the community is high, mostly due to fires. When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. Nine indicated it is more likely, seven indicated no change in likelihood, one indicated less likely, and one indicated they were unsure.

Score for Rural Clarke County: 9	Score for Murray: 5	Score for Osceola: 7	Score for Woodburn: 5
Score for Clarke Schools: 4	Score for Murray Schools: 4	Score for SWCC: 3	Score for hospital: 4

Infrastructure Failure Vulnerability to the Population:

Much of the county's population could be impacted for up to 2 days, mostly indirectly, but with so many means to communicate today, the real impact is negligible in terms of human life. Phone and data transmission could be impacted temporarily. Various firms provide communications services, so the loss of one service will be very localized. Should underground fiber systems become damaged, the E911 service as

well as contact with agencies outside the service areas may be impossible. Other avenues of communication such as cellular phones may also be affected. Radio communications would not be adversely affected by fiber loss but could be impacted if repeaters and towers are incapacitated. Rural facilities and assets are uniquely vulnerable in the event of fires and other emergencies. Cell tower damage would make communications responders very difficult. People who cannot afford services or rural residents that have limited reception would be most vulnerable.

Because Iowa is almost entirely dependent on out-of-state resources for energy, Iowans must purchase oil, coal, and natural gas from outside sources. World and regional fuel disruptions are felt in Iowa. It is likely that increasing prices will occur as market mechanisms are used to manage supply disruptions. This will greatly affect the low-income population because of their lower purchasing power. Agricultural, industrial, and transportation sectors are also vulnerable to supply, consumption, and price fluctuations. In Iowa, petroleum represents 97% of transportation fuel. Individual consumers such as commuters are also vulnerable. Many electrical systems are backed up and redundant systems prevail, making long-term vulnerability unlikely. Nursing homes, medical facilities, shelters, and assisted living facilities are especially vulnerable, due to the need to provide care to frail and sick individuals. Fortunately, because of past failures, many residents and public facilities owners have purchased backup power generators, but most people do not yet have access to these. Due to the distances involved, rural electric cooperative (REC) service areas are more vulnerable. The REC in Clarke County is retrofitting lines and poles to reduce future risk, but some areas have not been retrofitted yet.

There are many structures in Clarke County that are very old or which may become hazardous in the event of an earthquake, fire, high winds, or other natural events. All bridges are vulnerable to the effects of the elements and the deterioration that results. Increases in the amount and weight of traffic they are expected to support increase their vulnerability to failure. Clarke County has many old homes and buildings that can collapse due to age and disrepair. Grain elevator failures can cause widespread damage in some towns. Because some buildings and structures can contain a large number of people, 10% or more of the population can be impacted. Schools and the hospital can be subject to a partial collapse that will directly impact up to half the population on those properties.

Older structures with outdated electrical systems not built to current fire codes are particularly vulnerable to fire. Combustible building materials obviously are more vulnerable than structures constructed of steel or concrete. Structures without early detection devices are more likely to be completely destroyed before containment by response agencies. Structures in areas served by older, smaller, or otherwise inadequate water distribution infrastructure such as water mains and hydrants are also at significant risk. Income and other demographics are also involved, because some people cannot afford home improvements that might prevent fires. The fire death risk for the elderly and children under 5 years of age is more than twice that of the average population. Industrial and business fires could affect hundreds of people due to lost employment. Some public and high-occupancy buildings are not sprinkled due to being built before sprinkling was required. The hospital is even more at risk because it is difficult to move people and expensive equipment if a fire occurs in occupied areas. Flammable chemicals and gases can also exacerbate a fire at the hospital.

The scores below reflect the relative impact on any given area of any one of these infrastructure hazards.

Score for Rural Clarke County: 5	Score for Murray: 6	Score for Osceola: 6	Score for Woodburn: 6
Score for Clarke Schools: 7	Score for Murray Schools: 7	Score for SWCC: 7	Score for hospital: 7

Infrastructure Failure Area of Extent:

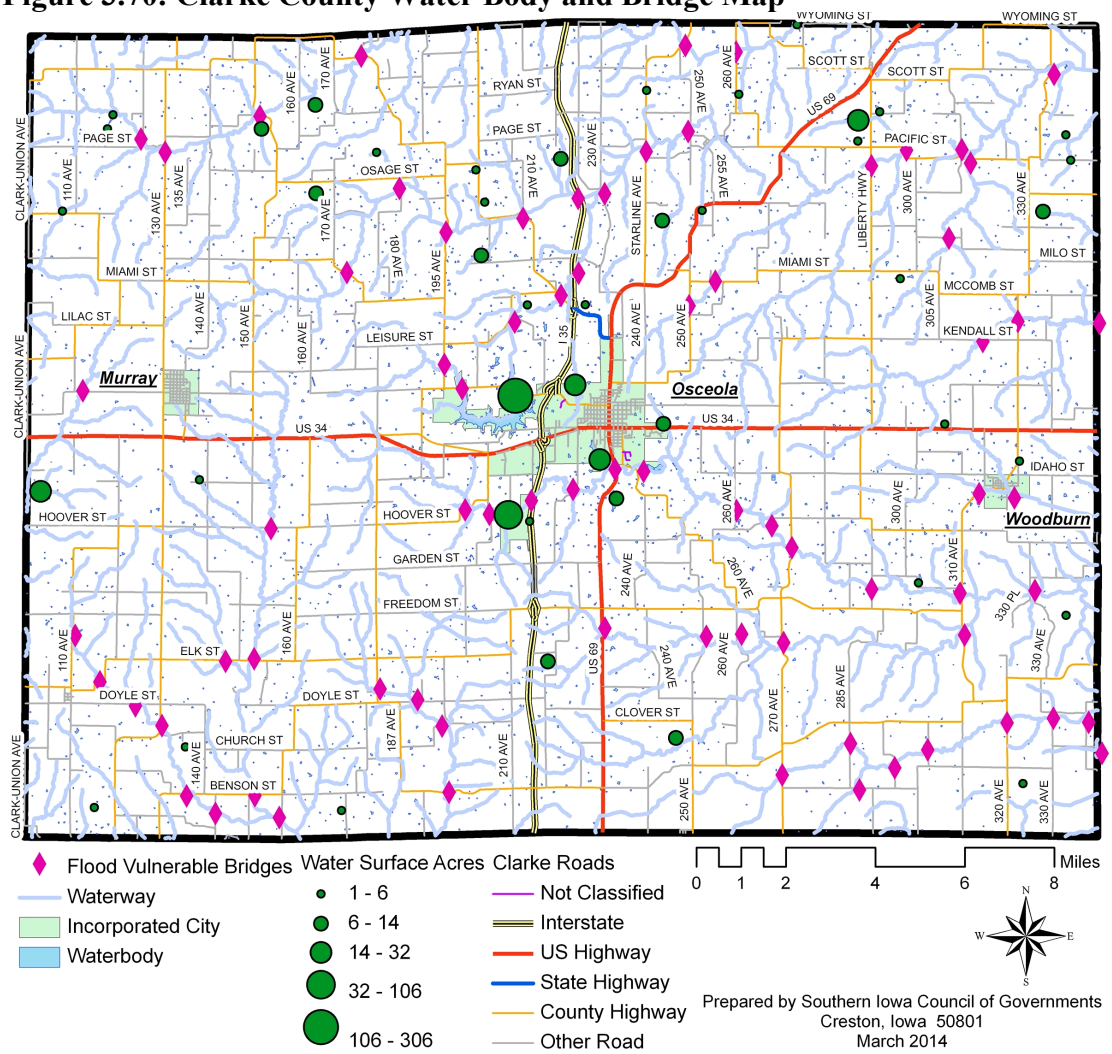
Most communications failures would be limited to localized areas. In the event of a widespread communications failure, only portions of the county would likely be impacted, but long-term or emergency

disruption is highly unlikely due to the support of other jurisdictions and secondary communication devices. The extremities of the county are the weakest in terms of reception through wireless devises due to topography. The increasing number of cell towers and improvement of fiber lines is reducing the areas where losses would be notable. Individual events are more likely to cause widespread impact on towns, schools, and the hospital due to their limited geographic area.

The effects of an energy shortage could be felt throughout the state if there is a loss of supply sources. Because the distribution systems are very developed, local shortages can quickly be covered by secondary sources in most cases; therefore, in normal conditions, most outages will be very localized and brief. Failures caused by weather events, however, can tax utility repair crews that must address local and regional damages. Most incidents will damage one power system or substation and impact a small part of the county or city. Smaller towns and individual buildings could see total loss.

The impacts of the failed structure would be contained to the immediate area and adjacent properties. This could be as small as the house and yard of a fallen chimney, or the area could be relatively extensive if the structure that failed was a multi-story downtown building, a grain elevator, and a tall communication tower. Dam and bridge failures and those involving hazardous materials can impact a wider area. Bridge failures cause transportation delays, crashes, and hazardous materials spills. The following map of bridges and related structures shows the areas of extent for a hazard of great concern at the county level, that of bridge failure, due to the aging of many bridges.

Figure 3.70: Clarke County Water Body and Bridge Map



With modern training, equipment, fire detection devices, and building regulations and inspections, most fires can be quickly contained and limited to the immediate structure involved. Certain circumstances, such as the involvement of highly combustible materials or high winds, can threaten a larger area. The age and density of a particular neighborhood can also make it more vulnerable to fire from neighboring structures. Flammable chemicals and gases can also exacerbate a fire at the hospital and in industrial facilities.

The scores below reflect the relative impact on any given area of any one of these infrastructure hazards.

Score for Rural Clarke County: 5	Score for Murray: 5	Score for Osceola: 5	Score for Woodburn: 5
Score for Clarke Schools: 7	Score for Murray Schools: 7	Score for SWCC: 7	Score for hospital: 7

Infrastructure Failure Severity of Impact:

The severity of communications failure will be related to the duration and area of effect. It will also depend on the specific system that is affected. For example, the loss of E911 communication would be more hazardous for public safety than the loss of one mile of phone line in a town where cell towers are available. The scoring considers more significant or widespread events than the common localized outage. Energy failure is often a result of other hazards and can cause various cascading effects, such as fires and economic disruption. Structural failure and fire can impact any structure, including those that have large and immobile populations, such as the elderly and young children. The following provides a summary of the severity of impact throughout the county.

Figure 3.71: Infrastructure Failure Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	A communications or energy failure would not directly result in injuries or fatalities. If 911 systems were to fail due to phone communication disruption, secondary impacts could occur by the inability of citizens to reach responders. Injuries and fatalities can occur if energy was not available for heating during extreme cold periods or for cooling during extreme heat or if people relied upon power to supply equipment such as life support and breathing equipment. Personal injury, death, and property damage may occur in a building or structure failure or fire itself or by falling debris from nearby structures. Based on national averages in the 1990s, there is one death for every 119 residential structure fires and one injury for every 22 residential fires. In nonresidential fires, there is one death for every 917 fires and one injury for every 52 fires. From 2006-April 2010, Iowa sustained 167 fire fatalities.	4
Health and safety of responders	If health and safety personnel cannot communicate with other personnel, they are at risk when responding; for example, if a firefighter is in a building and cannot call for assistance. Responders can be electrocuted or response equipment, such as boom trucks, can fail. Structural collapse rescue is a specialized form of rescue and can result in injury or death to responders. Workers in or near the building or structure could be subject to further impacts. In the US, about 100 firefighters die annually while on duty. Typically, responders are at less risk than the general public because they are properly clothed, trained, and alert when at the scene. Adverse weather conditions, which often cause failures, can put responders at additional risk.	4
Continuity of operations	Operations can be hindered when service interruptions are prolonged. So many things today depend on reliable communications. Hospitals, shelters, emergency response vehicles and facilities, and other critical facilities would have priority during energy shortages. Most critical assets have backup power, but heating systems may not be powered. Functional purpose of the building would be terminated or suspended until the integrity of the structure could be restored or a new location is found. Responders can be overly taxed and could operate at diminished efficiency for a time.	4
Property, facilities, infrastructure	Communications failures are often the result of infrastructure failures. Critical facilities, such as technical water plants, and infrastructure can fail due to the loss of communications between system components. Depending on the cause of an energy failure, the impact on property, facilities, and infrastructure could be greatly impacted. If there is a regional blackout, it might have no direct impact on local infrastructure. However, if it is caused by a storm, the damage to the infrastructure could be very extensive. Sometimes power outages in one area can cause damage to other facilities, especially if there are no modern and well-maintained surge protections and other measures. Impacts could range from minor disruption to full destruction of the structure.	4

Severity Criteria	Discussion	Score
Delivery of services	Service providers can be slowed by the lack of access to communications. Effects of energy failure could range from minor heating and air conditioning disruptions to transportation limitations all the way to civil unrest due to the high demand, low supply, and subsequent high price. Bridge failures and debris in the streets and sidewalks would interrupt normal routes of travel.	3
Environmental impacts	Failed communications and energy infrastructure could result in malfunctioning systems and the subsequent unplanned discharge of hazardous materials into the environment. The same is true if a structure fails or burns. Modern structural fires and many structural failures release hazardous substances that could contaminate the air, water, or soil.	3
Economic/financial conditions	Financial losses would be incurred due to the direct damage to electronic equipment and the communication system infrastructure. Today, almost all businesses and industry require extensive and reliable communications and energy. With modern day electronic funds and data transfers, economic and financial losses in the public and private sectors could be enormous. In the event that power is lost due to infrastructure failure, business disruption and increased cost of business would have far-reaching financial implications across many sectors of the economy. When structures fail or experience fire, there would also be a considerable price tag to replace or fix the structure, not to mention the loss of revenue that would occur because the structure could not be used. Cleanup costs could be very high. The incident can also severely damage surrounding businesses through disruption.	3
Regulatory/contractual obligations	Obligations of service providers to customers can be unmet. Failure or fire during construction can be the liability of the contractor or owner. Code development and enforcement can play a significant role in limiting the impact from structural failures and fires.	2
Reputation	Widespread communication failures could moderately harm the reputation of the jurisdiction. If 911 systems and inter-agency and intra-agency are affected, the reputation damage could be more serious. Data transmission failure could also affect public trust. If caused by natural disasters, there would be no significant impact unless the response to the power outage was poor. If the structural collapse or fire could have been averted or limited in any way by code enforcement or if response is inadequate, the reputation could suffer from public outcry.	2

Score for Rural Clarke County: 29	Score for Murray: 29	Score for Osceola: 29	Score for Woodburn: 29
Score for Clarke Schools: 29	Score for Murray Schools: 29	Score for SWCC: 29	Score for hospital: 29

Infrastructure Failure Speed of Onset:

The actual failure of any form of infrastructure, building, or other structure or any structural fire would likely occur suddenly with little or no warning. There are several events that could lead up to the failure that have various warning times. Causal hazards can include fire, explosion, overloading of ice and snow, vibration, earthquakes, flooding, high wind, erosion, tornado, flooding, chemical corrosion, subsidence, and lack of general upkeep. Sometimes structures begin failing long before there is a total collapse, but the planning team is concerned about those that have no warning, because if there is warning, the incident can be prevented or people can be out of the way.

Score for Rural Clarke County: 9	Score for Murray: 9	Score for Osceola: 9	Score for Woodburn: 9
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Infrastructure Failure Duration of Event:

The kinds of failures most likely to be hazards are rapid and will not take more than six hours from beginning until stabilization of the remaining members or security of the site is achieved. Structural fires and especially energy failures and communications failures can take a day or more before any meaningful response is provided to those at risk in a rural area such as Clarke County.

Score for Rural Clarke County: 7	Score for Murray: 7	Score for Osceola: 7	Score for Woodburn: 7
Score for Clarke Schools: 7	Score for Murray Schools: 7	Score for SWCC: 7	Score for hospital: 7

Infrastructure Failure Total Scores:
The following total scores for infrastructure failure indicate high risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 64	Score for Murray: 61	Score for Osceola: 63	Score for Woodburn: 61
Score for Clarke Schools: 63	Score for Murray Schools: 63	Score for SWCC: 62	Score for hospital: 63

Infrastructure Failure Vulnerability/Assets at Risk:
All structures, property, and people in the county, as outlined in Section 3.2, are susceptible to infrastructure failure.

All critical assets in the county, as outlined in Section 3.2, could be impacted by this hazard.

Infrastructure Failure Loss Estimation:
It is very difficult to estimate losses to infrastructure for several reasons: a) it is impossible to know for sure about the loss due to regular wear and use versus damage due to hazard events, b) much of the infrastructure cannot be seen because it is underground, and c) trained specialized people are required in many instances to properly estimate and articulate the real impact of hazard events on a given failure. Typically, when a local official or an insurance agent estimates damages due to a hazard, they consider primarily the physical losses to structures and properties, sometimes including contents but rarely considering more abstract values, such as functional use, economic, or displacement costs. In this way, infrastructure failure is a considerable form of loss in itself but it is also a hazard that can cause other losses.

The purpose of this loss estimation is to consider the further losses caused by the infrastructure failure types outlined in the profile (communications failure, energy failure, structural failure, and structural fire). As can be imagined, the greatest losses will be to infrastructure. Energy and communications failures may result in further losses to those systems. Structural failures and fires can destroy surrounding structures and infrastructure in addition to the initial failure or fire.

The physical losses due to communications failure and energy failure are less likely to affect other physical infrastructure, compared to structural failure and fire. The failure of utilities, towers, stations, cables, pipes and other assets can cascade and cost millions of dollars to fix. Only in some situations will extensive cascading effects occur, such as when lightning strikes a power line, which then damages computers and other equipment in numerous homes and businesses. There are considerable life-threatening issues with all these failures. Communications failures can cause responders not to respond or to respond in a delayed or ineffective manner so that lives that are in danger are then lost due to poor response. Similarly, an energy failure can cause emergency equipment to quit working, such as life-preserving oxygen in a home setting, thereby indirectly causing death or sickness. The elderly can suffer when natural gas heat supplies are cut off from homes. Economic and functional use losses are also likely when equipment is not functional and business cannot be conducted. It is very difficult to calculate these losses because they are often secondary or indirect, but the population and duration of the outage are key factors.

