Purpose

This hazard mitigation plan's risk assessment depicts each participating entity's risk to each of the profiled hazards. These calculated risks serve as the justifying basis for the proposed mitigation activities and projects found in Section 4. Additionally, this risk assessment can further serve Cedar County and the plan's participating entities by aiding in decision making processes of other planning initiatives.

Intent

The hazards profiled within this section were identified and selected based on their ability to reasonably affect the entire planning area or portions of Cedar County and its communities. If a hazard has been excluded or removed, justification has been given.

To properly and accurately depict each hazard's risk, Two Rivers Emergency Management employed various methodologies appropriately tailored by hazard application. Generally, each hazard profile: describes the type, location, and extent the hazard; includes information on previous occurrences of hazard events and estimates on future occurrence; describes a hazard's estimated impact; assesses each participating entity's vulnerability to a hazard; and analyzes how changes in development have affected an area since the development of Cedar County's last hazard mitigation plan.

Each hazard profile conforms to FEMA's requirements as set forth in its Local Mitigation Plan Review Guide, Elements B1 through B3, and B4 and D1 where applicable.

3.1 – Methodology

The natural characteristics of each hazard dictate that not one single approach works to accurately depict risk. In general, the hazard profiled in this plan can be categorized as either area-wide hazards or those with discretely identified hazard areas.

Area-Wide Hazards

Area-wide hazards indiscriminately impact the entire planning. Since it is beyond scientific measurement where an area-wide hazard, such as winter storms, will impact, and likely it will impact everywhere, it is reasonable to assume any significant growth and development will increase vulnerability and risk. Additionally, a hazard such as a tornado, will impact a specific path, but we are unable to predict where exactly it will begin. Thus, having any increase in growth or development increases the chance that a tornado will strike a developed segment of a jurisdiction. For this plan, this is relevant for droughts, flash flooding, tornadoes, severe storms, and winter storms.

Hazards with Identified Hazard Areas

If a jurisdiction grows or develops into an established dam spillway, floodplain, WUI zone, or an area with greater linear extensibility, that jurisdiction's vulnerability and risk increase by an amount equal to

the development or growth that now exists in that identified hazard area. For this plan, this is relevant for riverine flooding and wildfires.

3.2 – Hazard Selection

Appropriately identifying and selecting which natural hazards will be assessed is the first step in developing a risk assessment. The State of Iowa's Homeland Security and Emergency Management Department profiles twelve natural and seven human-caused hazards in its statewide hazard mitigation plan. Of those hazards, this plan profiles six of those hazards.

Cedar County has been designated as an affected area by federal declaration seventeen times. These declarations show a broad picture of the which hazards pose the greatest threat to the planning area. The table below lists each federal disaster declaration, the hazards which caused the impact, and the dates of the events:

Table 3.1 – Disaster Declarations

Designation	Declaration	Hazards	Start Date	End Date
DR-4557	10/05/2020	Severe Storms	08/10/2020	-
DR-4483	03/17/2020	Pandemic	03/17/2020	-
EM-3480	03/13/2020	Pandemic	01/20/2020	-
DR-4187	08/05/2014	Flooding, Severe Storms, Tornadoes	06/26/2014	07/07/2014
DR-4135	07/31/2013	Flooding, Severe Storms, Tornadoes	06/21/2013	06/28/2013
DR-4119	05/31/2013	Flooding, Severe Storms	04/17/2013	04/30/2013
DR-1763	05/27/2008	Flooding, Severe Storms, Tornadoes	05/25/2008	08/13/2008
DR-1737	01/04/2008	Severe Winter Storms	12/10/2007	12/11/2007
DR-1688	03/14/2007	Severe Winter Storms	02/23/2007	03/02/2007
DR-1518	05/25/2004	Flooding, Severe Storms, Tornadoes	05/19/2004	06/24/2004
DR-1420	06/19/2002	Flooding, Severe Storms	06/03/2002	06/25/2002
DR-1230	07/02/1998	Flooding, Severe Storms, Tornadoes	06/13/1998	07/15/1998
DR-1121	06/24/1996	Flooding	05/08/1996	05/28/1996
DR-996	07/09/1993	Flooding, Severe Storms	04/13/1993	10/01/1993
DR-986	04/26/1993	Flooding, Severe Storms	03/26/1993	04/12/1993
DR-868	05/26/1990	Flooding, Severe Storms	05/18/1990	07/06/1990
DR-443	06/24/1974	Flooding, Severe Storms	06/24/1974	06/24/1974

*The data are from the Federal Emergency Management Agency

Selecting only hazards that pose a reasonable risk to the planning area allows the mitigation strategy found in Section 4 to focus Cedar County's capabilities and resources where they are needed most and can be the most effective. We found those hazards to be: Droughts, Floods (River and Flash), Severe Storms (Hail, Thunderstorms, and Windstorms), Severe Winter Storms, Tornadoes, and Wildfires.

The table below lists all of the natural hazards included in the statewide plan, whether they are included in this plan, and if excluded, a summary justification of why it has been excluded. A lengthier justification for exclusion can be found later in this section, 3.9 – Excluded Hazards.

Table 3.2 – Hazard Inclusion

Hazard	Determination	Summary Justification
Dam & Levee Failure	Excluded	No High Hazard Dams
Drought	Included	Disaster History
Earthquakes	Excluded	No reasonable risk
Expansive Soils	Excluded	No reasonable risk
Landslide	Excluded	No reasonable risk
River & Flash Flood	Included	Disaster History
Severe Winter Storms	Included	Disaster History
Sinkholes	Excluded	No reasonable risk
Thunderstorms	Included	Disaster History
Tornado & Windstorm	Included	Disaster History
Wildfires	Included	Risk Identified
Winter Storms	Included	Disaster History

3.3 – Droughts

Drought is an abnormally dry period lasting months or years when an area has a deficiency of water and precipitation in its surface and or underground water supply. The hydrological imbalance can be grouped into the following non-exclusive categories.

Agricultural: When the amount of moisture in the soil no longer meets the needs of previously grown crops.
Hydrological: When surface and subsurface water levels are significantly below their normal levels.
Meteorological: When there is a significant departure from the normal levels of precipitation.
Socio-Economic: When the water deficiency begins to significantly affect the population.

Droughts are regularly monitored by multiple federal agencies using a number of different indices. Typically, they are seasonally occurring in the late spring through early fall. Drought monitoring focuses on precipitation and temperature. When precipitation is less than normal, and natural water supplied begins to decease, a drought is occurring.

When below average, little or no rain falls, soil can dry out and plants can die. If unusually dry weather persists and water supply problems develop the time period is defined as a drought. Human activity such as over farming, excessive irrigation, deforestation, and poor erosion controls can exacerbate a drought's effects. It can take weeks or months before the effects of below average precipitation on bodies of water are observed. Depending on the region droughts can happen quicker, noticed sooner, or have their effects naturally mitigated. The more humid and wet an area is, the quicker the effects will be realized. A naturally dry region, which typically relies more on subsurface water will take more time to actualize its effects.

Periods of drought can have significant environment, agricultural, health, economic, and social consequences. The effects vary depending on vulnerability and regional characteristics. Droughts can also reduce water quality through a decreased ability for natural rivers and streams to dilute pollutants and increase contamination. See the list below for the most common effects of droughts.

- Diminished crop growth or yield
- Erosion
- Dust storms
- Ecosystem and environmental damage
- Increased probability of wildfires
- Reduced electricity production due to reduced flow through hydroelectric dams
- Shortages of water for industrial production

Location & Extent

Drought is part of normal climate fluctuations in the United States. According to Cedar County's drought history, most drought events affect the state for roughly 2 to 6 weeks in length. It should be noted, though, that climatic variability and the uncertainty of the future could contain dry conditions for

up to years at a time. Droughts occur over large geographic areas. It is extremely likely that if any part of the planning area is experiencing a drought that the whole planning area will also be experiencing drought conditions.

Historically, droughts have been measured by a number of indices, most notably the Palmer Drought Severity Index. However, NOAA currently uses an updated drought severity classification, the Drought Monitor Scale, shown below. Given the complex nature and unpredictability of droughts, the planning area can be affected by a drought ranging from D0 to D4 on the Drought Monitor Scale.

Table 3.3 – Drought Monitor Scale

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

Drought warning is based on a complex interaction of many different variables, water uses, and consumer needs. Drought warning is directly related to the ability to predict conditions that produce drought, primarily precipitation and temperature. A drought is not official or declared until dry conditions have been met for a period of time, meaning that it is inherent that the planning area would be experiencing drought conditions prior to a drought being officially declared.

History & Probability

Comprehensive data on droughts, drought impacts, and drought forecasting is extremely limited and often inaccurate. Due to the complexity of drought monitoring, the complexity of agricultural and livestock market pricing, and the large areas droughts impact, the USDA and USGS have difficulty quantifying and standardizing drought data. Each of these contributing drought factors has confounding variables within them.

Since 2000, the NADM has recorded 365 weeks of drought in the planning area with an average index of 1.57. Please see the table on the following page for a breakdown of the severity of the recorded droughts. For a complete list of recorded drought events, please reference Appendix C.

Table 3.4 – Drought History

Drought Severity	Number of Weeks
D0	167
D1	84
D2	80
D3	34
D4	0
Total =	365

*The data are from the NADM.

Given the historic precedent set by past droughts, it is highly likely that the planning area will experience season-long droughts in the future. As a rough estimate, the planning area should expect to see on average 19 weeks of drought per year or roughly 35% of each year.

Vulnerability of and Impact on Facilities

Droughts do not have an impact on structures.

Vulnerability of and Impact on Critical Facilities

Droughts do not have an impact on structures.

Vulnerability of and Impact on Population

Droughts do not have a direct impact that threatens injury or death to the planning area's population.

Vulnerability of and Impact on Systems

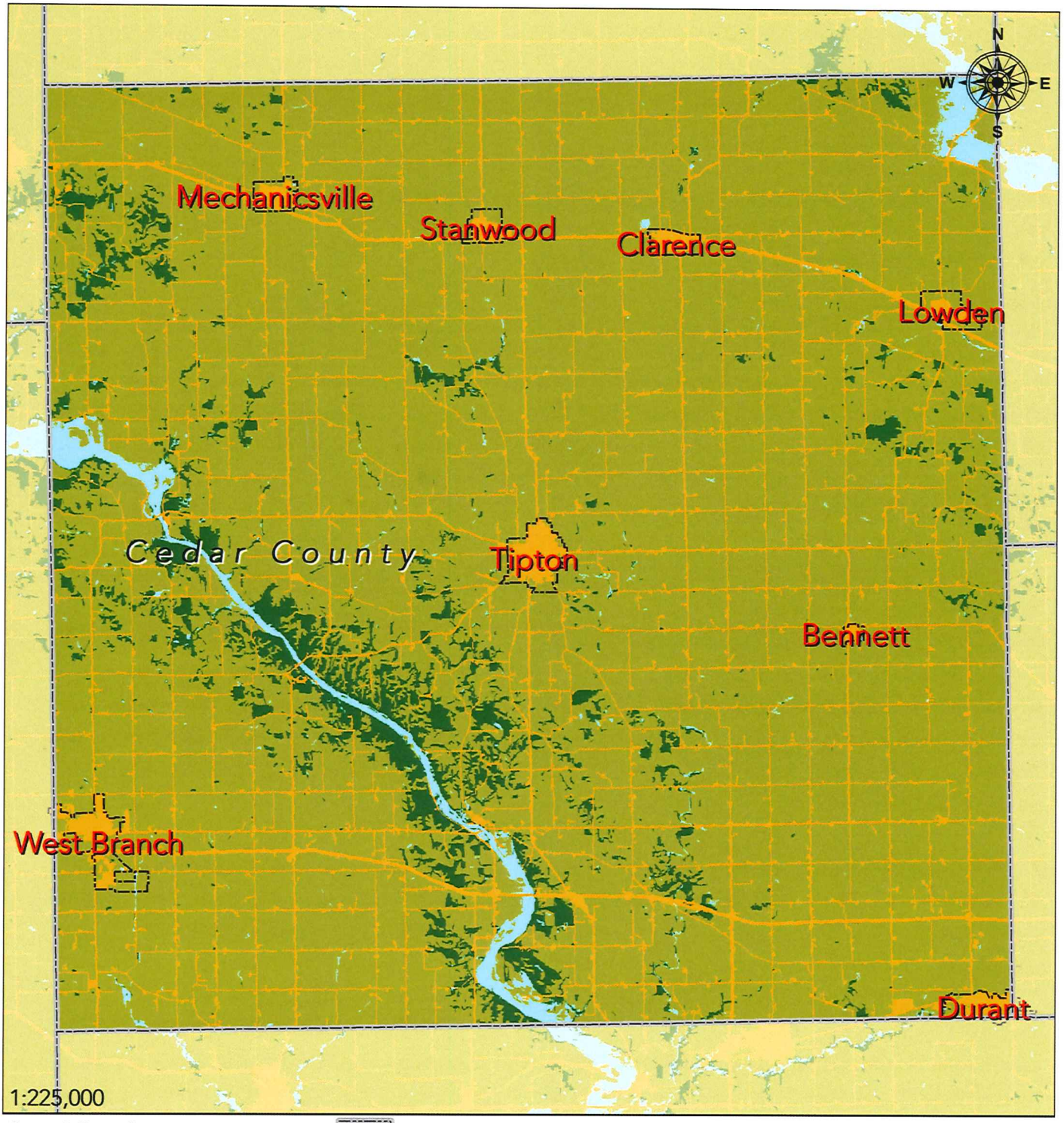
Drought's primary impact is on agriculture and livestock and thus can have significant effects on a jurisdiction's agricultural and tourist economies. If the precipitation level is below normal, farmers and ranchers will struggle to grow their crops and feed their livestock. If rivers, streams, and lakes dry up, tourists will be less likely to enjoy a jurisdiction's amenity resources.