Structural failure and fire are somewhat easier to account for losses because they are more tangible and localized. However, it is difficult to differentiate for the purpose of loss estimation the loss to a structure or property caused by another hazard and the cascading loss caused by the infrastructure failure. An attempt is made in this plan. In a given incident, likely only one or two buildings or structures will failure or burn, and the value of buildings ranges from a few thousand dollars to $10 million or more for the hospital, courthouse, and larger school buildings. Rarely will a larger building suffer complete failure, so we can estimate something on the range of $100,000 plus content loss and functional use loss per incident of a magnitude where life can be endangered.

Economic and functional use losses are even more difficult to ascertain. In most cases, these will involve the cost of loss of business, loss of records and contents that are required to conduct business, cost of detours and delays in delivery, and inability for people to report to work. These costs, depending on the type of structure lost could be very significant, topping a million dollars.

As an aid to loss estimation of this kind of hazard, FEMA has developed standard loss of use estimates in conjunction with their Benefit-Cost Analysis (BCA) methodologies to estimate the cost of lost utilities and infrastructure on a per-person, per-use basis. See the following table.

Figure 3.72: Example Loss of Service Values for Various Types of Infrastructure Failure

Type of Loss	Cost of complete loss of service
Loss of electric power – Total economic impact	$126 per person per day
Loss of potable water service – Total economic impact	$93 per person per day
Loss of wastewater service – Total economic impact	$41 per person per day
Loss of road/bridge service – Vehicle delay detour time	$38.15 per vehicle per hour
Loss of road/bridge service – Vehicle delay mileage	$0.55 per mile (or current federal mileage rate)

Source: FEMA BCA Reference Guide, June 2009, Appendix C

Future Development and Infrastructure Failure:
Increases in development and population growth increase the demand for utilities and use of infrastructure as well as the level of impacts when the utilities and infrastructure fail. Because growth is projected to be modest, without mitigation measures the future should be similar to today. The introduction of wind turbines to the area means that, if built in Clarke County, could add to the risk of infrastructure and energy failure. New structures will tend to be better built but overall the building stock of the county continues to age.

Severe Winter Storm Profile
Type: Natural

Definition: Severe winter conditions including blizzard conditions, heavy snow, blowing snow, freezing rain, heavy sleet, and extreme cold/wind chills that can affect day-to-day activities and can cause fatalities and property damage.

Severe Winter Storm Description:
Winter storms can take on many forms and involve many elements. Typically, the severity of the weather is dependent on the temperature. Because temperature can change in various seasons, severe winter weather is relatively common from October to April. Winter weather winds can be so much more dangerous at 25 MPH than the same winds during the summer because of the cold. Varying weather conditions, combined with cold, can bring about severe conditions due to the impact of ice and snow on surfaces such as roadways and power lines. Wind is not just cold but also causes snow to drift, causing impassable roads and damaged infrastructure and buildings. For the purposes of the local HMP, severe winter storms are the kinds of events that significantly impact commerce and cause widespread damage, whether or not they are accompanied by some form of advisory or warning. The planning team indicates that any winter weather that causes imminent danger to the public is severe, no matter its statistical magnitude.

Severe Winter Storm Historical Occurrence:
Clarke County experiences a great variety of winter weather every year, including heavy snow, blizzards, high winds, extreme wind chill, ice storms, and bitter cold. While most Iowans are accustomed to the cold, extreme weather is dangerous and causes extensive damage almost every winter. Some winters have multiple severe winter storms.

According to the NCEI, there have been 65 recorded winter storm related events (blizzard, cold and wind

chill, frost/freeze, heavy snow, ice storm, and winter storm) events affecting the county, causing $1.74 million in property damage and $6.894 million in crop damages, along with 1 fatality and 0 injuries from 1996 through the end of 2020. It is unknown how much of the reported damages occurred in Clarke County versus part of a larger storm. The actual casualties from severe winter weather is much higher when we add in traffic injuries and deaths due to icy roads, people that die due to exposure or over-exertion, and other causes. Many times these casualties are not included in NCEI reports. Two winter storm related Presidential Declarations for Major Disaster have been declared in Clarke County since 1996 (through 2020).

Perhaps the worst winter storm in recent memory was the December 2007 ice storm that knocked out power for hours in all parts of the county and days in many rural areas. This storm destroyed thousands of trees, and caused millions of dollars in power line losses in the county. Many rural electric cooperatives and other providers are now undertaking FEMA mitigation projects to strengthen power lines as result. The local economy was at a near standstill for a few days because of this storm.

Another major event was the 17-inch snowfall that covered the county in December 2009. The winter of 2009-10 was one of the top snow-makers in Iowa's recorded history, with over 70" of snow in this area. The State of Iowa declared a disaster area and authorized up to $5,000 in state individual assistance for damages due to ice and snow that winter. While the years 2015-18 were mild, there have been short periods with severe cold and wind chill conditions. A survey respondent stated that a snowstorm in 2019 stranded motorists and created problems for crews on roads and extreme cold kept road salt from melting ice. Another stated a storm in 2020 left several stranded and in ditches.

Severe cold and wind chills happened a few times each of 2019-20 and 2020-21 winters. Near Thanksgiving 2018, a blizzard resulted in the county opening shelters to handle stranded highway travelers. Interstate 35 was closed for a day in 2019, stranding hundreds of people.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. Seven indicated that this occurs more than once a year, eight indicated it happens most years, and three indicated it happened once or twice in the last five years.

From 2006 through end of 2020, there were over 330 warnings, watches, and advisories issued for Clarke County for various winter storm events (https://mesonet.agron.iastate.edu/vtec/search.php#byugc/IAZ083). The following were issued.

Figure 3.73: Historical Winter Weather Events

Type of Winter Weather	Warning	Watch	Advisory	Total
Blizzard	7	5	0	12
Blowing snow	0	0	5	5
Freeze	19	7	0	26
Freezing fog	0	0	2	2
Freezing rain	0	0	9	9
Frost	0	0	17	17
Ice storm	5	0	0	5
Snow	0	0	10	10
Snow and blowing snow	0	0	6	6
Wind chill	7	2	56	65
Winter storm	30	45	0	65
Winter weather	0	0	115	115
Totals	68	59	220	337

Source: Iowa State University Department of Agronomy, https://mesonet.agron.iastate.edu/vtec/search.php#byugc/IAZ083

The history of severe winter storm events can be visualized by looking at heavy snow events as a proxy. The following table shows the top 30 snow days, as reported in 24-hour calendar day periods from 1937 through March 31, 2021, at the Osceola weather station.

Figure 3.74: Historical Heavy Snow Days at Osceola Weather Station

Date	Snow (in.)	Date	Snow (in.)	Date	Snow (in.)
02/28/1939	14.5	04/09/1973	9	03/16/2004	8
12/09/2009	13.2	01/26/2021	8.7	12/22/2013	8
12/23/1961	13	02/06/2004	8.5	02/23/1999	7.9
11/26/2018	12	11/26/1992	8.3	02/02/2011	7.9
03/25/1957	11	01/05/2004	8.1	10/27/1997	7.7
12/12/2000	10.4	01/01/1942	8	03/09/1999	7.7
01/26/1996	10.2	04/03/1950	8	01/02/1999	7.6
03/17/2001	9.5	03/05/1959	8	03/03/1952	7.5
03/09/1998	9.1	12/28/1966	8	02/06/2008	7.2
03/05/1965	9	02/23/1994	8	01/13/1940	7

Source: Iowa State University Department of Agronomy, http://mesonet.agron.iastate.edu/request/coop/fe.phtml

As can be seen, the largest daily snowfall totals are spread throughout the history of records, although a few years had multiple days: 1999 (3) and 2004 (2). The same data source was accessed about the recorded low temperature. The coldest low recorded was -28 degrees F, with 34 days of recorded temperatures at or below -20 degrees F. The coldest day in the past five or so years was January 2 and 3, 2018 (tied at -25 degrees F).

Severe Winter Storm Future Probability:

Winter storms regularly move easterly and use both the southward plunge of arctic cold air from Canada and the northward flow of moisture from the Gulf of Mexico to produce heavy snow and sometimes blizzard conditions in Iowa and other parts of the Midwest. The cold temperatures, strong winds, and heavy precipitation are the ingredients of winter storms. Clarke County can usually expect a half dozen winter storms a season, but not all of them are severe. Almost every winter we can expect one severe winter storm with high winds, heavy snows, and/or crippling ice and cold. Sometimes high winds and crippling cold can last for days after or in the absence of a snow event. A snow of 10 inches or more occurs about half of the winters. A severe ice storm occurs about every three to five years.

When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. Ten indicated it is more likely, five indicated no change in likelihood, one indicated less likely, and two indicated they were unsure.

Score for Rural Clarke County: 9	Score for Murray: 9	Score for Osceola: 9	Score for Woodburn: 9
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Severe Winter Storm Vulnerability to the Population:

Due to the large number of low-income and elderly people in Clarke County, the limited sheltering, and the demand for nearly all people to travel on area roads, nearly all people are vulnerable. Heavy snows cause immobilized transportation systems, downed trees and power lines, collapsed buildings, and loss of livestock and wildlife. Heavy snows of more than 6 inches in a 12-hour period or freezing rain greater than 1/4 inch accumulation causing hazardous conditions in the community can slow or stop the flow of vital supplies as well as disrupt emergency and medical services. Loose snow begins to drift when the wind speed reaches 9 to 10 mph. The potential for some drifting is substantially higher in open country than in urban areas where buildings, trees, and other features obstruct the wind. Ice storms result in fallen trees, broken tree limbs, downed power lines and utility poles, fallen communications towers, and impassable transportation routes. Hazardous driving conditions due to snow and ice on highways and bridges lead to many traffic accidents, which is the leading cause of winter storm deaths. About 70% of winter-related deaths occur in automobiles

and about 25% are people caught out in the storm. The majority of these are males over 40 years of age. Emergency services such as police, fire, and EMS are unable to respond due to road conditions. Emergency needs of remote or isolated residents for food or fuel and for livestock care are unable to be met. People, pets, and livestock are also susceptible to frostbite and hypothermia during winter storms. Those at risk are primarily either engaged in outdoor activity (shoveling snow, digging out vehicles, or assisting stranded motorists), or are the elderly or very young. Use of kerosene heaters and other alternative forms of heating may cause structural fires and carbon monoxide poisoning. Elderly and others can slip and fall and can die due to exposure. Because schools are closed in severe storm situations, the vulnerability is slightly less, although buses can still crash or become stuck hours or days after a storm. The county hospital is somewhat insulated because the hospital can function in severe weather, although employees and responders may not be able to travel. Rural roads require tons of rock to meet demand after the winter thaw. Thawing conditions also exacerbate expansive soils conditions and cause water line breakage.

Score for Rural Clarke County: 7	Score for Murray: 6	Score for Osceola: 6	Score for Woodburn: 6
Score for Clarke Schools: 5	Score for Murray Schools: 5	Score for SWCC: 5	Score for hospital: 5

Severe Winter Storm Area of Extent:

Winter storms are quite vast and would likely impact multiple counties. Certain areas may experience local variations in storm intensity and quantity of snow or ice and thus severity within the parent storm.

Score for Rural Clarke County: 9	Score for Murray: 9	Score for Osceola: 9	Score for Woodburn: 9
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Severe Winter Storm Severity of Impact:

The National Weather Service bases winter weather warnings on stages of severity, as follows:

- Blizzard Warning: the most dangerous of all winter weather is occurring or imminent. A blizzard is defined as a combination of winds 35 mph or greater with snow or blowing snow reducing visibility to less than 1/4 mile for three or more hours. In blizzards, whiteout conditions, deep snowdrifts, and frigid wind chills form a life-threatening partnership. You should seek refuge immediately.
- Winter Storm Warning: severe winter weather is occurring or imminent. You should already be prepared and should take protective actions immediately. This warning is issued when 6 inches of snow are expected in 24 hours at lower elevations (below 7500 feet). Travel can become difficult or impossible, especially for vehicles without four-wheel drive.
- High Wind Warning: hazardous winds are occurring or will soon occur across a significant area. For elevations below 7500 feet, sustained winds of 40 mph or greater or gusts to 60 mph or more are expected. Travel can be dangerous, especially for high profile vehicles.
- Wind Chill Warning: wind chill is the combined effect of cold temperatures and wind in chilling the body. A warning is issued when wind chills of minus 40 degrees F or colder with winds of at least 10 mph are occurring or imminent. Frostbite can occur in seconds, and hypothermia within minutes. The effects of temperature and wind chill increase the severity of a winter storm. Wind blowing across exposed skin drives down the skin temperature and eventually the internal body temperature. Exposure to low wind chills can be life threatening to humans and animals.

Additionally, winter weather advisories and other bulletins are issued to help the public understand the relative severity and risks posed by a winter weather event.

As referenced in Figure 3.75, wind chills exacerbate cold weather by making it feel even colder. The current Wind Chill Temperature Index took effect in 2001, replacing the original index devised in 1945. To find the Wind Chill Temperature Index from the chart, find the air temperature along the top of the table and the wind speed along the left side. The point where the two intersect is the wind chill temperature.

Figure 3.75: Wind Chill Chart

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph) Effective 11/01/01

The severity of various events relates the probability and type of event. The following events are assessed for Clarke County.

Figure 3.76: Probability of Severe Winter Storm Events by Severity

Event Type	Probability in Clarke County	Severity Description
Heavy snow	Highly likely in a given year	Limited, mostly economic and delivery of services
Ice storm (half inch plus)	Occasionally to likely in a given year	Moderate to critical in many severity categories
Extreme cold & wind chill	Highly likely in a given year	Moderate, mostly to health and safety of the public
Blizzard	Likely in a given year	Moderate to critical to safety of the population and economy, limited to infrastructure

The following provides a summary of the severity of impact throughout the county.

Figure 3.77: Severe Winter Storm Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	Injuries and deaths occur every year in Iowa due to the impacts of severe winter storms, including the direct impacts of the cold and wind, such as frostbite, hypothermia, and various illnesses. Direct impacts of heavy snow, blizzards, and ice storms include structural failure, auto crashes, and inability to access emergency care. People also get sick, injured, or killed as a result of overexertion during and after severe weather. Severity is exacerbated by the inability to access health and emergency care, loss of power, and lack of access to fresh food. People living in older homes with poor heating systems, the elderly, the chronically ill, and the very young are at most risk. Motorists, outdoor workers and recreationists, and those with energy dependent medical needs are at higher risk of death and severe injuries.	4
Health and safety of responders	Response personnel are exposed to cold temperatures and traffic accidents when responding to the victims' needs. They also succumb to overexertion when performing their work.	3
Continuity of operations	Operations can be limited or halted when critical services are not available. Staff may not be able to make it to the place of work thus, limiting the continuity of operations. Damage to infrastructure may also hinder continuity of operations. Local government workers may have to work long hours to clear roads and maintain government facilities and will not be available for other essential tasks.	4
Property, facilities, infrastructure	Immobilized transportation (including emergency vehicles), downed trees and electrical wires, building and communication tower collapse, and bodily injury/death are just a few of the impacts of a severe winter storm. Vehicle batteries and diesel engines are stressed and the fuel often gels in extreme cold weather. This impacts transportation, trucking, and rail traffic, all of which are vital to Clarke County. In recent ice storms, rural electric providers sustained many millions of dollars in damage to lines and equipment, some of it in Clarke County. Water lines, roadways, and other infrastructure fail on a widespread basis during thawing conditions. Millions of losses are	4

Severity Criteria	Discussion	Score
	sustained most winters as a result to infrastructure damage and simply being overworked. In the December 2007 ice storm, rural electric providers sustained many millions of dollars in damage to lines and equipment, some of it in Clarke County.	
Delivery of services	Fire during winter storms presents a great danger because water supplies may freeze and firefighting equipment may not function effectively, or personnel and equipment may be unable to get to the fire. If power is out, interiors of homes become very cold and lead to pipes freezing and possibly bursting. Rivers and lakes freeze and subsequent ice jams threaten bridges and can close major highways. Ice jams can also create flooding problems when temperatures begin to rise. Ice coating at least one-fourth inch in thickness is heavy enough to damage trees, overhead wires, and similar objects and to produce widespread power outages. Buried water pipes can burst, causing massive ice problems and loss of water and subsequent evacuations during sub-zero temperatures.	3
Environmental impacts	Winter storms are a natural occurrence and there would be no direct significant impact on the environment. Localized impacts are possible if infrastructure such as natural gas lines burst as a result of the event.	2
Economic/financial conditions	The cost of snow removal, repairing damage, and loss of business can have large economic impacts on the community. The State estimates $76,159,000 in property damage, and $346,900,000 in lost crops due to heavy snow, ice storm, or extreme wind-chill events statewide from 1993 through 2006. More than this is the economic loss due to employees being unable to get to work, freight being stranded, and people being able to perform business transactions.	3
Regulatory/contractual obligations	Enforced snow ordinances allow the jurisdiction to more effectively open transportation routes. Delivery and adequate supplies of salt, sand, and saline are important inputs to the snow removal process. These contracts should be in place. Removal of debris and reinstatement of energy are vital to safety of the public as well. Agreements should be in place with the power company to ensure power is restored in an effective and timely manner following the storm.	2
Reputation	Effective and timely response to the snowstorm is key to maintaining a good reputation. Streets clear of snow and ice are important factors to the mobile public.	2

Score for Rural Clarke County: 27	Score for Murray: 27	Score for Osceola: 27	Score for Woodburn: 27
Score for Clarke Schools: 27	Score for Murray Schools: 27	Score for SWCC: 27	Score for hospital: 27

Severe Winter Storm Speed of Onset:

The NWS has developed effective weather advisories that are promptly and widely distributed. Radio, TV, and Weather Radios provide the most immediate means to do this. Accurate information is made available to public officials and the public up to days in advance. Notifications made by the NWS include winter storm watch, winter storm warning, blizzard warning, winter weather advisory, and a frost/freeze advisory. While the magnitude and severity of winter storms can vary greatly from place to place within a storm, typically warning is adequate so that people can prepare for the given storm.

Score for Rural Clarke County: 2	Score for Murray: 2	Score for Osceola: 2	Score for Woodburn: 2
Score for Clarke Schools: 2	Score for Murray Schools: 2	Score for SWCC: 2	Score for hospital: 2

Severe Winter Storm Duration of Event:

Severe winter storms can last up to 2 days. It may take another day or two before some sense of normalcy to return.