The planning area hosts 943 farms across 340,387 acres of land. The USDA estimates that the total value of products from these farms is $321,521,000 per year. All of them are considered vulnerable to droughts. An estimate of the land engaged in agricultural activities can be found in the map at the end of this section.

Key Considerations

The entire planning area is at risk to droughts. Even though the direct impact of a drought will likely affect the county at large and tertiarily the municipalities, a drought's effects would quickly spread to the interdependent economies. Additionally, a greater population would place various communities at a higher vulnerability to droughts, the usage of water by the population pales in comparison to the amount used by agricultural activities and is largely negated.

Map 3.1 – Land Use, Cedar County



3.4 – Floods

Flooding is the most prevalent and costly disaster in the United States. Flooding occurs when water, due to dam failures, rain, or melting snows, exceeds the absorptive capacity of the soil and the flow capacity of rivers, streams or coastal areas. At this point, the water concentration hyper extends the capacity of the flood way and the water enters the floodplain. Floods are most common in seasons of rain and thunderstorms.

Intense rainfall, accompanying the large thunderstorms in the planning area, may result in water flowing rapidly from higher elevations, exceeding river flow capacity, collecting in agricultural areas, inadequate municipal stormwater drainage, or inadequate soil absorption capacity caused by urban and suburban development.

Location & Extent

Various types of floods can happen quickly, under an hour, in the form of a flash flood, or accumulate seasonally over a period of weeks as is the case in a riverine flood. Flooding can occur anytime throughout the year, but typically happens May through August. A variety of factors affect the severity of flash and riverine flooding. These include topography, weather characteristics, development, and geology. Intense flooding will create havoc in any jurisdiction affected. The predicative magnitude of flash and riverine floods varies greatly.

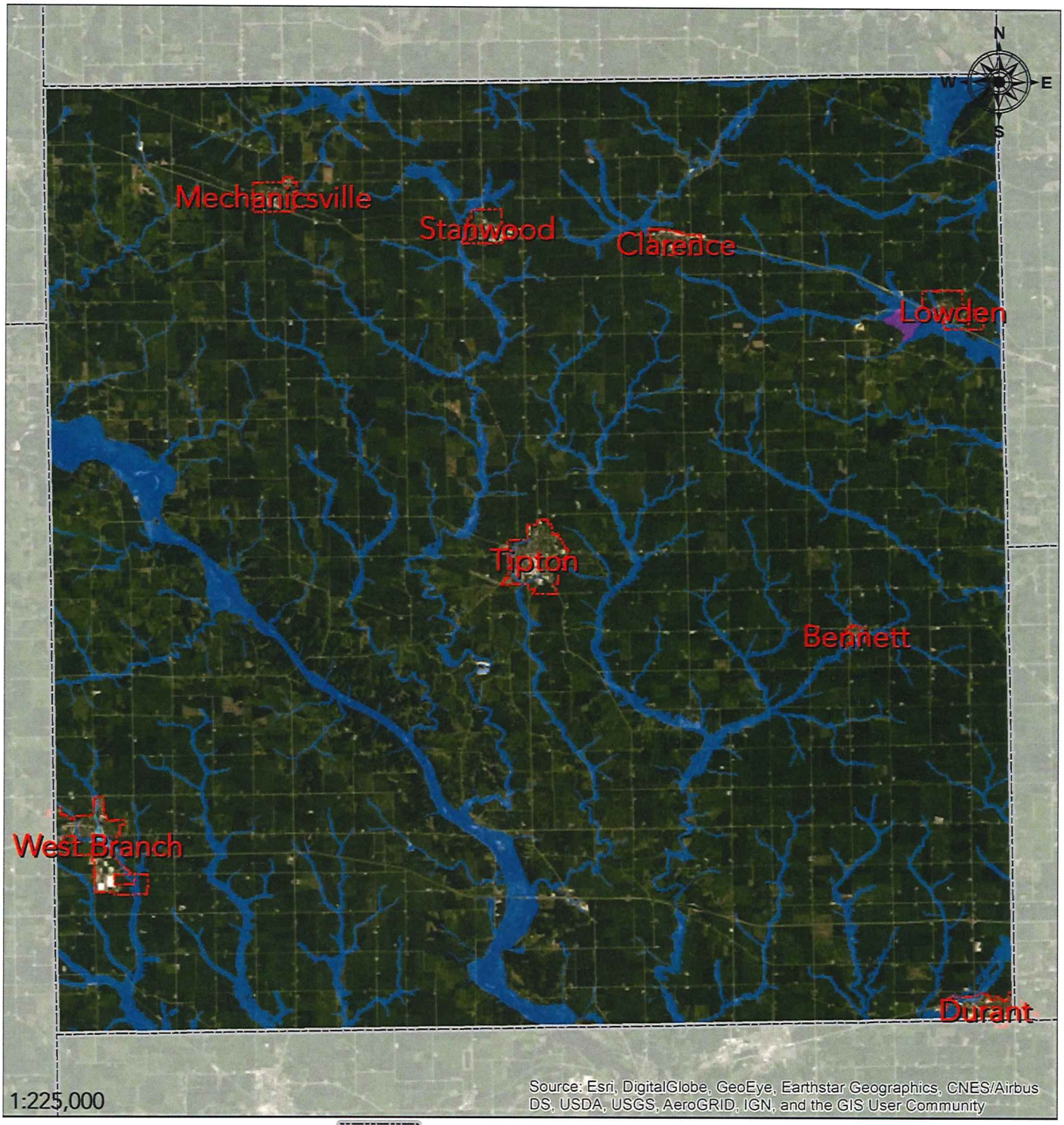
Flash flooding is unpredictable and can occur anywhere throughout the planning area. Cedar County, its municipalities, and the CSDs are generally equally likely to experience flash flooding in low-lying areas, areas of poor drainage, or suburban sprawl.

Road closures are common after flooding events. Flooding records show Highways 30 and 38 have been closed numerous times as have many rural, county roads. Some reports detail full waterflow over these highways. Gravel roads have been washed out and bridges have been washed away south of Sunbury and in the county outside of Lowden.

NOAA flash flood records indicate that rural parts of the planning area have seen up to 2 feet of accumulation, Lowden and Mechanicsville's downtown areas have seen repeated flash flooding as has many of their resident's basements. Repeated road washouts have been recorded in Durant, Lowden, and Tipton.

Riverine flooding throughout the planning area varies, but has had less of a historical effect on the planning area. Special Flood Hazard Areas (SFHA) were identified via effective NFHL maps produced by FEMA and are located later in this hazard profile. FEMA's established Zone AO's identify both one and two-foot floodplains depths. Every municipality within the planning area has identified floodplains except for Clarence and Mechanicsville. There are identified floodplains with Stanwood, but they do not encompass any structures. The Durant CSD's Bus Garage, the North Cedar CSD's Lowden Elementary, and the Tipton CSD's Middle & Elementary school locations are located within identified floodplains.

Map 3.2 – Floodplains, Cedar County



Map 3.3 – Floodplains, Bennett

0 0.035 0.07 0.14 Miles

Data Sources: ESRI, FEMA, Silvis Labs, U.S. Census Bureau, USACE, USDA

State Borders

County Borders

Municipal Borders

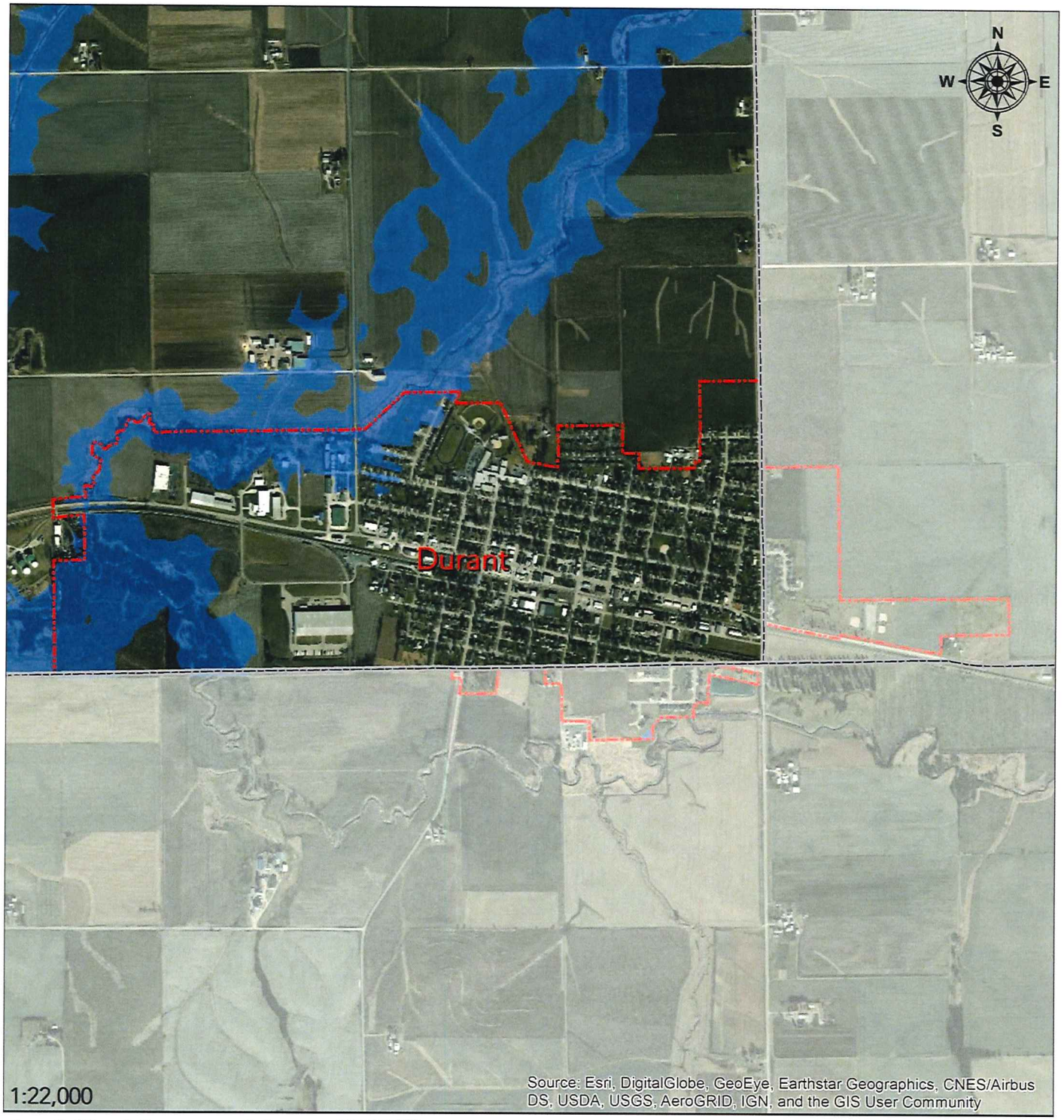
Floodplains

Zone AE

Zone A

Zone B

Map 3.4 – Floodplains, Durant



Map 3.5 – Floodplains, Lowden

Map 3.6 – Floodplains, Mechanicsville

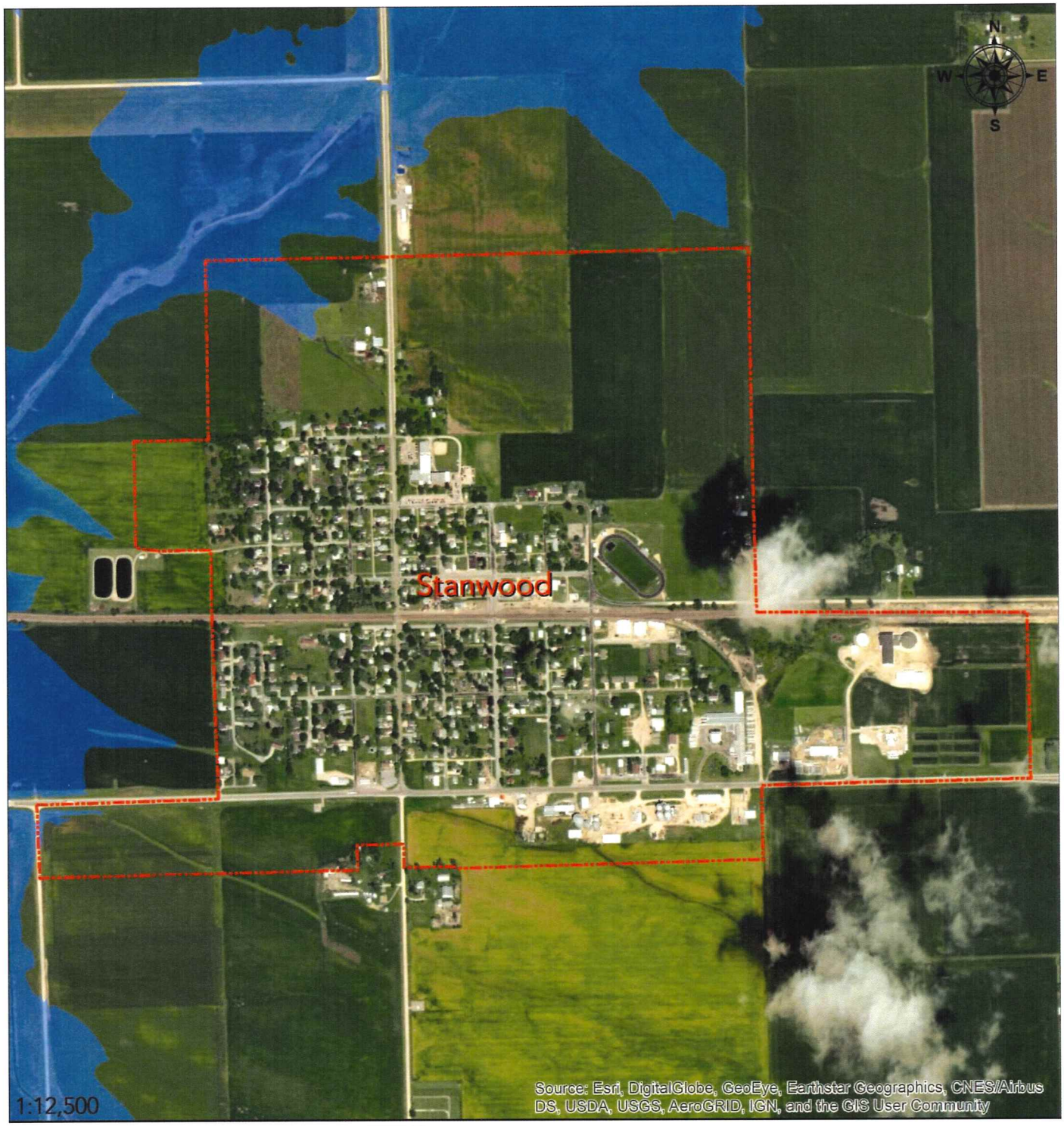
0 0.05 0.1 0.2 Miles

Data Sources: ESRI, FEMA, Silvis Labs, U.S. Census Bureau, USACE, USDA

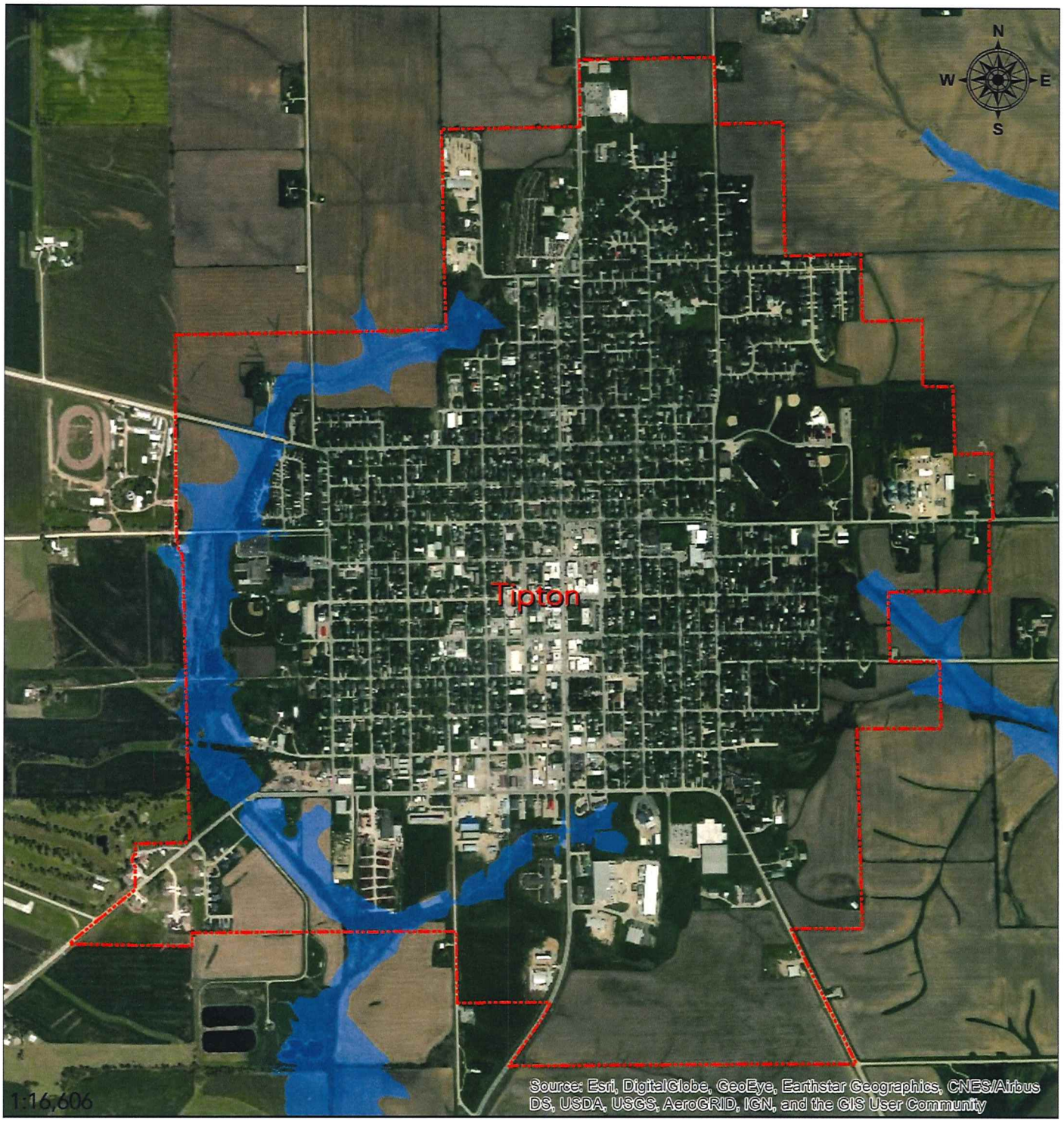
State Borders
County Borders
Municipal Borders