Score for Rural Clarke County: 6	Score for Murray: 6	Score for Osceola: 6	Score for Woodburn: 6
Score for Clarke Schools: 6	Score for Murray Schools: 6	Score for SWCC: 6	Score for hospital: 6

Severe Winter Storm Total Scores:

The following total scores for severe winter storm indicate high risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 60	Score for Murray: 59	Score for Osceola: 59	Score for Woodburn: 59
Score for Clarke Schools: 58	Score for Murray Schools: 58	Score for SWCC: 58	Score for hospital: 58

Severe Winter Storm Vulnerability/Assets at Risk:
All structures, property, and people in the county, as outlined in Section 3.2, could suffer from the effects of winter storms. Power lines, utility poles, towers, and poorly built buildings are at the most risk among structures. Contents losses are likely to be minor, even compared to structural losses. The greatest risk may be to human health and life due to exposure to cold by the body. Thousands of trees and shrubs can be damaged or even destroyed by heavy snow, wind, and ice accumulation. Additionally, because of the reduced productivity due to the effects of cold, ice, and snow on humans and infrastructure failures, economic losses could be severe in some sectors.

All critical assets in the county, as outlined in Section 3.2, are exposed to severe winter weather.

Severe Winter Storm Loss Estimation:
Severe winter storm events cause extensive damage to property, human health and life, and the local economy. While storms happen every winter, only once in a while are they truly severe. Many losses simply occur due to the combined effects of prolonged cold, winds, and heavy snow and ice, even in the absence of a single severe storm. This analysis attempts to address these facts.

Structural losses vary greatly by the kind of storm. Normal snowfall, extreme cold, and wind chill events generally don't cause direct structural losses. However, the combined effects of these conditions over one or more winters can bring about deterioration and failure of structures. Some building elements can become very brittle during extreme cold and break or fail easily when hit by another force. Heavy wet snow can cause failure of weak or old buildings, power lines and poles, and other infrastructure. The freeze-thaw cycle can cause underground pipes to burst and frost bubbles to form in roads and parking areas. All these problems occur commonly in Clarke County. These can cause millions of dollars in losses in the planning area during any given storm or winter to both public and private structures and infrastructure.

Ice storms are more likely than any other form of winter storm to cause structural damage. Damage to overhead utilities, trees, towers, and even buildings can be extensive with only a half-inch of ice. Yet, storms delivering over an inch of ice occur once a decade perhaps. Past ice storms have caused millions of dollars in damage in Clarke County. Costs include clearing debris, removing trees, repairing utility lines, restoring power to individual homes and businesses, and lost business and functional use loss.

USDA crop insurance claims for winter storms, cold, freeze/frost, and snow conditions for the five-year period of 2016-2020 show 28 claims. The total amount of claims was $142,124, which is very small compared to drought and flood/rainfall hazards, but is nonetheless significant. This averages to $28,425 annually. Clearly most of these losses occurred during early planting season or near harvest, during unseasonably cool weather but not during a traditional severe winter storm.

Economic losses can be severe simply because people cannot get to work, people are not conducting business, and transportation of goods comes to a standstill. When a storm is severe enough, the entire planning area's economy can virtually shut down for a day or more, at a cost of millions of dollars. Additional loss is suffered by businesses and government entities having to turn up the thermostat to heat their buildings and repair buildings damaged by storms. Local governments face functional use losses due to the costs of storm debris removal, snow removal, sanding and salting streets/roads, and fixing potholes and other road/bridge damage that comes with Iowa's winters.

The loss due to human life and health are significant due to winter storms. Despite this risk, it is difficult to attribute to winter storms a death that appears to be due to natural causes, with the exception of highway transportation incidents caused by ice and snow. People over the age of 65, which make up well over a thousand residents, people who are outside and cannot get indoors, and those with old homes and no reliable

heating and insulation are all at greater risk than the general population. People can die to exposure to the cold, health issues like heart attacks triggered by exertion (such as when scooping snow), and fires caused by use of unsafe heating systems during extreme cold. In a typical winter storm event, it is estimated that death is possible, severe illness requiring hospitalization is very likely, and multiple minor illnesses are very likely. Like extreme heat, unknown numbers may die because severe cold can be a silent killer.

Future Development and Severe Winter Storm:
As long as the population remains stable or even declines, it is unlikely that future development will increase exposure or risk of loss.

Thunderstorm/Lightning/Hail Profile
Type: Natural

Definition: Atmospheric imbalance and turbulence that may result in thunder, heavy rains (which may cause flash flooding), and strong winds reaching or exceeding 58 mph resulting in tornadoes, or surface hail of at least 1 inch in diameter, and lightning.

Thunderstorm/Lightning/Hail Description:
Most thunderstorms are small and do not cause notable damage. These common storms in Iowa contain mostly cloud-to-cloud lightning, moderate but short-lived rain, and little or no wind. Such storms of this nature are not a concern for the hazard mitigation plan. However, occasionally, the combination of moisture in the air, the collision of air masses (fronts), and the rise of unstable warm air cause severe storms, especially during the months of April through June, although they can occur during any month. Severe thunderstorms are dangerous because they can result in multiple hazards, including strong straight-line winds, heavy rain, hail, dangerous cloud-to-ground lightning, and even tornadoes. High winds, and tornadoes are profiled in greater detail in the tornado/windstorm profile.

Lightning in its own right is very dangerous and is found in any thunderstorm, although in most thunderstorms there are no or very few bolts that reach the ground. Not just does it reach up to 50,000 degrees Fahrenheit in a spit second, it packs enough energy to kill people and animals instantly, start fires, and destroy infrastructure. The electromagnetic effects of lightning can destroy and render unreliable other equipment and systems not even directly hit. Lightning can also occur far (up to 10 miles) from the base of the storm, even in areas where sunshine remains overhead, where people may not have started to take cover. Things can be confusing for the public because storms can occur singly, in clusters, and in lines, sometimes without warning or meteorological explanation.

Hail is a fairly common ingredient in thunderstorms that are severe or that occur on cool days. Large hail over one inch in diameter becomes a hazard because of its destructive power.

Thunderstorm winds can be very light to very strong. At 58 MPH, thunderstorm winds become severe. Thunderstorm winds can be unpredictable because they originate within various parts of the storm and might blow in different directions in the forms of updrafts, downdrafts, microbursts, derechos, outflow boundaries, and other phenomena. Most high wind events in Iowa are associated with thunderstorms. Those that are not are covered in the tornado/windstorm profile.

Thunderstorm/Lightning/Hail Historical Occurrence:
Severe thunderstorms have occurred many times in Clarke County and are an annual event somewhere in the county. Most years, multiple severe thunderstorm warnings are issued. The most common cause for the severe thunderstorm warnings are strong straight-line winds, but small hail and heavy rain over 1” per hour is also common. Large hail and tornadoes are relatively rare, but have occurred on numerous occasions.

Dangerous lightning is common, although most lightning strikes do not cause damage to personal property or cause injuries and death, due to the relatively low density of development in most of the county. The total number of historical events increases (compared to the previous plan) because hail is now included in the thunderstorm/lightning profile rather than as a separate hazard.

The NCEI provides data about severe thunderstorms, lightning, and hail events. This data includes reports of damaging events. Not all declared severe storms end up causing local damage that is reported in to the NCEI, and some damaging storms that are reported by the NCEI are not necessary deemed severe storms at the time they occur.

The NCEI has reported 2 lightning and 76 thunderstorm wind events since 1950, through December 2020, with an average reported loss of $18,256 per storm event. There have been 0 deaths and 2 injuries reported, both from thunderstorms, not lighting events. Over $1.33 million in property damage and $87,000 in crop damage in the county attest to the destruction due directly to thunderstorms. Some of these losses may not have occurred in the county but were part of a larger storm that also caused damage in the county. Iowa is among the top states in the nation in lightning-related fatalities and the annual property damages sustained by lightning. There have been 12 Presidential Declarations of Major Disaster in Clarke County since 1953 due to severe thunderstorms.

According to the National Centers for Environmental Information, there have been 91 hailstorm events in Clarke County from 1950 through December 2020, resulting in no deaths and injuries but in $345,000 in property damages and $311,000 in crop damage (note that most events before 1995 did not include damage information). Most of these events occurred since 1990, when better reporting was initiated. Of these, 58 were hailstorms that produced hail at or exceeding 1 inch in diameter. Most but not all of the damage reported had resulted from the hailstorms of this magnitude. Hail events were reported in all parts of the county, including the rural area and all municipalities. Most reports did not show the exact location of events, and it is likely that an event that reported from a specific area also affected other jurisdictions not on the list. The following is the summary of the number of events reported by the NCEI that meet the plan definition of a hailstorm listed by reported hail size.

Figure 3.78: Historical Events by Hail Intensity

Hail Size (inches)	Intensity (TORRO Hail Intensity Scale)	# of Events – 1950-11/2017
1.00	Severe	32
1.25	Severe	3
1.50	Severe	5
1.75	Destructive	14
2.00	Destructive	2
2.25	Destructive	0
2.50	Destructive	1
2.75 or more	Destructive	1 (largest is 2.75”)

Source: National Centers for Environmental Information, 4/2021 (data available through 12/2020)

The 169 recorded events clearly illustrate that large numbers of thunderstorm events with damaging wind (76), hail (91), and lightning (2) occur in Clarke County. While the report goes back to 1950, most of the events in the record are since 1993.

Note that these events/losses do not include windstorms, tornadoes, and other damages, even though most of those damages are spawned by or related to severe thunderstorms. It is likely the actual losses are somewhat under-reported, as many storms cause slight or modest damage to properties on a wide scale, and often these losses are not reported or are only reported to individual owner’s insurance.

Thunderstorms have impacted all jurisdictions and areas of the county. The Clarke County planning team recalls events in June 1981, June 1985, August 1987, June 1990, May 1996, July 1996, May 1997, June 1997, July 1997, August 1997, June 2008, and August 2011. More recent events have included hail and high winds. The county was on the south edge of the notorious 2020 derecho and damage was modest compared to parts of Iowa. One member of the committee mentioned a hailstorm already in the early months of 2021. A record storm occurred in mid-December 2021, producing a derecho with 70+ MPH winds in the county.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. Seven indicated this hazard happens more than once a year, nine indicated it happens most years, one indicated it happened once or twice in the last five years, and one responded that it has not occurred.

The following is the number of severe thunderstorm watches and warnings issued by NOAA's NWS. The data is housed on the Iowa Environmental Mesonet, Iowa State University Department of Agronomy website, (http://mesonet.agron.iastate.edu/vtec/search.php). There have been 320 severe thunderstorm warnings since 1986.

Figure 3.79: Historical Severe Thunderstorm Events in Past Five Years

Year	Warning	Watch	Total
2016	6	7	13
2017	12	6	18
2018	8	4	12
2019	21	13	34
2020	14	7	21
2021 (through March)	2	0	2
Totals	63	37	100

Source: Iowa State University Department of Agronomy, http://mesonet.agron.iastate.edu/vtec/search.php

The average over the past five years is 12.2 warnings and 7.4 watches per year.

Thunderstorm/Lightning/Hail Future Probability:

Thunderstorms are an annual event in all jurisdictions of the county, and hail of any size is expected two or three times annually. Southern Iowa experiences between 40 and 50 thunderstorm days annually, according to the NCEI. Severe thunderstorms occur nearly every year in all jurisdictions. During most summers, more than one severe thunderstorm occurs in the county, and any given storm affects multiple jurisdictions. Because large hail tends to occur only in some severe storms and occupies only part of the thunderstorm cell, the probability of 1" or larger hail is not as high as generic severe thunderstorms in any given jurisdiction on a given year. With Iowa's location in the interior of the U.S., and with the noted trend of increasing severity of weather in recent years, there is a very high likelihood that this trend will continue. According to the NWS, Clarke County is subject to 2 to 4 lightning cloud-to-ground strikes per square kilometer per year (roughly 6 to 11 per square mile).

When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 17 persons responded. Nine indicated it is more likely, six indicated no change in likelihood, none indicated less likely, and two indicated they were unsure.

Score for Rural Clarke County: 9	Score for Murray: 9	Score for Osceola: 9	Score for Woodburn: 9
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Thunderstorm/Lightning/Hail Vulnerability to the Population:

During a storm, those in unprotected areas, mobile homes, or automobiles are at risk. Sudden strong winds often accompany a severe thunderstorm and may blow down trees across roads and power lines. Lightning

presents the greatest immediate danger to people and livestock during a thunderstorm. It is the second most frequent weather-related killer in the U.S. (after flash flooding) with nearly 100 deaths and 500 injuries each year. Livestock and people who are outdoors, especially under a tree or other natural lightning rods, in or on water, or on or near hilltops are at risk from lightning. Cascading events, such as tornadoes, power loss, and flooding, can also cause significant loss. The planning team noted that lightning has knocked out power and key facilities for many hours. TV, computer, refrigeration, and power line losses cause hardship particularly for the low-income and elderly population. Generally, schools and the hospitals have lower population vulnerability because of sturdy modern design and in many cases lightning protections in place. In a given storm, fewer of the rural residents might be directly impacted due to the low density of population, but rural residents tend to have extensive exposed assets that are susceptible to storms.

Hail 1" in diameter or greater, which is not uncommon in severe thunderstorms, can be very dangerous to people, pets, and livestock if shelter is not available. Additionally, hail has destroyed windows, siding, vehicles, and roofs. Agricultural crops such as corn and beans are particularly vulnerable to hailstorms stripping the plant of its leaves. Hail only rarely results in loss of life directly, although minor injuries are not uncommon. People outside away from buildings are most vulnerable to injury, such as those at parks and campgrounds or those out on a lake. People watching the storm inside, but near windows or inside cars can also be hurt if glass is broken. Because most hailstorms impact largely rural areas and people can find safety, the planning team indicates that the vulnerable population is somewhat lower than the percentage of area impacted. Schools are more likely than the hospital to be vulnerable because large numbers of children can be outside, such as on a playground, bus stop, or ball field when the storm hits.

Score for Rural Clarke County: 8	Score for Murray: 6	Score for Osceola: 6	Score for Woodburn: 6
Score for Clarke Schools: 5	Score for Murray Schools: 5	Score for SWCC: 4	Score for hospital: 4

Thunderstorm/Lightning/Hail Area of Extent:

Severe thunderstorms can be quite expansive with areas of localized severe conditions. Most severe thunderstorm cells are 5 to 25 miles wide with a larger area of heavy rain and strong winds around the main cell. Most non-severe thunderstorms have a lifespan of 20 to 30 minutes, while severe thunderstorms often last longer than 30 minutes. Because Clarke is a small county, a single thunderstorm can impact the entire county very easily, with the severe area covering half of the county and all of any other jurisdictions.

The land area affected by individual hail events is not much smaller than that of parent thunderstorm, an average of 15 miles in diameter around the center of the storm. The largest and most damaging hail usually covers a relatively small part of the hail path. The area of extent is likely to be larger than the true vulnerability of the population and consists of wherever the hail at or exceeding 1" falls. The hazard mitigation planning team indicates that up to 50% of the rural part of the county would be affected by the severe portion of a single storm event, but a much larger part of cities would be affected, and an event would likely cover the entire campus of schools and hospital.

Score for Rural Clarke County: 6	Score for Murray: 8	Score for Osceola: 8	Score for Woodburn: 8
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Thunderstorm/Lightning/Hail Severity of Impact:

The severity of thunderstorms is related to the severity of the other hazards that come from the storm clouds: high winds, tornadoes, flood-producing rains, hail, and lightning. Severity, therefore, is a measure of combined impacts of these hazards in a typical storm, which includes winds at the low limit of severe level, hail at 1", cloud-to-ground lightning, heavy rain, and slight potential for a small tornado. Note that tornadoes and flash floods are covered in their own profiles.

Severity of hailstorms is mostly a factor of the size of hail but also is influenced by the location of the storm and time of day. Most of the past hail events, as reported by the NCEI, were 1" in size or less and were defined as "significant" and "severe" events. However, a quarter of them were "destructive" events. For the assessment in this plan, the planning team is considering the severity of a "destructive event." Below is a scale showing the classifications of hailstone intensity created by the Tornado and Storm Research Organization (TORRO).

Figure 3.80: Potential Damages by Hail Intensity

Intensity Category	Typical Diameter (in)	Size Description	Typical Damage Impacts
Hard hail	0.2-0.4	Pea	No damage
Potentially damaging	0.4-0.6	Mothball	Slight general damage to plants and crops
Significant	0.6-0.8	Marble, grape	Significant damage to fruit, crops, and vegetation
Severe	0.8-1.2	Walnut	Severe damage to crops; damage to glass and plastic structure; paint and wood scored
Severe	1.2-1.6	Pigeon's egg	Widespread glass damage, vehicle bodywork damage
Destructive	1.6-2.0	Golf ball	Wholesale destruction of glass; damage to tiled roofs; significant risk of injuries
Destructive	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick walls pitted
Destructive	2.4-3.0	Tennis ball	Severe roof damage; risk of serious injuries
Destructive	3.0-3.5	Large orange, softball	Severe damage to aircraft bodywork; increased risk of serious injuries; slight risk of death.
Super hailstorm	3.5-3.9	Grapefruit	Extensive structural damage; risk of severe or even fatal injuries to persons caught in the open.
Super hailstorm	4.0+	Melon	Extensive structural damage; risk of severe or even fatal injuries to persons caught in the open. Damage could be catastrophic if the hail is large enough.

Source: TORRO, www.torro.org/uk/site

The following provides a summary of the severity of impact throughout the county.