Floodplains
Zone A
Zone AE
Zone B

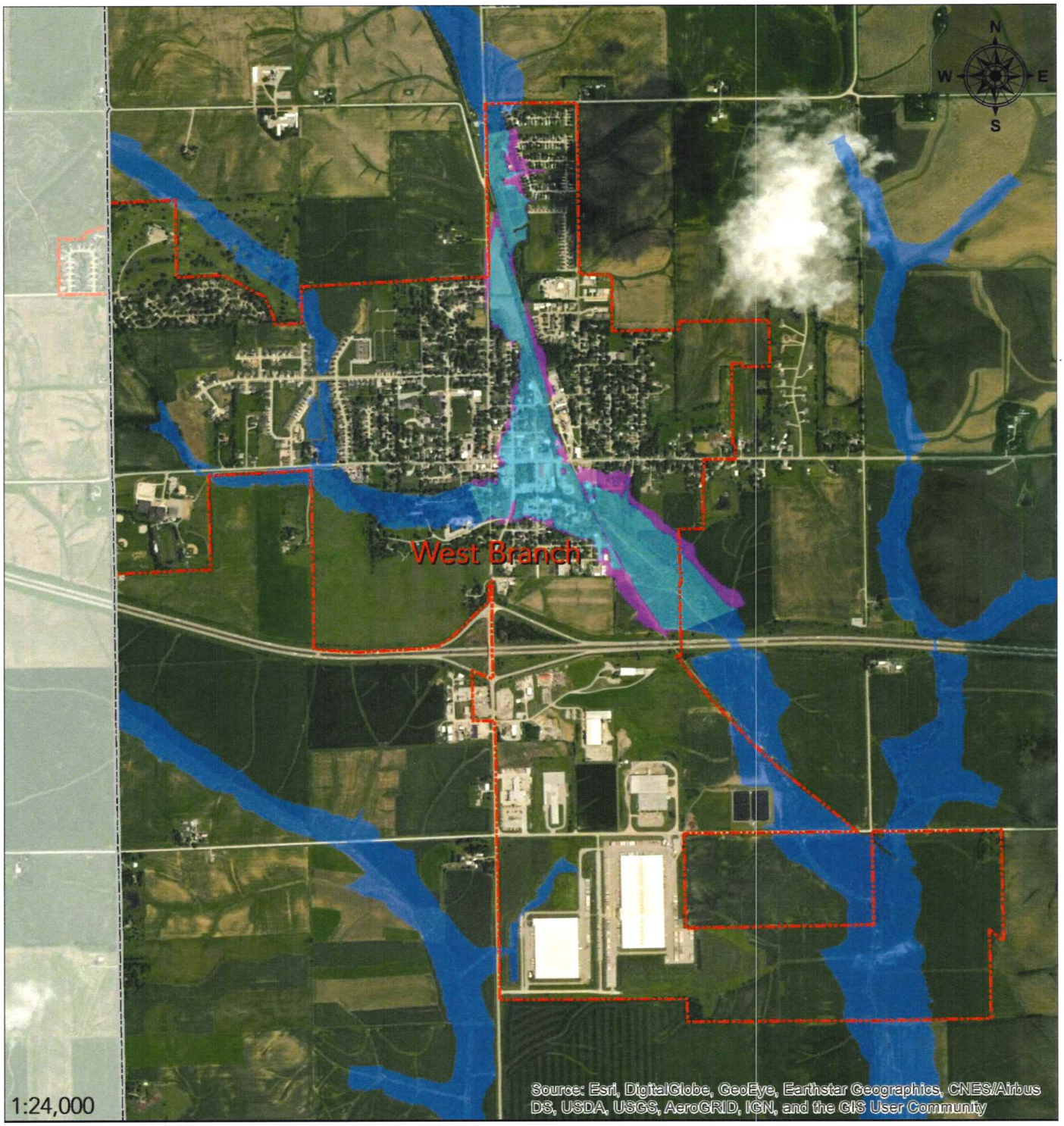
Map 3.7 – Floodplains, Stanwood



Map 3.8 – Floodplains, Tipton



Map 3.9 – Floodplains, West Branch



Map 3.10 – Floodplains, Durant Community School District, Bus Garage

0 0.02 0.04 0.08 Miles

Data Sources: ESRI, FEMA, Silvis Labs, U.S. Census Bureau, USACE, USDA

State Borders

County Borders

Municipal Borders

Floodplains

Zone AE

Zone A

Zone B

Map 3.11 – Floodplains, North Cedar Community School District, Lowden Elementary

Map 3.12 – Floodplains, Tipton Community School District, Middle & Elementary

Table 3.5 – Floodplain Classifications

Zone Class	Description
A	Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
AE	Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base Flood Elevations (BFEs) are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
AO	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between one and three feet. Some Zone AO have been designated in areas with high flood velocities such as alluvial fans and washes. Communities are encouraged to adopt more restrictive requirements for these areas.
B	Areas subject to inundation by 0.2-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown.

History & Probability

In the spring of 2008, the Cedar River began to rise due to excessive rainfall. After a period of roughly one week, the Cedar River exceed its banks flooding communities throughout Iowa. In Cedar County, this affected numerous rural areas along the river, most notably, the unincorporated Town of Rochester (East of West Branch, South of Tipton).

Waters eventually rose so high that the Cedar County EMA was forced to close a number of bridges across the river as the western (river bank side) of Rochester took on water. A voluntary evacuation order was issued for all inhabitants along the Cedar River. By this time (the 2nd day) the western portion of the Town of Rochester was under 2 feet of water, already exceeding the floods of 1993. Firefighters and volunteers across the county were brought to sandbag off the eastern parts of Rochester. At that point, the eastern portion was cut off and accessible only by boat.

On the 3rd day, Cedar County was included in part of the greater declared disaster area. The Iowa Department of Transportation had closed interstate 80, south of Rochester to all traffic, leaving the county cut in two. At the end of the 3rd day, the Cedar River had reached its maximum crest at 31.12 feet.