Figure 3.81: Thunderstorm/Lighting/Hail Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	Thunderstorms and lightning can cause death, serious injury, and substantial property damage. The power of lightning's electrical charge and intense heat can electrocute people and livestock on contact, split trees, ignite fires, and cause electrical failures. Lightning is the greatest thunderstorm cause of death in Iowa, but the probability of being struck is very low. 128 injuries and 4 deaths are attributed to hail in Iowa since 1980 (through April 2013). "Destructive" hailstorms rarely cause death, but it is always possible when people are exposed and cannot get to shelter quickly. Injuries of minor nature are likely if enough people are exposed. Triggered hazards can greatly increase the risk of and number of people injured or killed. Despite this, most severe thunderstorms do not cause severe injury and death.	3
Health and safety of responders	Response personnel are exposed to the same risk as the general public when caught in the storm without shelter. Work on ladders and other apparatus during lightning can expose responders to higher risk situations. Typically, they will not respond to the incident until hail has passed but sometimes they have no choice.	3
Continuity of operations	Continuity of operations would be affected through indirect impacts such as loss of critical services. Destruction and disruption of communications equipment, computers, and electronics will make it impossible to complete some tasks at least temporarily. Operations should not be affected to any significant degree by hail, unless utilities are damaged. Impacts might delay services up to one day to electrical systems and other exposed infrastructure and facilities.	3
Property, facilities, infrastructure	High winds can damage trees, homes (especially mobile homes), and businesses and can knock vehicles off of the road. Power lines and related electrical facilities are lost to lightning and high winds. Straight-line winds are responsible for most thunderstorm damage. Hail damage to property, facilities, and infrastructure is usually limited to broken windows, damaged siding, damaged roofs, and vehicle damage. Hail has damaged many properties in the past ten years in Clarke and surrounding counties. Most of the losses were insured. Utilities, crops, and trees have been damaged.	3

Severity Criteria	Discussion	Score
Delivery of services	One or more severe thunderstorms occurring over a short period (especially on saturated ground) can lead to flooding and cause extensive power and communication outages as well as agricultural damage. Delivery of services should not be affected to any significant degree due to hail. Disruptions are likely to come from high winds and lightning, which damage power systems and block roads.	2
Environmental impacts	High winds and hail can damage trees and other plants, but this is a naturally occurring hazard and the environment proves to be resilient following these and other natural hazards. The destruction of plants and crops can adversely affect the environment temporarily at best. Blowing debris and fire hazards caused by wind and lightning can cause temporary modest impacts.	2
Economic/financial conditions	Thunderstorm wind and lightning can damage any exposed assets. The aftermath may cause moderate economic impacts, but most will be related to cascading hazards such as flooding. Hailstorms cause nearly $1 billion dollars annually in property and crop damage in the United States. The peak hail activity coincides with the Midwest's peak agricultural season. Financial impacts resulting from damage to property is in the millions of dollars every year, most of which is covered by crop and hazard insurance. Damage to homes, vehicles, and electrical facilities could greatly disrupt local business and possibly cause business failure.	3
Regulatory/contractual obligations	These are not likely to be affected in any significant way.	1
Reputation	Reputation is not likely to be affected unless any response and cleanup is inadequate or delayed.	1

Score for Rural Clarke County: 21	Score for Murray: 21	Score for Osceola: 21	Score for Woodburn: 21
Score for Clarke Schools: 21	Score for Murray Schools: 21	Score for SWCC: 21	Score for hospital: 21

Thunderstorm/Lightning/Hail Speed of Onset:

Some thunderstorms can be seen approaching, while others hit without warning, as they develop rather quickly in warm unstable air. The NWS issues severe thunderstorm watches and warnings as well as statements about severe weather and localized storms. These messages are broadcast over NOAA Weather Radios and area TV and radio stations. Advances in weather prediction and surveillance have increased warning times. The resolutions of radar and Doppler radar have increased the accuracy of storm location and direction as well as intensity and likelihood/size of hailstones. Weather forecasting and severe weather warnings issued by the NWS usually provide residents and visitors alike adequate time to prepare. Warnings in the 20 to 1 hour range are usually available prior to the occurrence of the storm. Often the warning that the conditions are right for large hail is given hours or even days ahead of time, although sometimes isolated areas of hail at least 1" in diameter can occur in storms that were not expected to produce such hail.

Score for Rural Clarke County: 7	Score for Murray: 7	Score for Osceola: 7	Score for Woodburn: 7
Score for Clarke Schools: 7	Score for Murray Schools: 7	Score for SWCC: 7	Score for hospital: 7

Thunderstorm/Lightning/Hail Duration of Event:

Individual thunderstorm and lightning events generally last up to one hour, although a cluster or line of severe storms can last a few hours over a given area. Hailstorms typically last only a few minutes and always less than 1 hour over a given area. Because of the size of the rural area, it is more likely to see the effects of a storm for a longer duration before the storm moves to another county.

Score for Rural Clarke County: 4	Score for Murray: 3	Score for Osceola: 3	Score for Woodburn: 3
Score for Clarke Schools: 3	Score for Murray Schools: 3	Score for SWCC: 3	Score for hospital: 3

Thunderstorm/Lightning/Hail Total Scores:

The following total scores for thunderstorm/lightning/hail indicate moderate to high risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 55	Score for Murray: 54	Score for Osceola: 54	Score for Woodburn: 54
Score for Clarke Schools: 54	Score for Murray Schools: 54	Score for SWCC: 53	Score for hospital: 53

Thunderstorm/Lightning/Hail Vulnerability/Assets at Risk:
All structures, property, and people in the county, as outlined in Section 3.2, could suffer from the effects of thunderstorms and their associated cloud-to-ground lightning, hail, and thunderstorm winds. Power lines, utility poles, towers, and poorly built buildings are at the most risk among structures. Contents losses are likely to be minor, even compared to structural losses.

All critical assets in the county, as outlined in Section 3.2.

Thunderstorm/Lightning/Hail Loss Estimation:
Most lightning damages occur to electronic equipment located inside buildings. However, structural damage can also occur when a lightning strike causes a building fire. In addition, lightning strikes can cause damages to crops if fields light on fire. Communications equipment and warning transmitters and receivers can also be knocked out by lightning strikes. Thunderstorm winds and hail can cause damage to property, vehicles, trees, and crops.

Loss estimation for structures can be obtained from NCEI historical data on for structures. From 1996 through 2020, there have been $1.42 million in property damages due to lightning and wind and $0.65 million in property damages due to hail, for a total of $2.07 million. The annualized loss is $83,000 to structure and properties (not including contents).

In the past five years (2016-2020), there has been $214,176.47 in 13 claims for crop insurance in Clarke County, an average of $42,835.29 per year, due to hail damage. According to the 2013 Iowa Crop Profile from the USDA's Risk Management Agency, 90.5% of insurable crops in Iowa are insured with USDA crop insurance. Based on insured loss data above for the past five years, it can be stated that approximately $21,000 in uninsured losses occurred over that time for an average of $4,000 per year. An estimated $46,900 in total hail crop losses occur per year. An estimated 0.2% of crop value is lost due to thunderstorms.

Usually severe thunderstorms do not have a long-term impact on the local economy. Typical storms have only a temporary impact on the economy other than as a direct result of structural damage or damage caused by electrical damage from lightning. Sometimes fallen trees will disrupt commerce by damaging power lines and other utilities and blocking roads. Again, this is usually temporary in nature. Functional use losses are also usually minor in nature.

The loss due to human life and health are small for most storms. The greatest risk of death is from lightning, but the probability of any one person being struck by lightning during their lifetime is very small, let alone in one given storm. Falling and flying debris from storms and exceptionally large hail can also cause death. The risk of injuries is much higher. There is a 1% chance of death, 5% of serious injury, and 25% of a minor injury in the planning area in a given year directly as a result of a thunderstorm.

Future Development and Thunderstorm/Lightning/Hail:
Generally, this hazard will impact new development similar to existing development.

Tornado/Windstorm Profile
Type: Natural

Definition: A high wind event involving either widespread straight-line winds of at least 64 knots/73 MPH (windstorm) or a violent whirling wind characteristically accompanied by a funnel shaped could extending down from a cumulonimbus cloud in a narrow, erratic path (tornado).

Tornado/Windstorm Description:
Rotating tornado wind speeds can exceed 300 mph and travel across the ground at average speeds of 25-30 mph. A tornado can be a few yards to around a mile wide where it touches the ground. An average tornado is a few hundred yards wide. A tornado can move over land for distances ranging from short hops to many miles, causing damage and destruction wherever it descends. The funnel is made visible by the dust and debris sucked up and condensation of water droplets in the center of the funnel.

Windstorms are extreme winds associated with severe winter storms, severe thunderstorms, downbursts, and very steep pressure gradients. Windstorms, other than tornados, are experienced in all regions of the United States. It is difficult to separate the various wind components that cause damage from other wind-related natural events that often occur with or generate windstorms. Although Iowa does not experience direct impacts from hurricanes, the state is no stranger to strong, damaging winds. Unlike tornadoes, windstorms may have a destructive path that is miles wide and duration of the event could range from hours to days. These events can produce straight-line winds in excess of 64 knots (73 mph) causing power outages, property damage, impaired visibility, and crop damage.

It is often difficult to separate windstorm and tornado damage when winds get above 64 knots. For this reason, the State of Iowa and the Clarke County planning team chose to combine the formerly separate hazards of tornado and windstorm.

Existing weather reporting systems always have wind speeds recorded in knots. The conversion table below will provide a quick conversion for winds from calm to 99 knots. The converted values are all rounded to the nearest integer. The formula for exact conversion is 1 Knot=1.15155 MPH. The following is a conversion chart through 99 knots.

Figure 3.82: MPH/Knots Wind Speed Conversion Chart

Knots	+0 MPH	+1 MPH	+2 MPH	+3 MPH	+4 MPH	+5 MPH	+6 MPH	+7 MPH	+8 MPH	+9 MPH
0	0	1	2	3	5	6	7	8	9	10
10	12	13	14	15	16	17	18	20	21	22
20	23	24	25	26	28	29	30	31	32	33
30	35	36	37	38	39	40	41	43	44	45
40	46	47	48	49	51	52	53	54	55	56
50	58	59	60	61	62	63	64	66	67	68
60	69	70	71	72	74	75	76	77	78	79
70	81	82	83	84	85	86	87	89	90	91
80	92	93	94	96	97	98	99	100	101	102
90	104	105	106	107	108	109	110	112	113	114

Tornado/Windstorm Historical Occurrence:
Each year approximately 1,000 tornadoes are spawned by severe thunderstorms in our nation. Although most tornadoes remain aloft, those that touch ground are forces of destruction. Though the description of "tornado alley" varies slightly, Iowa is generally considered to be included in, or on the edge of, the geographic area. Between 2000 and 2013, Iowa has averaged more than 17 tornadoes per year and is ranked third in the number of tornadoes per 10,000 square miles. Most occur in April, May, and June, although Iowa has experienced tornadoes during all seasons/months. Tornadoes tend to be the most common in the late afternoon or evening, but they can occur at any time of day. The vast majority of tornadoes in Iowa's history have been EF0 and EF1, although tornadoes of all sizes have occurred.

Through 2020, seventeen tornadoes, many of them F2 (pre-Enhanced Fujita scale) in magnitude, have impacted Clarke County and have caused over $2.0 million in property damages, $7,000 in crop damage, no fatalities, and no injuries. The NCEI has also reported 2 funnel clouds (both in 2008) with no reported damages. Six Presidential Declarations have been declared for Clarke County due to tornado events. Many

of the local jurisdictions have been directly impacted by tornadoes, especially the rural area. The following table summarizes the NCEI data about tornadoes to date.

Figure 3.83: Historical Tornado Events by Fujita Scale Intensity

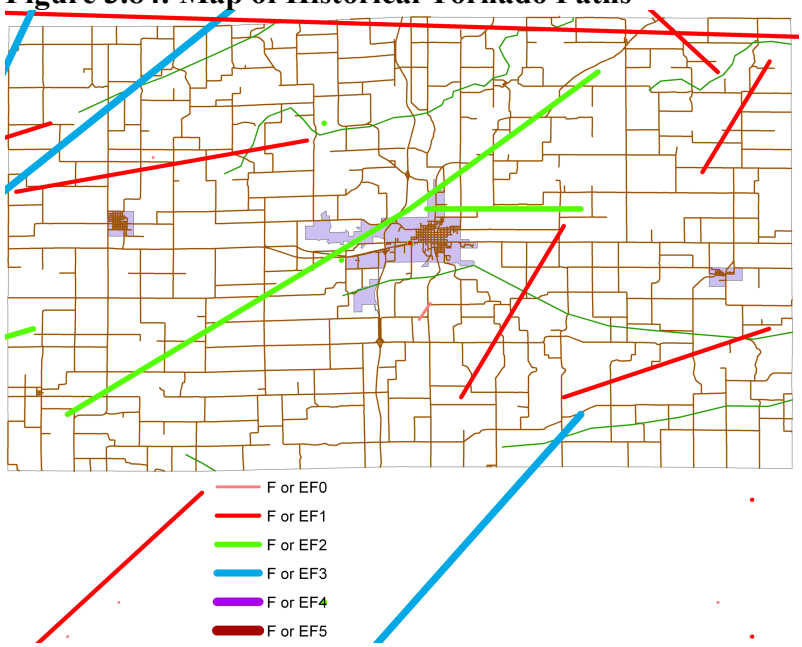
Scale *	Number	Years	Locations	Fatalities	Injuries	Avg. Property Damage	Avg. Crop Damage
F0	3	1973, 2008, 2014	Rural, Murray, Osceola	0	0	$15,000	$1,667
F1	7	1980 (2), 1991, 2008 (3), 2018	Rural, Murray, Woodburn	0	0	$81,071	$286
F2	7	1964, 1965, 1967, 1973, 1975, 1986, 2001	Rural, Murray	0	0	$200,000	$0
F3	0	n/a	n/a	n/a	n/a	n/a	n/a
F4	0	n/a	n/a	n/a	n/a	n/a	n/a
F5	0	n/a	n/a	n/a	n/a	n/a	n/a

*Source: National Centers for Environmental Information, 4/2021 (data available through 12/2020) *Most were pre-Enhanced Fujita Scale*

According to the Clarke County planning team, major tornado events in Clarke County occurred in June 1980, June 1981, July 1986, and April 2001. Tornadoes in the early parts of the past decade brought tree damage to Murray, damage to the Osceola airport, and private property damage to the east part of the town of Osceola. The Murray representative for the plan completed in 2009 indicated three tornadoes over history have done damage to the town. Generally larger communities have experienced more tornadoes. One committee member stated two tornadoes in 2020 caused minimal home damage in the rural area. Another member stated that a tornado or windstorm did some damage in Woodburn. A third member stated a tornado went north of Osceola in 2012. No damage report has been published for any of these events.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. Three indicated it happens more than once a year, nine indicated it happens most years, and six indicated it happened once or twice in the last five years. Three respondents described three different tornado events. One was in the eastern part of the county and destroyed two houses and several crops in 2018. Another touched down in Liberty Township and did minor damage. A third touched down north of Osceola around 2015 and caused damage to homes. The following map shows the historical tornado tracks from 1950 to 2019, as identified by the NWS.

Figure 3.84: Map of Historical Tornado Paths



NOAA NWS Storm Prediction Center GIS mapping (http://www.spc.noaa.gov/gis/svrgis/), 4/2021

According to the NCEI, there have been 19 high wind events in Clarke County from 1996 through 2020, the most recent in 2014. Winds exceeded 70 MPH in some areas (in 1998 was strongest wind recorded at 61 knots), destroying trees, flattening crops, and damaging or destroying outbuildings. Again, like winter storms and river floods, it is difficult to determine from the NCEI data how much of the high wind damage is located in Clarke County, due to the large area such wind events often cover. The reported damages are 0 death, 0 injuries, over $787,000 in property damage, and $30,100 in crop damage. It is possible that significant wind damage has occurred due to storms that have not reached windstorm warning levels, so possible millions of dollars of accrued losses may not be reported.

Over the recent history of Clarke County, windstorms have affected all jurisdictions and have caused widespread damage to trees, crops, buildings, and property in yards and on farms. The planning team has no information on specific storms. No fatalities are known.

Clarke County has had one Presidentially Declared Disasters that included straight-line winds in the disaster description (2014).

The total number of high wind events not directly part of a thunderstorm in recent history is difficult to estimate. However, some thunderstorms have caused exceptional damage due to wind gusts associated with microbursts, derechos, and squalls.

The following is the number of tornado watches and warnings and various wind-related alerts issued by NOAA's NWS. The data is housed on the Iowa Environmental Mesonet, Iowa State University Department of Agronomy website (http://mesonet.agron.iastate.edu/vtec/search.php).

Figure 3.85: Tornado and High Wind Historical Event Data

Year	Tornado Warning	Tornado Watch	Wind Advisory	Red Flag Warning	Red Flag Watch	High Wind Warning	High Wind Watch	Total
2016	0	4	6	0	0	0	0	10
2017	1	3	8	1	0	0	0	13
2018	2	5	5	1	0	0	0	13
2019	0	2	8	0	0	0	0	10
2020	1	2	8	2	0	0	0	13
2021 (through March)	0	0	3	2	0	0	0	5
Totals	4	16	38	6	0	0	0	64

Source: Iowa State University Department of Agronomy,
http://mesonet.agron.iastate.edu/vtec/search.php#byugc/IA/IAC159/20130101/20180309

The average over the past five years is 4.0 tornado watches/warnings and 7.8 wind watches/warnings per year.

Tornado/Windstorm Future Probability:
May and June are peak Iowa tornado months. In the future, the chances of tornadoes do not increase notably, but more developed areas are likely to be affected. Developed areas occupy a small but slowly growing portion of Clarke County and stand a likely chance of having a damaging tornado occur in the next ten years. Because of the large expanse of rural Clarke County, it has the greatest chance of experiencing a tornado. Larger towns have a greater chance of experiencing the effects compared to the smaller towns. An EF2 tornado is considered typical for this assessment and is used for the estimate of probability.

Based on historical averages, Iowa would expect to have about 15 to 20 wind events each year in which wind speeds exceed 64 knots. According to NOAA, Clarke County has a probability of 1.50 to 1.75 days of winds at or over 65 knots per year, based on historical data.

When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. Ten indicated it is more likely, seven indicated no change in likelihood, none indicated less likely, and one indicated they were unsure.

Score for Rural Clarke County: 8	Score for Murray: 7	Score for Osceola: 7	Score for Woodburn: 7
Score for Clarke Schools: 7	Score for Murray Schools: 7	Score for SWCC: 7	Score for hospital: 7

Tornado/Windstorm Vulnerability to the Population:

Those most at risk from tornadoes include people living in mobile homes, campgrounds, and other dwellings without secure foundations or basements, and people in vehicles. The elderly, very young, and the physically and mentally handicapped are most vulnerable because of the lack of mobility to escape the path of destruction. Because most Iowa tornadoes occur from 4 to 9 PM, especially EF3 and larger tornadoes, when people are commuting or recreating outside, Clarke County, with its large commuter population and high Interstate traffic, faces greater risk. People who may not understand watches and warnings due to language barriers, such as those of Hispanic origin, are also at risk. Because of the concentration of homes in a city, the percentage of the population at risk is higher. Using the size and typical path of an EF3 tornado as an example, the percentage of the people directly impacted is modest, especially in rural areas of the county. Small towns are likely to have a higher percentage of the town's population impacted by an EF3. Single assets, like schools, could receive significant impacts unless they are constructed to FEMA 361 standards. At this time, there are no certified safe rooms in the county. People are always at risk if they are not in a FEMA 361 structure when a tornado makes a direct hit.

For this assessment, the planning team based its vulnerability or risk scenario on an EF3 tornado, which is typical of the more damaging tornadoes, although the true vulnerability will vary greatly based on the location and size/strength of the twister.

Those most at risk from windstorms include people living in mobile homes, campgrounds, and other dwellings without secure foundations or basements, as are those in vehicles, especially large and high-profile vehicles. Large sections of Interstate 35 are exposed to high winds. Several sections in the area known for high crosswinds contain signs to warn travelers of this risk. The elderly, very young, and the physically and mentally handicapped are most vulnerable because of the lack of mobility to seek shelter or escape the path of destruction. Wind can precede a storm when people are not prepared for it. People who may not understand watches and warnings due to language barriers are also at risk. Winds can pick up rapidly even on sunny days and clear nights, when the public is not expecting it. An estimated 30% of the population is at direct risk by being outdoors or traveling when high winds hit. A small percentage of properties in the path of the storm are likely to be damaged significantly. Generally, those in schools and the hospital are less vulnerable than the general public because these properties contain modern, well-built brick structures.

The following scores reflect the fact that windstorms are likely to impact more area, and therefore, more people, but that tornadoes are likely to be a true hazard to a larger percentage of the people in a smaller area. In this way, adding these hazards together produces a higher score, especially for schools and the hospital, which are likely not at great risk to a typical windstorm.

Score for Rural Clarke County: 5	Score for Murray: 6	Score for Osceola: 6	Score for Woodburn: 6
Score for Clarke Schools: 5	Score for Murray Schools: 5	Score for SWCC: 5	Score for hospital: 5

Tornado/Windstorm Area of Extent:

The area of extent varies greatly between tornados and windstorms. For this assessment, the planning team elected to consider the larger damage path of a potential windstorm. The risk assessment looks at the part of the windstorm path that is most destructive, which is perhaps more in line with a large tornado.

Generally the destructive path of a tornado is only a couple hundred feet in width, but stronger tornadoes can leave a path of devastation up to a mile wide. Normally a tornado will stay on the ground for no more than 20 minutes; however, one tornado can touch ground several times in different areas. Large tornadoes can follow a wide path across an entire county. Damages will be greater as a percentage of area in the towns because a single tornado can be as wide as a small community.

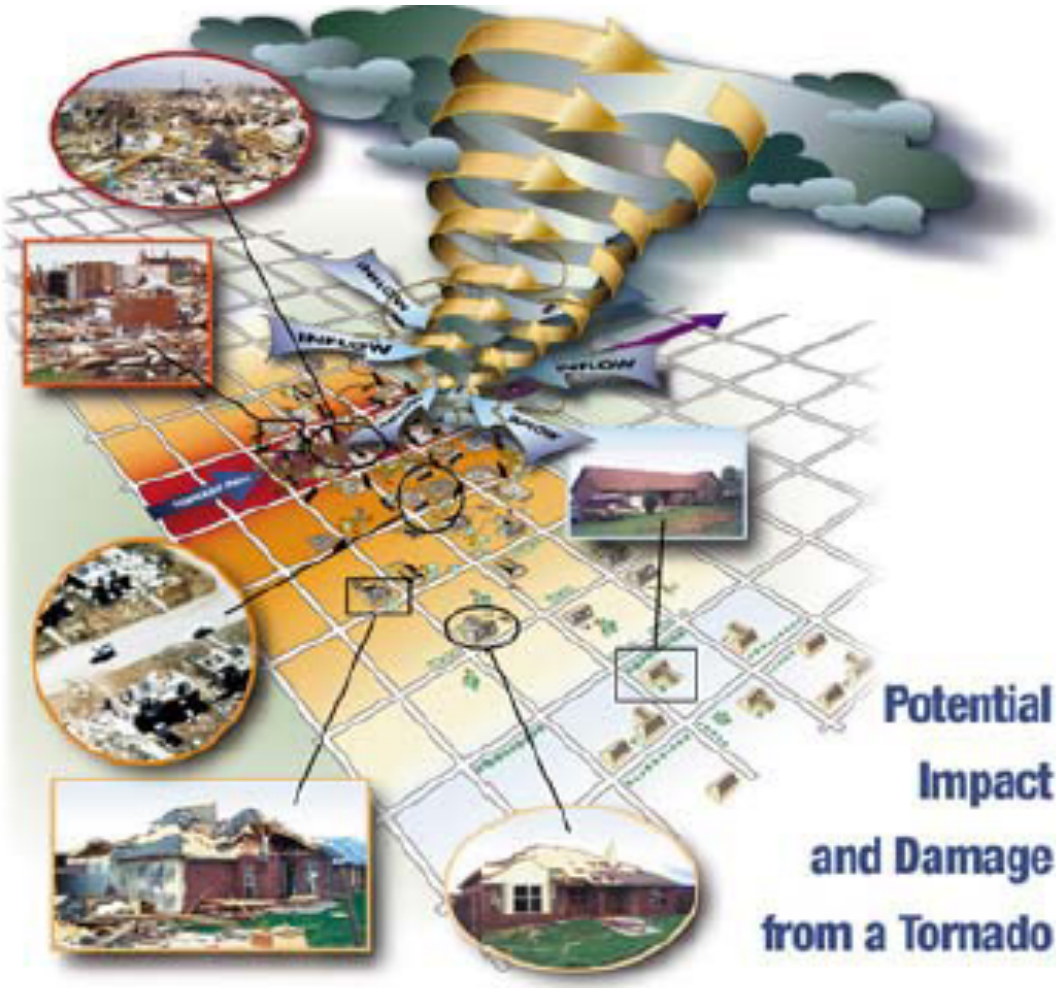
In 1973 Dr. Fujita and Dr. Allen Pearson added in factors related to the width and length of the tornado path and called the scale the Fujita-Pearson Scale. This additional information helps estimate the area that may be impacted and the number of people and property that could be affected.

Figure 3.86: Tornado Damage Path Information by Intensity

Scale	Wind Speed (mph)	Pearson Path Length (miles)	Pearson Path Width
F0	40-72	0.3-0.9	6-17 yards
F1	73-112	1.0-3.1	18-55 yards
F2	113-157	3.2-9.9	56-175 yards
F3	158-206	10-31	176-566 yards
F4	207-260	32-99	0.3-0.9 miles
F5	261-318	100-315	1.0-3.1 miles

The graphic to the right shows possible damage as it relates to the tornado path. Based on the size of communities and the distances from the center of a tornado, small towns could easily be devastated by one tornado. As shown, a few blocks from even an EF-3's center can experience significant damage. Clearly, the area that could be impacted varies greatly depending on the intensity of the tornado. Storms can also spawn additional tornadoes and other damaging phenomenon that extend the area of impact.

Figure 3.87: Tornado Damage Path Graphic



Unlike tornadoes, windstorms may have a destructive path that is tens of miles wide and several hundred miles long. Wind speed can vary greatly in the affected area, but damage can be found throughout the windstorm area if exposure to wind below 64 knots continues for hours unabated. Certainly, entire individual buildings and properties will be impacted. The rural county will feel widespread impacts but not necessary the entire area. Clarke County is part of Wind Zone IV, which

includes winds up to 250 MPH, the highest wind zone in the nation. This wind zone covers most of the interior Midwest from northern Texas to western Pennsylvania.

Score for Rural Clarke County: 7	Score for Murray: 8	Score for Osceola: 8	Score for Woodburn: 8
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Tornado/Windstorm Severity of Impact:

Severity of a tornado relates to the size, wind speed, length of time and distance traveled on the ground, and the assets and population in the exposed area where the tornado occurs. Generally, no matter the size and strength of the twister, if people are exposed and the area has many weak and poorly built buildings, severity is greatly increased. The rating scale used to rate tornado intensity is called the Enhanced Fujita Scale. The Enhanced Fujita Scale (EF) is used to assign a tornado a 'rating' based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of Damage Indicators and Degrees of Damage, which helps estimate better the range of wind speeds the tornado likely produced. From that, a rating (from EF0 to EF5) is assigned. The National Weather Service is the only federal agency with authority to provide 'official' tornado EF Scale ratings. The following chart shows the relationship between structure damage and wind speeds as it pertains to EF tornado ratings.

Figure 3.88: Tornado Damage Potential by Intensity

EF Rating	Wind Speeds	Expected Damage		
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.		
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.		
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.		
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.		
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.		
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.		

The following table gives more details about the relative frequency of each EF scale in Iowa.

Figure 3.89: Tornado Frequency by Intensity

Scale	Wind Speed (mph)	Relative Frequency	Potential Damage
EF0	65-85	53.5%	Light. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. NOTE: Confirmed tornadoes with no reported damage (i.e. those that remain in open fields) are always rated EF0).
EF1	86-110	31.6%	Moderate. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	10.7%	Considerable. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	3.4%	Severe. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	0.7%	Devastating. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	<0.1%	Explosive. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 300 ft.; steel reinforced concrete structure badly damaged; high rise buildings have significant structural deformation; incredible phenomena will occur.

In this profile, the local planning team performed analysis based on a scenario. The team considers a risk due to a typical EF3 tornado because smaller tornadoes do not need extensive new mitigation actions, and larger tornadoes are quite rare. Larger tornados are less common but are much more severe.

Severity of a windstorm depends primarily on a) wind speed, b) duration, c) size of area of impact, and d) existing conditions of the area where the windstorm occurs. Higher wind speeds produce more damage, as does the size of impact area, which causes damage to more properties. Sustained winds tend to exacerbate conditions, even if below the threshold of a windstorm, because the continuous strain on power lines, trees, and buildings over hours or even days weakens them. Delays in business and construction activities caused by high wind, i.e., wind is too strong to allow work to continue, also have economic impacts. Existing conditions, such as excessive debris, old structures, and exposed hazardous materials can exacerbate windstorm severity by exposing people and surrounding properties to those conditions.

The Land Beaufort Scale was originally developed in 1805 by Sir Francis Beaufort as a system for estimating wind strength without the use of instruments. It is currently still in use for this same purpose as well as to tie together various components of weather (wind strength, sea-state, observable effects) into a unified picture. This table details the scale.

Figure 3.90: Windstorm Potential Damage by Wind Speed

Force	Speed (knots)	Speed (MPH)	Land Conditions
0	<1	<1	Calm, smoke rises vertically
1	1-3	1-3	Light air, direction of wind shown by smoke drift only
2	4-6	4-7	Light breeze, wind felt on face, leaves rustle, vanes moved by wind
3	7-10	8-12	Gentle breeze, leaves and small twigs in constant motion, wind extends light flag
4	11-16	13-18	Moderate breeze, raises dust and loose paper, small branches move
5	17-21	19-24	Fresh breeze, small trees in leaf begin to sway
6	22-27	25-31	Strong breeze, large branches in motion, umbrellas used with difficulty
7	28-33	32-38	Near gale, whole trees in motion, inconvenience felt walking against the wind
8	34-40	39-46	Gale, breaks twigs off trees, impedes motion
9	41-47	47-54	Strong gale, slight structural damage occurs
10	48-55	55-63	Storm, trees uprooted, considerable damage occurs
11	56-63	64-73	Violent storm, widespread damage
12	64+	74+	Hurricane, extreme destruction

In this profile, the planning team looks at the severity of a widespread windstorm that lasts a few hours and

includes at least one gust over 64 knots.

The NWS can issue High Wind Watch, High Wind Warning, and Wind Advisory to the public. The following are the definitions of these issuances:

- High Wind Watch—This is issued when there is the potential of high wind speeds developing that may pose a hazard or is are life-threatening.
- High Wind Warning—The 1-minute surface winds of 35 knots (40 mph) or greater lasting for one hour or longer, or winds gusting to 50 knots (58 mph) or greater, regardless of duration, that are either expected or observed over land.
- High Wind Advisory—This is issued when high wind speeds may pose a hazard. Sustained winds 25 to 39 mph and/or gusts to 57 mph.

The following provides a summary of the severity of impact throughout the county.

Figure 3.91: Tornado and High Wind Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	Injury or death related to tornadoes and windstorms most often occurs when buildings collapse, people are hit by flying objects, or when they are caught trying to escape in a vehicle. From 1950-2006, Iowa has had 2007 injuries related to tornadoes and 67 deaths over the same time period. There were 12 deaths and 561 injuries from 1980-2006. Over a dozen people died in several tornadoes in 2008. All people not within a reinforced building are at risk. High winds can blow trucks and cars off highways, causing severe injury and death. People are more likely to exposed to the hazards from straight-line winds because they can precede a storm or occur on an otherwise "nice" day.	4
Health and safety of responders	Response personnel are exposed to the same risk as the general public when caught in the storm without shelter. Typically, responders will be aware of conditions and will be in shelter during the initial storm but could be at risk to the secondary effects, such as fire, downed power lines, traffic accidents, lightning, and follow-up tornadoes. They may be more prepared than the average person and alert that the event is approaching, but many responders are also active storm watchers, so they are exposed as the storm approaches.	4
Continuity of operations	Tornadoes and windstorms can destroy government facilities just as they could other property. Disruption of critical services can also affect operations. Employees may be affected and unable to attend to work-related issues. The widespread loss of utilities and facilities can stop numerous government and other essential operations. Power lines and emergency equipment can be blown down and lost. Extended windstorm events can delay response and repair for hours to days.	4
Property, facilities, infrastructure	Impacts can range from broken tree branches, shingle damage to roofs, and some broken windows all the way to complete destruction and disintegration of well-constructed structures, infrastructure, and trees. While not likely due to an EF3 storm, entire neighborhoods can be destroyed. Based on the level of destruction due to an EF3 tornado and the size of its path, its impact could be catastrophic in some cases, if the tornado impacts areas of highly vulnerable structures. Windstorms are likely to cause less damage to an individual structure but their widespread impact could be critical to catastrophic.	4
Delivery of services	Tornadoes can impact many critical services, mainly electrical power and communications. Buried services are not as vulnerable, but can be affected by their system components that are above ground. Because of the extent of damage and lack of funds and resources to repair facilities, areas can be off-limits and systems may be off-line for days or more. Roads can be closed and bridges can be destroyed, so deliveries can be slowed. Items like bottled water and basic supplies may need to be brought in, and roads can be clogged with response vehicles.	4
Environmental impacts	Tornadoes and windstorms are naturally occurring phenomena. Damages to the environment could result from spills and other contaminants from the built environment. Debris can fly for tens of miles, delivering substances to areas not in the direct path of the storm. Sometimes debris is not spotted for some time, so leaks can persist. Damage to infrastructure can cause persistent environmental damage.	3
Economic/financial conditions	Whole towns have been destroyed. Economic impacts can result from direct damages to facilities or business disruption from the lack of critical services such as power, gas, or water. If a tornado causes great damage to a residential area away from the business, and many workers are	4

Severity Criteria	Discussion	Score
	dramatically affected, it can cause excessive loss in employee productivity, even if the business is not hit. Crop damage is often associated with windstorms; laying down crops, breaking stalks, and twisting plants, reducing crop yield and making it difficult to harvest. Wind-related road closures are rare but can delay business road, rail, and air travel.	
Regulatory/contractual obligations	Debris removal is a vital service that is often too vast for the jurisdiction to do without contractual assistance. These plans should be in place and monitored. When services and response are postponed too long, lawsuits are likely due to the failure to provide contractual services. When property is destroyed, it is difficult to maintain any level of service in the immediate aftermath of a storm.	3
Reputation	Adequate warning is key to the positive reputation of the jurisdiction. Responding in a timely manner and reconstructing the community is also important. Bringing critical services back on line quickly will ensure the residents can recover.	2

Score for Rural Clarke County: 32	Score for Murray: 32	Score for Osceola: 32	Score for Woodburn: 32
Score for Clarke Schools: 32	Score for Murray Schools: 32	Score for SWCC: 32	Score for hospital: 32

Tornado/Windstorm Speed of Onset:

Tornadoes can form and strike in seconds. Wind speeds may exceed 300 miles per hour and the storm can travel across the ground at more than 70 mph. These winds turn harmless objects into deadly missiles in a matter of seconds. The advancement in weather forecasting has allowed watches to be delivered to those in the path of these storms up to hours in advance. The best lead-time for a specific tornado is about 30 minutes. Tornadoes have been known to change paths very rapidly, thus limiting the time in which to take shelter. Tornadoes may not be visible on the ground due to blowing dust or driving rain and hail.

The NWS has developed a windstorm warning system similar to other events such as tornado, winter storm, and thunderstorm watches that are issued when conditions are favorable for high winds to develop; these are often issued 12 to 24 hours in advance. Advisories are issued when existing or imminent high winds cover part or all of the area and pose a mere inconvenience. High wind warnings are issued when existing or imminent high winds cover part or all of the forecast area and pose a threat to life and property.

While warning times might be nearly a day, the best warning lead-time for a specific severe storm is about 30 minutes, because these storms can precede a parent thunderstorm by tens of miles and can move across the ground at or exceeding 50 MPH. Further, in Iowa, high winds are associated with strong air pressure gradients, which means that winds can pick up with no warning (not a cloud in the sky) and can change speed and direction rather rapidly.

Score for Rural Clarke County: 8	Score for Murray: 8	Score for Osceola: 8	Score for Woodburn: 8
Score for Clarke Schools: 8	Score for Murray Schools: 8	Score for SWCC: 8	Score for hospital: 8

Tornado/Windstorm Duration of Event:

Tornado events last up to 1 hour, with the passing of a supercell or line of storms containing multiple tornadoes taking up to 2 hours on rare occasions. FEMA tornado safe rooms are designed to house people for two hours.

Windstorms typically last from a few minutes to a few hours with damaging winds at or above 64 knots, but the storm can last a day or longer with occasional wind gusts approaching or even exceeding 64 knots. The total duration of the severe part of a windstorm might be 6 hours with rare exceptions.