River waters began to subside (an estimated 2 inches per hour) on the 4th day. Infrastructure damage was excessive, with multiple bridges damaged and part of the Herbert Hoover Highway having been washed away. Six power lines were reported lost near the river and the National Guard was brought in for relief efforts and to block residents from crossing damaged bridges.

Since 1996, NOAA has recorded 32 floods (17 flash and 15 riverine) in the planning area. Most floods have shown to accumulate under 3 inches, but a few have reach upwards of 7 inches and 24 inches in rural areas.

These floods have caused no recorded injuries or fatalities in the planning area. They have however caused $3,750,000 from riverine and $425,000 from flash floods in property damage. For a complete list of NOAA recorded flash and riverine floods, please reference Appendix C.

Based on the data recorded by NOAA, the planning area should expect a notable flash flood at a rate of 0.71 per year or at a 71% chance per year. All FEMA identified SFHAs classified as primary zone A floodplains meaning they are subject to inundation at a rate of 1% per year, while those identified as zone B are subject to riverine flood at 0.2% per year. Please see the table above for the various floodplain classifications that exist throughout the planning area.

Vulnerability of and Impact on Facilities

Cedar County and the participating jurisdictions have school buildings, agricultural, commercial, industrial, and residential structures in floodplains. Flooding can cause minimal or complete damage to any of these types of facilities taking them offline for days to years depending on the resources available and remediation costs after an event. Recently, structures have been damaged west of Mechanicsville, south of Lowden, and round Tipton.

The average riverine flood event in Cedar County costs $250,000, while the existing range of a single incident has been from $0 to $3,500,000. The average flash flood costs $25,000, while the existing range of a single incident has been from $0 to $250,000. The planning area has incurred a total of $3,750,000 in property damage from riverine floods and $425,000 in property damage from flash floods.
The planning areas municipal and community school district structures are valued at $1,643,432,558. Since flash flooding threatens the entire planning area, all structures are considered exposed and vulnerable. A GIS analysis of FEMA's identified SFHAs puts a total of $75,797,000 worth of the planning area's municipal structural inventory exposed to riverine flooding. As previously noted, the Durant CSD's Bus Garage, of the North Cedar CSD's Lowden Elementary, and the Tipton CSD's Middle & Elementary school locations are located within identified floodplains.