Score for Rural Clarke County: 4	Score for Murray: 4	Score for Osceola: 4	Score for Woodburn: 4
Score for Clarke Schools: 4	Score for Murray Schools: 4	Score for SWCC: 4	Score for hospital: 4

Tornado/Windstorm Total Scores:
The following total scores for tornado/windstorm indicate high risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 64	Score for Murray: 65	Score for Osceola: 65	Score for Woodburn: 65
Score for Clarke Schools: 65	Score for Murray Schools: 65	Score for SWCC: 65	Score for hospital: 65

Tornado/Windstorm Vulnerability/Assets at Risk:
All structures, property, and people in the county, as outlined in Section 3.2, could suffer from the effects of tornadoes and windstorms. Severity can vary greatly depending on the actual wind speed and other factors.

All critical assets in the county, as outlined in Section 3.2.

Tornado/Windstorm Loss Estimation:
Structural loss can be very severe, as tornadoes are considered one of the greatest causes for structural loss among the hazards listed. Although death is less likely than structural loss, tornadoes are more likely than almost any other hazard to cause death (and serious injury).

In Clarke County, the NCEI estimate for past property damage resulting from tornadoes from 1950-2020 was nearly $2.1 million. This averages $30,000 per year in property damage. In Clarke County, the NCEI estimate for past property damage resulting from windstorms from 1996-2020 was $787,000. This averages $31,500 per year in property damage. The total average annual structural loss would be $61,500. Keep in mind that much of the historical loss data might not reflect modern inflation values, but it provides a basis for future loss estimates. According to the State's HM Viewer, tornado tab, accessed in April 2020, the average annual loss due to tornadoes is $144,620.

Crop insurance payments for the period from 2016-2020 were $34,001 for wind damage (2 claims). Considering that 90.5 percent of insurable crops are insured in Iowa (2013 Iowa Crop Insurance Profile, USDA, RMA), the adjusted losses calculate to just over $37,000 for all insurable crops for the period. This results in an average annual loss of $7,400 to insurable crops as a result of wind damage.

A useful way to analyze the potential losses for a tornado is through a potential scenario. As described earlier, the planning team used an EF3 as a basis for this risk assessment. This scenario involves a tornado track through the middle of each jurisdiction at a 45-degree angle, such as southwest to northeast, a common angle. Since school districts and the hospital own relatively few structures all in one place, school and hospital loss data in this scenario are included in the town in which they are located. As much as possible, parcel and public building/asset value, as outlined in Section 3.2, are utilized to determine possible losses.

With the infinite variables associated with tornado occurrences such as wind speed, direction, length, width, and time on the ground, etc., it is not possible to accurately estimate future losses. However, this methodology provides loss estimates for a defined scenario. Utilizing GIS data with associated building values considers variations in density of the built environment as well as variations in values. Again, it makes it possible for local jurisdictions to imagine or picture their risks in defined values to allow for some level of comparison.

An EF3 tornado is used here but most of the tornadoes will be smaller and cause less damage. However, some will be even larger, so it is realistic to use this scenario. Once the number of buildings within the hypothetical tornado track is determined, a 50% damage calculation was made within the base. The base is defined as within 566 yards (roughly 1,700 feet or one-third of a mile) of width of the tornado. A 10-mile long track was used. This damage percent is based on information from the NOAA Storm Prediction Center,

which estimates and EF-3 tornado can do "severe" damage: entire stories of well-constructed homes destroyed, significant damage done to large buildings, homes with weak foundations blown away, cars thrown, and significant tree damage. Clearly the amount of damage to a structure will vary within the path, but this provides a reasonable scenario for planning purposes.

The following table provides the results of the analysis in terms of the number and value of buildings in the scenario tornado path and estimated losses in Clarke County. A planning area total was not calculated. Notice that in each of the tornado track scenarios, a portion of the county is impacted along with each incorporated city. This is due to the 10-mile average length, which exceeded the city boundaries at the approximate center and 45-degree angle for all tracks.

Figure 3.92: Tornado/Windstorm Loss Estimate

Jurisdiction and Track Location	Property Type	Number of Impacted Properties	Estimated Values	Estimated Contents Values	50% Loss Estimate
Rural County (No Cities)	Residential	27	$3,000,000	$1,500,000	$2,250,000
	Commercial	1	$100,000	$50,000	$75,000
	Industrial	0	$0	$0	$0
	Agricultural	25	$4,000,000	$2,000,000	$3,000,000
	Taxable Infrastructure	1	$2,500,000	$500,000	$1,500,000
	Government/Institutional	1	$5,000,000	$2,500,000	$3,750,000
	Totals	**55**	**$14,600,000**	**$6,550,000**	**$10,575,000**
Murray	Residential	100	$6,000,000	$3,000,000	$4,500,000
	Commercial	3	$500,000	$250,000	$375,000
	Industrial	1	$300,000	$150,000	$225,000
	Agricultural	1	$100,000	$50,000	$75,000
	Taxable Infrastructure	1	$500,000	$100,000	$300,000
	Government/Institutional	5	$15,000,000	$7,500,000	$11,250,000
	Totals	**111**	**$22,400,000**	**$11,050,000**	**$16,725,000**
Rural and Murray	Residential	24	$2,400,000	$1,200,000	$1,800,000
	Commercial	0	$0	$0	$0
	Industrial	0	$0	$0	$0
	Agricultural	25	$4,000,000	$2,000,000	$3,000,000
	Taxable Infrastructure	1	$2,000,000	$500,000	$1,250,000
	Government/Institutional	1	$1,000,000	$500,000	$750,000
	Totals	**51**	**$9,400,000**	**$4,200,000**	**$6,800,000**
Osceola	Residential	500	$35,000,000	$17,500,000	$26,500,000
	Commercial	75	$25,000,000	$12,500,000	$18,750,000
	Industrial	7	$8,000,000	$4,000,000	$6,000,000
	Agricultural	1	$750,000	$375,000	$562,500
	Taxable Infrastructure	2	$4,500,000	$1,500,000	$3,000,000
	Government/Institutional	15	$30,000,000	$15,000,000	$22,500,000
	Totals	**600**	**$103,250,000**	**$50,875,000**	**$77,062,500**
Rural and Osceola	Residential	30	$3,500,000	$1,750,000	$2,625,000
	Commercial	1	$100,000	$50,000	$75,000
	Industrial	0	$0	$0	$0
	Agricultural	25	$4,000,000	$2,000,000	$3,000,000
	Taxable Infrastructure	1	$2,000,000	$500,000	$1,250,000
	Government/Institutional	2	$2,000,000	$1,000,000	$1,500,000
	Totals	**59**	**$11,600,000**	**$5,300,000**	**$8,450,000**
Woodburn	Residential	40	$1,100,000	$550,000	$825,000
	Commercial	2	$50,000	$25,000	$37,500
	Industrial	0	$0	$0	$0
	Agricultural	1	$100,000	$50,000	$75,000
	Taxable Infrastructure	1	$500,000	$100,000	$300,000
	Government/Institutional	3	$2,000,000	$1,000,000	$1,500,000
	Totals	**47**	**$3,750,000**	**$1,725,000**	**$2,737,500**
Rural and Woodburn	Residential	20	$1,800,000	$900,000	$1,350,000
	Commercial	0	$0	$0	$0
	Industrial	0	$0	$0	$0
	Agricultural	25	$4,000,000	$2,000,000	$3,000,000
	Taxable Infrastructure	1	$2,000,000	$500,000	$1,250,000
	Government/Institutional	1	$1,000,000	$500,000	$750,000
	Totals	**47**	**$8,800,000**	**$3,900,000**	**$6,350,000**

The above table shows that, if an EF-3 tornado makes a path through the county, it will cause millions or tens of millions of dollars of damages to properties in the county. The actual losses will be directly affected by its path. Fortunately, only about 10% of the future projected tornadoes will reach or exceed the EF-3 intensity.

Overhead power lines and infrastructure are also vulnerable to damages from windstorms. Windstorms can cause damage to structures and power lines, which in turn create hazardous conditions for people. Debris flying from high wind events can shatter windows in structures and vehicles and can harm people that are not adequately sheltered. Other potential losses include cost of repair or replacement of damaged facilities and lost economic opportunities for businesses. Public safety hazards include risk of electrocution from downed power lines. Specific amounts of estimated losses are not available due to the complexity and multiple variables associated with this hazard. The electric power loss of use estimates can be calculated using FEMA's Standard Values for Loss of Service for Utilities published in the June 2009 *BCA Reference Guide*. These figures are used to provide estimated costs associated with the loss of power in relation to the populations in Clarke County's jurisdictions. The loss of use estimates for power failure associated with windstorms is provided as the loss of use cost per person, per day of loss, totaling $126. The estimated loss of use provided for each jurisdiction represents the loss of service of the indicated utility for one day for 10 percent of the population. It is understood that in rural areas, the typical loss of use may be for a larger percentage of the population for a longer time during weather extremes. These figures do not consider physical damages to utility equipment and infrastructure. For the entire planning area, with a population of approximately 9,500, this loss would amount to $119,700 per day.

Both windstorm and tornado are hazards that can have substantial economic impacts, including business building destruction, power loss shutdown, inability for people to get to work, and inability to make and receive shipments. Windstorms especially can cause greater economic losses than other hazards.

The loss due to human life and health is not high for the typical windstorm and even for most tornadoes. However, in the event of an EF-3 tornado, the risk could be high for multiple deaths and injuries, especially if the tornado makes a direct hit on a municipality. The chance of death and serious injury greatly increases with no or limited warning or if warning is not heeded or if people are exposed with nowhere to go, such as in a campground. There is an estimated 10% chance of death, 25% of serious injury, and 50% of a minor injury in a given year directly as a result of a storm.

Future Development and Tornado/Windstorm:
As long as the population growth is slow or modest, it is unlikely that future development will increase exposure or risk of loss in a notable way. New homes and other buildings are being built, but most of them are strong and meet modern building standards. In the past five to ten years, FEMA and the State of Iowa have made great effort to promote the use of public and in-home safe rooms as part of construction of new projects where vulnerable populations will be. Assuming that some organizations building new structures heed this advice and take advantage of funding, the new development might actually reduce the risk to human life and limit the increase of risk to buildings.

Transportation Incident Profile
Type: Technological

Definition: An accident involving any mode of transportation that directly threatens life, property damage, injury, or adversely impacts a community's capabilities to providing emergency services.

Transportation Incident Description:
This hazard encompasses air transportation, highway transportation, railway transportation, and waterway

incidents. The following paragraphs describe each mode of transportation.

An air transportation incident may involve a military, commercial, or private aircraft. Airplanes, helicopters, and other modes of air transportation are used to transport passengers for business and recreation as well as thousands of tons of cargo. A variety of circumstances can result in an air transportation incidents, including mechanical failure, pilot error, weather conditions, or an on-board fire could all lead to an incident at or near the airport.

A highway transportation incident can be single or multi-vehicle requiring responses exceeding normal day-to-day capabilities. If the designed capacity of the roadway is exceeded, the potential for a major highway incident increases. Weather conditions play a major factor in the ability of traffic to flow safely as does the time of day and week. Incidents involving buses and other high-occupancy vehicles could trigger a response that exceeds the normal day-to-day capabilities of response agencies.

A railway transportation incident is a train accident that directly threatens life, property, or adversely impacts a community's capabilities ability to provide emergency services. Railway incidents may include derailments, collisions, and highway/rail crossing accidents. Train incidents can result from a variety of causes including human error, mechanical failure, faulty signals, or problems with the track. Results of an incident can range from minor "track hops" to catastrophic hazardous material incidents with human/animal casualties.

A waterway incident is an accident involving any water vessel that threatens life, property, or adversely affects a community's capability to provide emergency services. Waterway incidents primarily involve pleasure craft on rivers and lakes. Waterway incidents may also include events in which a person, persons, or object falls through the ice on partially frozen bodies of water. Impacts include fuel spillage, drowning, and property damage.

Transportation Incident Historical Occurrence:
There have been or can be air, rail, and highway transportation incidents in Clarke County.

From 1962 to 2010, there were approximately 2,035 (around 40 per year) air transportation incidents/accidents in Iowa according to the National Transportation Safety Board. Since the year 2000 only 214 air transportation incidents (around 16 per year), so the number of incidents is dropping due to advances in air transportation safety. The vast majority of fatalities are from large airline crashes, but the vast majority of crashes, including those in rural Clarke County, have been small planes. The local planning team indicates only two known events occurring in the county. The first was a small pesticide spray plane crashing with only minor damage many years ago. In early June 2009 a small plane crashed just south of Murray with injuries to both passengers. No fatalities have been reported.

According to the Iowa Department of Transportation (IDOT), there were 314 vehicle crashes with 336 fatalities in 2019, most of them involving passenger and commercial vehicles, motorcycles, and pedestrians. From 2009-2018, there were 17 fatalities in Clarke. Most of these incidents were not of the magnitude of exceeding local first response agencies, but some incidents have exceeded capabilities. All county fire departments have responded to highway transportation incidents. In the past, high cross winds and icy and snow-covered roads have been responsible for significant crashes on Highway 34 and I-35 on the average of once annually. Other incidents have closed the Interstate for hours. For example, in 2006 a large truck on the Interstate hit the bottom of the US 34 south (east-bound) bridge and caused the closure of that part of the double bridge for days. Most of the other crashes have occurred in rural areas, but they can occur almost anywhere where highway speeds exceed 35 MPH, including the cities. They do not have a direct effect on schools and the hospital. However, in April 2013 Clarke Community Schools suffered from a bus crash that

occurred in rural Clarke County. It is not common that major crashes cause either the north- or south-bound lanes of I-35 to close and then detours are necessary. This happens enough that the IDOT has designated paths for detours and installed signs on these detour routes. The most recent notable incident was a crash near Murray that claimed multiple teen lives in late spring 2021.

Modern rail incidents have occurred in Osceola, Murray, and the rural part of the county but have been relatively minor in nature, with no extensive property or economic loss. Over fifty years ago, more significant crashes have occurred, but there are no available records. Service has been back online within about 24 hours in modern events. According to Federal Railroad Administration data (https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/TenYearAccidentIncidentOverview.aspx), Clarke County had 28 incidents from 2001-2011, with one fatality and five injuries. The planning team outlines that minor derailments have occurred in recent years but with minor and short-term impacts. Causes of past incidents have included driver fatigue, animals and vehicles caught in front of the train, and severe weather, such as heavy snow and high wind. Local fire and other response agencies have been trained in rail transportation incident response and response to hazardous materials involving railroads. Rail lines do not affect the schools, SWCC, or hospital directly, although bus and response route crossings can be cut off by trains, thereby delaying access to other areas.

There are few significant waterways and water bodies in Clarke County, consisting of several lakes and a few rivers. Only West Lake is used routinely for surface recreation (small boats and other personal watercraft). Historically, no known incidents, other than vehicles and anglers falling through the ice, have been reported in Clarke County. These have occurred as people were recreating in conditions where they should not have been on the ice. There are no navigable rivers, so commercial/transportation incidents have not occurred.

When asked about the past occurrence of this hazard in the online survey, 18 persons responded. Three indicated it happens more than once a year, two indicated it happens most years, six indicated it happened once or twice in the last five years, five responded that it has not occurred, and two responded they did not know.

Transportation Incident Future Probability:
Osceola's Airport handles a relatively small number of planes and the likelihood is small in a given year that an incident will occur, despite the popularity of the local airport for recreational flying. Air traffic overall is limited and any planes that crash are likely to be small planes with no more than a pilot and one passenger. However, since there are many commercial planes that fly over the county, there is always a chance for a major crash. More and more people are utilizing air travel now than in the past (with the dip caused by COVID excepted). Once COVID's impacts abate, it is likely that air travel will reach new records.

Although traffic engineering, inspection of traffic facilities, land use management of areas adjacent to roads and highways, and the readiness of local response agencies have increased, highway incidents continue to occur. As the volume of traffic on the state's streets, highways, and interstates increases, the number of traffic accidents will likely also increase. The combination of large numbers of people on the road, wildlife, unpredictable weather conditions, potential mechanical problems, and human error always leaves open the potential for a transportation accident. Local jurisdictions continue to look at where traffic signals and speed limit changes are needed in order to protect the public. Greatest risks are on Interstate 35, US Highways 34 and 69, and paved county roads for major incidents that require more than local response.

The BNSF Railway continues to handle large volumes of railway freight. The twice-a-day AMTRAK service adds the risk of a crash with large loss of life. Anywhere from 30 to 50 trains pass through the

county each day, most of them at 50 MPH or greater. Some of the trains handle hazardous materials, while most of them are very heavy with loads of coal.

Several ponds, rivers, and lakes are used for recreation, including angling, boating, and swimming. The number of users of Iowa lakes and rivers is increasing. Minor incidents involving one or two boats and/or individuals can occur that tie up response resources and cause death and injury are possible but unlikely in a given year. Incidents will be recreational-related, as opposed to transportation-related, because the waterways are too small to support barges. Only in rural areas and Osceola can waterway incidents occur.

When asked about the likelihood that the incidence of this hazard will increase in the future compared to today in the online survey, 18 persons responded. Eight indicated it is more likely, seven indicated no change in likelihood, none indicated less likely, and three indicated they were unsure.

The following probabilities are based on incidents that cause fatalities and/or require response beyond local capabilities. The potential for an incident is virtually impossible on school and hospital property due to the slow speeds involved, with the exception of air transportation incidents.

Score for Rural Clarke County: 7	Score for Murray: 2	Score for Osceola: 4	Score for Woodburn: 2
Score for Clarke Schools: 1	Score for Murray Schools: 1	Score for SWCC: 1	Score for hospital: 1

Transportation Incident Vulnerability to the Population:

People aboard airplanes are the most vulnerable to air transportation incidents. Statistics from the National Transportation Safety Board and the airline industry show that the majority (over 75%) of airplane crashes and accidents occur during the takeoff or landing phases of a flight. As a result, developed areas adjacent to the airports and in airport flight paths are particularly vulnerable to this hazard. The Osceola Airport is surrounding row crop fields and a little traveled road. Airport zoning is now being implemented to ensure that development will be limited and low-impact near the airport. For areas away from the airport, a smaller percentage of the population would be directly in the area of impact. However, because of the concentration of populations in smaller areas, especially for schools and the hospital, the percentage of persons in the impact area of an incident would be higher even though the probability of an incident is actually less than the immediate area around an airport.

Those who use the surface transportation system are most vulnerable to highway transportation incidents. Travelers, truckers, delivery personnel, and commuters are at risk at all times when they are on the road. During rush hours and holidays, the number of people on the road in Iowa is significantly higher. This is also true before and after major gatherings such as sporting events, concerts, and conventions. Pedestrians and bystanders of the community are less vulnerable unless they are in the roadway. Any individual incident will have a direct impact on only a few people.

People and property in close proximity to the railway lines, crossings, sidings, switching stations, and loading/unloading points are most at risk of rail transportation incidents. Those away from railroad tracks and facilities are vulnerable only to large-scale incidents including those in which hazardous materials are involved. The railroad travels through the more populated parts of the county.

Operators and passengers of pleasure craft are vulnerable to a waterway incident. The environment is vulnerable to contents and fuels that come from boats and vehicles/equipment on the top of winter ice; however, only a very small percentage of the population is at risk of a single incident. Vulnerability may be reduced by the improved water rescue training and equipment capabilities of regional first response departments. Warning signs and law enforcement are also important mitigation measures.

Score for Rural Clarke County: 3	Score for Murray: 4	Score for Osceola: 3	Score for Woodburn: 4
Score for Clarke Schools: 4	Score for Murray Schools: 4	Score for SWCC: 4	Score for hospital: 4

Transportation Incident Area of Extent:
While the area of extent can vary greatly based on materials involved, size of plane, and location of crash, compared to many other hazards, an air transportation accident would occupy a relatively small area. The extent to which the impacts would be felt would depend on the materials involved. For example, if a cargo plane transporting volatile or hazardous substances were involved in an accident, the area of concern would be significantly larger than the area for an accident involving a small personal aircraft carrying stable materials. The most severe of accidents would likely affect only a few city blocks. In any case, only a small part of most jurisdictions would be directly affected.

Highway incidents are usually contained to areas on the roadway or directly adjacent to the roadway. Very few highway incidents affect areas outside the traveled portion of the road and the right-of-way. Extensive segments of the transportation system can be impacted during significant weather events, such as a large snowstorm, when multiple separate accidents occur. While incidents may affect a larger part of a small jurisdiction, like a small town, generally a typical crash will affect only 1% of the area. (When hazardous materials are involved, the impact is likely to a larger area. See the hazardous materials profile for more information.)

Vehicle/train collisions could impact areas within a few hundred feet of the railroad. It might include pedestrians, automobiles, and buildings near the tracks. While incidents may affect a larger part of a small jurisdiction, like a small town, generally a typical crash will affect only 1% of the area. (When hazardous materials are involved, the impact is likely to a larger area. See the hazardous materials profile for more information.)

The maximum extent of a waterway incident would be limited. Impacts would not extend beyond the immediate incident scene. The only exception would include a search and rescue event that could expand downstream. In the case of a hazardous material being released to the waterway, the impact could expand considerably but still would be a very small part of any jurisdiction.

Score for Rural Clarke County: 3	Score for Murray: 4	Score for Osceola: 4	Score for Woodburn: 4
Score for Clarke Schools: 5	Score for Murray Schools: 5	Score for SWCC: 5	Score for hospital: 5

Transportation Incident Severity of Impact:
The level of severity would depend on the type of transportation mode used. Air transportation incidents are likely to be the most destructive. Severity depends aircraft involved, the type of cargo being transported, and the area on the ground on which the accident occurred. Because of the limited number of response personnel in Clarke County, a crash of a major airliner would very quickly exceed local capabilities. For this assessment, the planning team looks at a mid-sized passenger plane flying over the county and crashing in a random location.

Highway transportation incidents claimed more lives in Clarke County than any other of the profiled hazards during the past 25 years. Often, they can be prevented through education, roadway improvements, law enforcement, and restrictions during severe weather, but some fatal accidents will still occur. The following severity assessment considers the worst types of incidents found in the county's history: a fatal multiple-vehicle incident during severe weather and rush hour traffic that results in closure of a main highway (I-35) and a detour through the county.

A rail transportation incident, especially one involving AMTRAK, could cause mass casualties of dozens to hundreds of people. In most past derailments or collisions, only a small percentage have died, but injuries have been tremendous and it has shut down the railroad tracks for hours to days, thereby delaying commerce.

The following is the severity assessment that considers the impacts of a waterway or water body incident involving multiple pleasure boats in adverse weather conditions that complicate response, search, and rescue. Because there are no high traffic lakes with high-speed boats and no cargo ships using waterways in the county, this risk is fairly low.

The following provides a summary of the severity of impact throughout the county. For the sake of discussion, it is assumed that no large quantities of hazardous materials are involved, as these are profiled elsewhere. If hazardous materials were involved, the severity would increase.

Figure 3.93: Transportation Incident Severity of Impact Scoring Matrix

Severity Criteria	Discussion	Score
Health and safety of the public	Multiple deaths and injuries are likely to almost any form of transportation incident. The lives and health of the pilot, crew, passengers, and the population on the ground would be at risk. There are very few injuries and fatalities when compared to the number of people involved in travel as a whole, but if there is an accident, it is very likely that injuries will be serious or fatal. During adverse weather conditions, people may not see a crash in front of them and may run into it, causing a big pile-up. Fires in vehicles, planes, and trains can cause more deaths and injuries. Exposure to cold and other conditions can exacerbate the problem until they are rescued and able to be taken in an ambulance. People are also at risk of further crashes on busy detour routes. In adverse weather conditions, people are more likely to drown or suffer hypothermia after an incident on a body of water.	4
Health and safety of responders	Response personnel would likely be exposed to fire hazards and other hazards associated with crashes such as sharp objects, glass, and confined spaces. Responders are at risk while traveling to the scene and while dealing with traffic, including directing detours. The sheer number of vehicles in the incident area presents increasing risk to those responding. Gawkers and other distracted drivers passing through can add to risk. Responders are also exposed to the severe weather that caused the crash. Because of the number of hours that law enforcement are on the road, they have a higher risk than do other response personnel in a given year. During cold weather or storms, water rescue personnel engaged in a rescue attempt are at even greater risk. Fuel spills can result in health and safety (fire or explosion) issues for those involved.	3
Continuity of operations	In all forms of transportation incidents, local government and partners are able to continue operating, but things like closed roads, exhausted rescue teams, and damaged infrastructure and facilities will have a short-term effect. A long-term effect is likely if a critical asset essential for continuity of operations takes a direct hit. The site or the community as a whole may be restricted until the rescue, salvage or possible cleanup/decontamination operations have been completed. For example, salvage operations may not be able to get underway until a successful testing and decontaminating operation is completed.	3
Property, facilities, infrastructure	Significant damage can also occur to property on the ground as well as the vehicles that crashed. Often buildings, fences, utility lines, and trees are damaged or destroyed in the event of a plane crash. The cargo aboard a plane, truck, or train that has crashed can also sustain damage or destruction. This too can be extremely costly. Property damage would be limited to vehicles and cargo involved; roads, bridges, and other infrastructure; utilities such as light and power poles; and other property adjacent to the accident scene such as buildings and yards. Bridges can be damaged and thus disrupt other transportation modes.	3
Delivery of services	In all forms of transportation incidents, services can be delayed if transportation routes are blocked, bridges are destroyed, or lengthy detours are required. Often local emergency responders suffer when response capabilities are tied up. There may be short term localized impacts if utility poles are affected and the like. Also, major routes, like I-35 and US 34, can be closed down, thus slowing transportation of people and materials for up to several hours. Cargo will be delayed significantly and services that depend on cargo can be diminished or delayed. Water search and rescue efforts could tie up considerable first response and medical resources. The area's only water rescue team, based in Ringgold County (45 minutes away), is composed of volunteers from all over the region.	3

Severity Criteria	Discussion	Score
Environmental impacts	Fuel and other fluids can be spilled from the affected vehicles and affect the environment, including air, water, and soil. When no HAZMAT is involved, the impacts are negligible in the long-term.	2
Economic/financial conditions	Damage would be much localized, and the economic impact to the local economy will be mostly due to damage of business property at the crash site. Damage to the aircraft itself is costly to the owner in terms of direct value lost and amount lost because the airplane is now out of commission. The area impacted could be isolated for weeks or months, thus hindering economic activity in the area. Business and traffic disruptions could last several days until the cleanup efforts are complete. In a waterway, if major contamination results or a lake were closed for recreation, the costs of cleanup and lost tourism spending could be considerable.	3
Regulatory/contractual obligations	Generally, transportation infrastructure, traffic regulations, vehicle regulations, and investigations are handled by agencies outside of the county or other local jurisdictions, including the FAA, US DOT, IDOT, IDNR, Iowa Highway Patrol, and Army Corps of Engineers. Therefore, the regulatory and contractual obligations issues should have minimal direct impact on the county.	1
Reputation	Reputation is based on effective and timely response. Crashes occur often enough that reputations will not be damaged unless the responders do a poor job, such as respond too slowly or without adequate resources or the detour and closure time is too excessive. When State and Federal agencies get involved, it is essential that a chain of command is established early, but if there is a failure, it can harm multiple agencies.	2

Score for Rural Clarke County: 24	Score for Murray: 24	Score for Osceola: 24	Score for Woodburn: 24
Score for Clarke Schools: 24	Score for Murray Schools: 24	Score for SWCC: 24	Score for hospital: 24

Transportation Incident Speed of Onset:

Most transportation incidents involving any of the modes included here (highway, air, rail, or waterway) will be unanticipated. Had they been anticipated, in most cases they would have been prevented. Because of this, these incidents will usually occur with no warning. There may be no or a limited amount of time to warn those in the pathway of the harmful effects.

Score for Rural Clarke County: 9	Score for Murray: 9	Score for Osceola: 9	Score for Woodburn: 9
Score for Clarke Schools: 9	Score for Murray Schools: 9	Score for SWCC: 9	Score for hospital: 9

Transportation Incident Duration of Event:

Transportation incidents will likely occur rather quickly from the time the incident begins until motion stops. Stopping oncoming trains and other immediate actions may prolong the incident up to several minutes to an hour. Securing the site and ensuring secondary crashes/cascading events don't occur will add minutes to even hours. The real immediate impact, to where responders have "things under control" might be 1 to 6 hours for incidents such as a major airliner crash or a train derailment.

Score for Rural Clarke County: 4	Score for Murray: 4	Score for Osceola: 4	Score for Woodburn: 4
Score for Clarke Schools: 4	Score for Murray Schools: 4	Score for SWCC: 4	Score for hospital: 4

Transportation Incident Total Scores:

The following total scores for transportation incident indicate moderate risk to the public and the planning area where incidents can occur.

Score for Rural Clarke County: 50	Score for Murray: 47	Score for Osceola: 48	Score for Woodburn: 47
Score for Clarke Schools: 47	Score for Murray Schools: 47	Score for SWCC: 47	Score for hospital: 47

Transportation Incident Vulnerability/Assets at Risk:

All structures, property, and people in the county, as outlined in Section 3.2, could suffer from the effects of transportation incidents. This is because an air transportation incident can occur anywhere. Clearly rail

transportation incidents, highway transportation incidents, and waterway incidents will only occur on those facilities or directly adjacent to them.

All critical assets in the county, as outlined in Section 3.2, are at risk of an air transportation incident. Generally, none of them are at direct risk from the other assessed modes, other than bridges and some buildings adjacent to major transportation routes.

Transportation Incident Loss Estimation:
The bulk of the losses from transportation incidents will be to human life and injury. Those at risk include drivers, pilots, engineers, and passengers of vehicles, trains, boats, and airlines as well as pedestrians and bystanders. During response, responders can also be injured or killed. In a plane crash, one or more people can be killed inside buildings or while exposed outdoors if they cannot get out of the way of the falling plane.

The U.S. Department of Transportation Federal Highway Administration issued a technical advisory in 1994 providing suggested estimates of the cost of traffic crashes to be used for planning purposes. These figures were converted from 1994 dollars to 2014 dollars using an annual inflation rate of 2.85 percent. The costs are listed below.

Figure 3.94: Loss Estimate by Transportation Incident Matrix

Severity	Cost Per Injury (in 2014 dollars)
Fatal	$4,171,814
Evident Injury	$57,782
Possible Injury	$30,487
Property Damage Only	$3,209 (mostly the vehicle(s) involved)

Source: U.S. Department of Transportation Federal Highway Administration Technical Advisory T 7570.2, 1994. Adjusted to 2014 dollars

Using this crash severity data combined with historical crash data outlined in the "historical occurrence" section of this profile, the planning team estimates the following loss data per year for the planning area:

- Fatalities (2.0 per year): $8,343,628.
- Major injuries: (5.0 per year): $288,910.
- Minor injuries (8.0 per year): $243,896.
- Property damage (50 per year): $160,450.

Based on this analysis, the estimated average annual cost of traffic accidents for the planning area is $9,036,884. Virtually all the losses will occur in rural areas, with 5% of losses in Osceola. At least half of the annual losses are anticipated on Highways 34 and I-35.

Associated costs of a highway transportation incidents include the economic cost of detours, the cost of response and cleanup, and possible environmental costs if hazardous materials are spilled or released. These costs can translate to functional use losses for local governments, response agencies, and businesses. In a given year, these costs can exceed $1 million.

Waterway incidents involving watercraft are unlikely because the local lakes are small and boats are limited to no-wake speed in most instances. More likely, the greatest future risk of life and health is due to falling off a small boat or falling through the ice. The regional water/ice rescue response capabilities are improving.

Airplane crashes involving more than a single-seated plane are more likely to cause significant casualties and destroy property but rarely occur. When they occur, up to and over 100 people on the plane can perish along with dozens or even hundreds on the ground, depending, of course, on where the plane crashes. Because of

many risks involved in response to major airliner crashes, it is very possible that responders could also die.

Future Development and Transportation Incident:
According to the *Impacts of Rural Development on Iowa's Secondary Road System*, September 2010, completed by Iowa State University, Institute for Transportation, the development of new rural agricultural and residential uses in rural areas, and now the development of wind turbines, increases construction-related and long-term new traffic patterns on secondary roads. Local development will not have a great impact in other local modes of transportation, and there are no plans to build new airports or railroads. Development is not likely to result in new railroad-road crossings.

3.6: Risk Assessment Summary

As can be seen, the various hazards can/will affect any or all of the population and assets in the county, depending on the nature of the impacts and locational restrictions placed on them. This section provides a summary of the potential impact. Please note that more information, such as flooding base floor elevations (BFEs) and soil types, is needed to identify specific risks and magnitude of impact on a particular property. This mitigation plan provides only the basic information that is known for the hazards and assets that are impacted.

This part of the plan addresses the following Stafford Act requirement:

Section 201.6I(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph I(2)(i) of this section. The description shall include an overall summary of each hazard and its impact on the community.

Total Scores and Hazard Priority Groupings

The following matrix shows the total scores for each profiled hazard as it impacts each jurisdiction.

Figure 3.95: Total Hazard Risk Assessment Scoring

Hazard	Rural Clarke Co.	Murray	Osceola	Woodburn	Clarke Schools	Murray Schools	SWCC	Clarke Co. Hospital
Dam/levee failure	50	--	50	--	--	--	--	--
Drought	54	51	52	51	51	51	51	51
Expansive soils	44	40	41	40	40	40	40	40
Extreme heat	55	55	55	55	51	51	51	51
Flood, flash	54	55	55	55	52	52	50	50
Flood, river	43	--	40	40	--	--	--	--
Grass and wildland fire	50	42	43	42	39	--	--	--
Hazardous materials incident	52	52	60	51	52	51	51	52
Infrastructure failure	64	61	63	61	63	63	62	63
Severe winter storm	60	59	59	59	58	58	58	58
Thunderstorm/Lightning/Hail	55	54	54	54	54	54	53	53
Tornado/Windstorm	64	65	65	65	65	65	65	65
Transportation incident	50	47	48	47	47	47	47	47

-- Hazard does not affect/occur in the jurisdiction.

The above table is simply a snapshot that allows the reader to compare the relative risks from various hazards by jurisdiction. It is not perfect. First, it only considers the direct impact of a hazard event, but in reality, hazard events often occur simultaneously and consecutively, causing triggered hazards. Second, the table shows the scores based on fixed criteria for each hazard without consideration of the differences among hazards. In other words, the scores are not meant to compare the hazards. Third, the results are based on

available information combined with planning team opinions of risk. Despite these factors, the scores in the table paint a picture of relative risk.

Using the State Hazard Mitigation Plan for guidance, the local planning team created a three-tier system to prioritize the hazards in terms of which should receive the most attention and resources in the hazard mitigation process over the next five years. The following illustrates the priority groupings.

Figure 3.96: Priority Groupings for Mitigation Actions Graphic

Priority Group 1	**Unacceptable Consequences**	Maximum possible effort should be given to eliminate unacceptable risk factors, including injury, death, economic loss, property loss, and other damages
Priority Group 2	**Risk Reduction**	Mitigation actions, when feasible and affordable, should be taken to address these, especially when they can be part of the effort to mitigate Priority 1 hazards.
Priority Group 3	**Risk Acceptance**	Typically, these hazards are not a focus with the limited resources available but might be addressed incidentally as part of Priority 1 hazard mitigation efforts.

Priority Group 1 hazards, as identified by jurisdiction, should be the focus of sustained and new mitigation actions, and the remaining parts of the plan considers the risks to the jurisdictions due to Priority Group 1 hazards. It is important to understand that not all hazards affect individual jurisdictions in the planning area equally; therefore, the Priority 1 hazards vary by jurisdictions. The classifications result from the total individual hazard scores for each jurisdiction, as shown a few paragraphs earlier.

The following matrix shows the risk assessment ratings and priority groups for all participating jurisdictions. The hazards are listed by jurisdiction alphabetically by type. Natural hazards are *italicized*.

Figure 3.97: Priority Groupings Matrix by Jurisdiction

Jurisdiction	Priority Group 1 Hazards	Priority Group 2 Hazards	Priority Group 3 Hazards
Rural Clarke County	*Drought* *Flood, Flash* *Flood, River* ** Hazardous materials incident Infrastructure failure *Severe winter storm* *Thunderstorm/lightning/hail* *Tornado/windstorm*	*Dam/levee failure* *Extreme Heat* *Grass and wildland fire* Transportation incident	*Expansive soils*
Murray	*Flood, Flash* Infrastructure failure *Severe winter storm* *Tornado/windstorm*	*Drought* *Extreme Heat* Hazardous materials incident *Thunderstorm/lightning/hail* Transportation incident	*Expansive soils* *Grass and wildland fire*
Osceola	*Flood, Flash* *Flood, River* ** Hazardous materials incident Infrastructure failure *Severe winter storm* *Tornado/windstorm*	*Dam/levee failure* *Drought* *Extreme Heat* *Thunderstorm/lightning/hail* Transportation incident	*Expansive soils* *Grass and wildland fire*
Woodburn	*Flood, River* ** Infrastructure failure *Severe winter storm* *Tornado/windstorm*	*Drought* *Extreme Heat* *Flood, Flash* Hazardous materials incident *Thunderstorm/lightning/hail* Transportation incident	*Expansive soils* *Grass and wildland fire*
Clarke Schools	Infrastructure failure *Severe winter storm* *Tornado/windstorm*	*Drought* *Extreme Heat* *Flood, Flash* Hazardous materials incident *Thunderstorm/lightning/hail*	*Expansive soils* *Grass and wildland fire*

Jurisdiction	Priority Group 1 Hazards	Priority Group 2 Hazards	Priority Group 3 Hazards
		Transportation incident	
Murray Schools	Infrastructure failure *Severe winter storm* *Tornado/windstorm*	*Drought* *Extreme Heat* *Flood, Flash* Hazardous materials incident *Thunderstorm/lightning/hail* Transportation incident	*Expansive soils*
SWCC – Osceola Campus	Infrastructure failure *Severe winter storm* *Tornado/windstorm*	*Drought* *Extreme Heat* *Flood, Flash* Hazardous materials incident *Thunderstorm/lightning/hail* Transportation incident	*Expansive soils*
Clarke Co. Hospital	Infrastructure failure *Severe winter storm* *Tornado/windstorm*	*Drought* *Extreme Heat* *Flood, Flash* Hazardous materials incident *Thunderstorm/lightning/hail* Transportation incident	*Expansive soils*

*** In most jurisdictions, the committee recommended a lower rating for river flood hazards; however, they are being mitigated as part of this plan (Chapter 4) as a NFIP requirement.*

Annual Loss Estimation

This section itemizes the results of possible *direct* structural, economic/functional use, and human losses on an annual basis from the hazards outlined in the hazard profile. Direct effects are those resulting from the hazard, not including cascading events. When using the formula, Damage per Event X (multiplied by) Number of Events Per Year, we can come up with the total losses in one year. Doing this provides a clearer picture of which hazards are likely to impact the community in a given year in terms of expected losses in today's dollars.

The following table shows the annual estimate for total losses by hazard inclusive of direct property losses, functional use losses, and losses in terms of human fatalities and injuries. This is very subjective and should only be used for discussion purposes.

Figure 3.98: Total Annual Loss Estimate by Hazard by Jurisdiction

Hazard	Rural Clarke Co.	Murray	Osceola	Woodburn	Clarke Schools	Murray Schools	SWCC	Clarke Co. Hospital
Dam/levee failure	$100,000	--	$25,000	--	--	--	--	--
Drought	$5 M	$20,000	$1 M	$10,000	$1,000	$1,000	$500	$1,000
Expansive soils	$150,000	$20,000	$100,000	$10,000	$2,000	$1,000	$500	$1,000
Extreme heat	$2 M	$200,000	$2 M	$100,000	$25,000	$25,000	$5,000	$10,000
Flood, flash	$1.5 M	$250,000	$1 M	$125,000	$10,000	$10,000	$1,000	$2,500
Flood, river	$1 M	--	$100,000	$100,000	--	--	--	--
Grass and wildland fire	$500,000	$5,000	$25,000	$2,500	$250	--	--	--
Hazardous materials incident	$500,000	$25,000	$500,000	$10,000	$10,000	$1,000	$1,000	$10,000
Infrastructure failure	$3 M	$250,000	$1 M	$125,000	$15,000	$10,000	$5,000	$5,000
Severe winter storm	$4 M	$500,000	$1 M	$250,000	$100,000	$50,000	$2,500	$10,000
Thunderstorm/Lightning/Hail	$1 M	$100,000	$250,000	$50,000	$25,000	$15,000	$5,000	$10,000
Tornado/Windstorm	$4 M	$500,000	$1 M	$250,000	$100,000	$50,000	$25,000	$40,000
Transportation incident	$6 M	$100,000	$1 M	$25,000	$10,000	$5,000	$2,500	$2,500
Totals	$28.750 M	$1.97 M	$9 M	~1.06 M	$298,250	$168,000	$48,000	$92,000

-- Hazard has no direct effect on this jurisdiction.

The total loss in the planning area per year is $41,383,750. Of this total estimated annualized loss, two-thirds is human loss, which is what makes transportation incident, extreme heat, and severe winter storm so high. Approximately 60% the overall loss will occur in the rural unincorporated area. The hazards with the greatest overall loss (over $4 million) in the planning area are as follows:

- Transportation incident: $7,145,000
- Drought: $6,033,500
- Tornado/windstorm: $5,965,000
- Severe winter storm: $5,912,500
- Infrastructure failure: $4,410,000
- Extreme heat: $4,365,000

See the individual hazard profiles to read more detailed information about hazard losses by type of structure, infrastructure, and other types of losses and how future development may affect the future losses for each hazard.

The above loss table is not created for insurance purposes or detailed planning and budgeting. At best, the table should be used for comparison purposes when developing goals and objectives. Losses that cannot be included in such tables are considerations such as emotional anguish, losses of records and irreplaceable items, losses to pristine forests, water quality deterioration, and pollution creation. For many hazards a large area is at risk, but damage to any property will be very limited, and hazard effects would be mostly economic and operational. Items like water and sewer systems may or may not be damaged by an event, and it may be difficult to determine whether the deterioration of underground systems is due simply to age or from hazard events over the years.

Description of the Nature of Vulnerability to Key Hazards

This final section categorized, as much as possible, the effects the profiled hazards have on the physical planning area. It is important to understand the nature of vulnerability that considers the impact of hazards in terms of <u>*how*</u> they affect the community most. While each hazard can cause damage to the planning area, the risks vary greatly by hazard. While any hazard event can impact a number of asset types, the overall risk is higher in some categories than in others. The following table provides a summary of the relative nature of hazard risk among six categories. This gives the reader an idea that, while one hazard might destroy more property than another, the overall impact of any hazard is significant when we consider sometimes overlooked impacts. This helps fulfill the "overall summary of each hazard and its impact on the community" requirement of Section 201.6(c)(2)(ii) of the Stafford Act.

Figure 3.99: Description of Overall Vulnerability by Hazard

Hazards (*natural italicized*)	**Jurisdictions Affected**	**Areas at Risk**	**People**	**Structures**	**Land, Resources**	**Economic**	**Personal Property**	**Intangible, Quality of Life ***
Dam/levee failure	Rural, Osceola	The impoundment itself and several miles downstream		1	2			3
Drought	All	Widespread/anywhere			2	1	3	
Expansive soils	All	Most areas of the county, but depends on soil type		1		3	2	
Extreme heat	All	Widespread/anywhere	1	3		2		
Flood, flash	All	Widespread, but depends on topography and surface conditions	3	1	2			
Flood, river	Rural, Osceola, Woodburn	Within identified flood hazard areas		2	1	3		
Grass and wildland fire	Mainly rural, not Murray School or	On or near un-managed vegetation, crop, wildland areas; interface areas		3	1	2		

Hazards (*natural italicized*)	Jurisdictions Affected	Areas at Risk	People	Structures	Land, Resources	Economic	Personal Property	Intangible, Quality of Life *
	hospital							
Hazardous materials incident	All	1,000 feet of fixed sites and transportation routes	1	2		3		
Infrastructure failure	All	Widespread, anywhere where infrastructure is found	2	1		3		
Severe winter storm	All	Widespread/anywhere	2	3		1		
Thunderstorm/lightning/ hail	All	Widespread/anywhere	2	1		3		
Tornado/windstorm	All jurisdictions	Widespread/anywhere	1	2			3	
Transportation incident	All jurisdictions	Widespread/anywhere (air), on or near transportation routes (others)	1	3			2	

** Intangibles are things of intrinsic value: vital/financial records, emotional loss, personal financial loss, fear and intimidation, reputation, etc.*

The planning team assessed the risks caused by 13 hazards in the planning area. Many of these hazards have acceptable levels of risk or are already being mitigated using current mitigation measures. However, each jurisdiction used the results from this chapter to select several "Priority I" hazards that will be the focus of a five-year mitigation strategy, outlined in the next chapter. For this remainder of this plan, only Priority I hazards, as selected by each jurisdiction, will be considered. Other hazards, while causing harm to the planning area, are not the focus of the strategy.

In conclusion, it is important to remember that specific assets will be affected by specific hazards depending on factors, such as the type of building materials, roofing, size of site, elevation, soils on which asset is located, slopes, quality of construction, topography, and location related to hazard zones (for fires, floods, etc.). This data is not always readily available, nor can it be analyzed easily, and it is not often needed for the level of planning performed here. What is presented is a basis for prioritizing mitigation actions and ensuring they make sense with the data available. More detailed analysis is necessary for specific mitigation projects involving specific infrastructure. This being said, Clarke County has extensive assets that can be impacted by many different hazards, and the remaining part of this plan should be focused on addressing those assets at direct risk due to the hazards that cause the most harm.

Risk Assessment Problem/Issue Statements

Based on the information in this chapter, we have identified statements that summarize the impact of hazards in the county. The following statements lead to the development of goal statements in the next chapter. Only hazards identified as Priority I hazards for at least one jurisdiction are included in this statement. Also, there are several statements related to hazards in general.

Issue Statements for All Hazards:

- Because of the limited resources for some jurisdictions, some hazards that may be of concern were not rated as Priority 1 hazards. Some jurisdictions, such as small communities and schools, are forced to focus just on a few hazards in the next five years.
- The need exists to continue to improve severe weather awareness. People seem to become too reliant on their cell phones and no longer observe weather conditions. If cell coverage fails during severe weather, people may not know what is going on.

- The large and growing senior population presents a disadvantage of concern to the committee when it comes to hazard mitigation because of the greater difficulty to alert them, their reduced mobility, and greater risk of spreading human disease. The same can be said for the growing non-English speaking Hispanic population due to language and cultural barriers.
- We have the key assets in place, such as modern utilities, a modern hospital, and modern emergency services, but keeping the people to serve in these roles in rural areas is very difficult. Keeping training current is a concern for committee members.
- Groups like SICOG can provide valuable help with grant applications for mitigation projects, but obtaining state and federal assistance can be difficult because the programs and funding streams constantly change.
- The lack of funding at the state and federal level in the past few years diminishes the incentive to continue this level of future hazard mitigation planning.

Issue Statements for Drought:

- Drought is a key concern for the county and has the most direct impact on the rural areas, where mitigation measures are most likely to be implemented. It is a Priority 1 hazard in rural Clarke County.
- Drought remains a main issue mostly because the county's water supply is projected to fall below sustainable level in the next ten years. Consequently, a plan has been in progress for many years to build another large reservoir to supply water needs for farmers and communities.
- Drought is one of the most damaging hazards in rural areas and overall in the county (second highest in the overall loss estimation), especially in terms of crop and economic losses.
- The county remains very much surface water dependent due to the considerable need for agricultural and industrial process needs.

Issue Statements for Flood, Flash:

- Flash flooding is a Priority 1 hazard for rural Clarke County and all three municipalities.
- Flash flooding is a growing problem due to the increasing risk of extreme rain events and continued population growth and development, which makes more of the land in the county impervious.
- Recognizing the problem, Murray and Osceola is implementing storm water projects to reduce urban flash flooding, but resources are insufficient to address the scope of the problem.
- Flash flooding is not responsible for as much in overall losses as other hazards but does enhance the level of loss sustained by infrastructure failure, which is among the greatest in the county of the profiled hazards.
- Flash flooding is one of the greatest causes of physical and infrastructure losses.

Issue Statements for Flood, River:

- This is considered a Priority I hazard wherever SFHAs exist, because FEMA has a strong interest in implementing the NFIP nationally. These communities include: rural Clarke County, Osceola, and Woodburn.
- Annual loss due to river flood is modest compared to other hazards because the rivers of the county are small. Most of the losses are property losses, especially bridges and culverts in rural areas. A large part of the county budget is used for maintenance of rural roads, culverts, and bridges.
- Adopted regulatory maps are in place, which will make mitigation easier over the next five years.

Issue Statements for Hazardous Materials Incident:

- Rural Clarke County and Osceola rated hazardous materials incident as a Priority I hazard.

- Annual loss due to hazardous materials incident is in the low range because most incidents are handled quickly without widespread damage. However, the threat of a significant event is very high due to the many busy highways, the railroad, and manufacturing facilities.
- Local capabilities, mainly trained and certified staffing and volunteers, are limited. The County's contracted professional response team, SIRG of Ottumwa, is 1.5 hours driving distance from Clarke County.
- Traffic detours and evacuations can tax local responder resources to the limit and increase risk of hazards in other areas where detours and new traffic flow.
- Hazardous materials incidents will also cause or worsen water quality issues, which are a considerable local concern.

Issue Statements for Infrastructure Failure:

- All jurisdictions rated infrastructure failure as a Priority I hazard.
- Annual loss due to infrastructure failure is in the middle to high range for the various hazards (just over $4.4 million).
- The breadth of infrastructure included in this hazard and that so much of the vital infrastructure is exposed to other hazards elevates its importance for mitigation.
- The respondents of the online survey about hazards indicated that this hazard is the second most likely to cause economic damage and social unrest in the county, with four of 18 respondents giving this hazard the top ranking and four giving it the second highest ranking.
- The local and national population and economy are more dependent on reliable and efficient infrastructure than ever before in our connected world.
- Even a few minutes of energy failure can cause casualties in populations of elderly, sick, or others in special care who rely on oxygen and other technology. Few facilities have fixed power generators.
- There is a lack of human resources (staff or volunteers) in event of major event that causes extensive utility/infrastructure damage throughout the county.
- Severe thunderstorms, windstorms, and winter storms damage power lines all over the county nearly every year. An Alliant Energy representative stated this hazard is a very major concern in all parts of the county because of the exposed power lines. He shared that the company would have difficulty getting enough help to the county to restore power and fix a widespread failure.
- Energy failure slows local emergency response time and affects communications facilities.
- Many buildings are very old and/or lack proper maintenance and are at higher risk of failure or fire.
- Fire departments rely on limited funding and limited numbers of volunteers, many of which are not available when a fire alarm sounds.
- Transportation incidents, which are estimated to have the greatest annual loss, due to loss of human life, are often the result of infrastructure failure.

Issue Statements for Severe Winter Storm:

- All the jurisdictions rated severe winter storm as a Priority I hazard.
- Annual loss due to severe winter storm is the fourth highest for the various hazards (over $5.9 million).
- Humans are very susceptible to severe winter weather, especially seniors who live in homes that lose power or that go outside when it is slippery and travel on slippery roads.
- The respondents of the online survey about hazards indicated that severe winter storm is among the two four most likely to cause deaths and injuries in the county, with seven of 18 respondents giving this hazard a top three ranking.
- Winter weather in general costs local government tens to hundreds of thousands of dollars annually in road clearing and repair costs alone.

- Clarke County has many homes built before insulation was used. These homes can be very cold and can pose a hazard to infants, elderly, and sick persons. Weatherization programs are available but cannot possibly meet all the need with funding limitations.
- Ice and snow cause many highway transportation incidents in the county each year, some of them fatal.
- Smaller towns and remote rural areas are affected more because of the lack of alternative power sources and emergency services. Emergency services have difficulty traveling and working in severe winter weather.
- Early and late season (April and September) winter weather can cause extensive crop loss.

Issue Statements for Thunderstorm/Lighting/Hail:

- Rural Clarke County rated thunderstorm/lighting/hail as a Priority I hazard, mostly due to the added threat to crops due to hail.
- Annual loss due to thunderstorm/lighting/hail is in the lower range of the range for the various hazards (nearly $1.5 million).
- The respondents of the online survey about hazards indicated that this hazard is one of the two most likely to cause property and infrastructure damage in the county, with four of 18 respondents giving this hazard the top ranking and five giving it the second highest ranking.
- It is believed that climate change issues will continue to spawn more damaging severe storms with more large hail and dangerous lightning as well as excessive downpours.
- In an increasingly wired society, the risks of energy and communications failure due to lighting continue to increase. More and more equipment, towers, and utility lines are exposed to lightning, hail, and high winds.

Issue Statements for Tornado/Windstorm:

- All the jurisdictions rated tornado/windstorm as a Priority I hazard.
- Annual loss due to tornado/windstorm is third highest for the various hazards (over $5.9 million).
- The respondents of the online survey about hazards indicated that tornado/windstorm is by far the most likely to cause deaths and injuries in the county, with eight of 18 respondents giving this hazard the top ranking and four giving it the second highest ranking.
- The respondents of the online survey about hazards indicated that this hazard is one of the two most likely to cause property and infrastructure damage in the county, with six of 18 respondents giving this hazard the top ranking and two giving it the second highest ranking.
- The respondents of the online survey about hazards indicated that this hazard is the most likely to cause economic damage and social unrest in the county, with seven of 18 respondents giving this hazard the top ranking and three giving it the second highest ranking.
- Rural recreational areas generally are not served by any kind of outdoor warning system. Cell-based systems work well only where service is available and when towers are not damaged by storms.
- No FEMA safe rooms exist in the county. While there are other sturdy buildings, and most homes have basements and/or cellars, few properties are designed to protect people from large tornados that can exist. Most homes are aging and no longer sturdy.
- Planning team members continue to point to the seemingly increasing intensity and frequency of severe weather, including tornadoes and high wind events.

Certainly, there are risks and problems related to other hazards on the identified hazard list, and some of them are profound. They should not be ignored but rather should be addressed as necessary outside of or incidental to the implementation of this plan. Thankfully, most of the issues caused by other hazards are addressed by other existing plans and mitigation efforts.