Table 3.6 – Vulnerable Municipal Structures by Count, Riverine Floods

Municipality	Ag	Com	Gov	Ind	Res	Res-M	Total
Cedar County	7	10	0	4	161	0	182
Bennett	0	1	0	1	7	0	9
Clarence	0	0	0	0	0	0	0
Durant	0	3	0	2	23	0	28
Lowden	0	3	0	0	29	0	32
Mechanicsville	0	0	0	0	0	0	0
Stanwood	0	0	0	0	0	0	0
Tipton	0	1	0	0	9	0	10
West Branch	1	16	1	5	135	1	159
Total =	8	34	1	12	364	1	420

**Multi-Unit Residential is defined as a structure with 5 or more residential units*
***The data are from the U.S. Census Bureau and FEMA*

Table 3.7 – Vulnerable Municipal Structures by Value, Riverine Floods

Municipality	Ag	Com	Gov	Ind	Res	Res-M	Total
Cedar County	$2,550,000	$4,781,000	$0	$2,595,000	$22,623,000	$0	$32,549,000
Bennett	$0	$1,811,000	$0	$164,000	$611,000	$0	$2,839,000
Clarence	$0	$0	$0	$0	$0	$0	$0
Durant	$13,000	$997,000	$0	$1,041,000	$2,861,000	$0	$4,912,000
Lowden	$0	$1,436,000	$0	$0	$3,721,000	$0	$5,157,000
Mechanicsville	$0	$0	$0	$0	$0	$0	$0
Stanwood	$0	$0	$0	$0	$0	$0	$0
Tipton	$0	$229,000	$0	$0	$1,150,000	$0	$1,379,000
West Branch	$157,000	$8,961,000	$303,000	$3,551,000	$15,457,000	$532,000	$28,961,000
Total =	$2,720,000	$18,215,000	$303,000	$7,351,000	$46,426,000	$532,000	$75,797,000

*Multi-Unit Residential is defined as a structure with 5 or more residential units

**The data are from the U.S. Census Bureau and FEMA

Vulnerability of and Impact on Critical Facilities

Since flash floods have the potential to affect the entire planning area, all of this plan's identified critical facilities are equally vulnerable to flash flooding. Of the planning area's 91 critical facilities, 8 are located within FEMA identified SFHAs. Please see the following table for a list of these facilities.

Table 3.8 – Vulnerable Critical Facilities, Riverine Floods

Facility	Type	Location
Bennett Wastewater Lagoons	Water Utility	Bennett
Clarence Water Treatment Plant	Water Utility	Cedar County
Herbert Hoover Presidential Library	Government	West Branch
Lowden Maintenance Shop	Public Works	Lowden
Lowden Water Treatment Facility	Water Utility	Lowden
West Branch Fire Station	Fire Prevention/EMS	West Branch
West Branch Maintenance Shop	Public Works	West Branch
West Branch Police Station	Law Enforcement	West Branch

Vulnerability of and Impact on Population

If evacuation is not heeded, or flood waters rise quickly enough, Cedar County and it participating jurisdictions' population can drown or become trapped on rooftops or other points of high elevation. Depending on the conditions, this will expose them to the elements and deprive them of basic needs and services.

As described previously, water that is long lasting and slow to drain will encourage the growth of mold and other bio-hazardous material, rendering a facility unusable until remediation is finished. Extra care, assessment, and sanitization are required before students and staff can re-inhabit a school or university facility, or they may face serious health concerns. Assisted care facilities housing vulnerable populations can take longer to evacuate. Additionally, the potential presence of mold after a flood requires extra care to be taken before their population can re-inhabit an assisted care facility where the inhabitants are at greater risk of infection.

Although the planning area has seen significant flooding, it has not experienced any direct injuries or deaths as a result. The entire population of 18,627 and their 8,308 housing units are considered vulnerable and exposed to flash flooding while 805 residents in 396 housing units are currently identified as exposed and vulnerable to riverine floods. Similarly, all 3,253 CSD students and their respective 614 faculty and staff are considered vulnerable and exposed to flash flooding. Of the CSD locations identified or suspected to be in a floodplain, none of them are fully within the geographic range that would reasonably put any of their students, staff, or faculty at risk.

Table 3.9 – Vulnerable Municipal Populations, Riverine Flooding

Municipality	Population	Housing Units
Cedar County	321	164
Bennett	15	7
Clarence	0	0
Durant	57	23
Lowden	67	29
Mechanicsville	0	0
Stanwood	0	0
Tipton	20	9
West Branch	325	164
Total =	805	396

*The data are from the U.S. Census Bureau and FEMA

Vulnerability of and Impact on Systems

Flash flooding does not often cause widespread damage to property or infrastructure limited its ability to impact systems. Even in the case of a swept away roadway, the problem is often limited to secondary roadways. However, catastrophic riverine flooding can cause significant damage to a community's systems.

Extensive riverine flooding can significantly impact local governments' ability to provide basic goods and services to their communities either by losing essential facilities or by blocked infrastructure. This can take the form of lost law enforcement, fire prevention, medical, or water treatment facilities.

Significant damage to residential and or commercial structures can irrevocably damage a community and its economy creating refugees and economic hardship. If a chemical facility is significantly impacted it is possible the chemicals stored at the facilities can wash away with the flood waters and have detrimental effects on the local environment.

Key Considerations

Currently there are no severe repetitive loss or repetitive loss properties in Cedar County or any of the participating municipalities.

3.5 – Severe Storms

Severe storms comprise the hazardous and damaging weather effects often found in violent storm fronts. They can occur together or separate, they are common and usually not hazardous, but on occasion they can pose a threat to life and property.

This plan defines Severe Storms as a combination of the following severe weather effects as defined by NOAA and the NWS.

Hail: Showery precipitation in the form of irregular pellets or balls of ice more than 5 mm in diameter, falling from a cumulonimbus cloud.

High/Strong Wind: Sustained wind speeds of 40 miles per hour or greater lasting for 1 hour or longer, or winds of 58 miles per hour or greater for any duration. Often referred to as straight line winds to differentiate from rotating or tornado associated wind.

Lightning: A visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground or between the ground and a cloud.

Thunderstorm Winds: The same classification as high or strong winds, but accompanies a thunderstorm. It is also referred to as a straight-line wind to differentiate from rotating or tornado associated wind.

For consistency with the NWS and NOAA, high and strong winds are shown separate from thunderstorm winds when raw, collected data is displayed. However, for their impacts and probability, they are combined and referred to simply as "wind" events. Undoubtedly, numerous more lightning strikes have occurred in the planning area throughout recorded history. However, for the purposes of assessing the planning area's vulnerabilities and risk, only the strikes recorded by the NWS and NOAA are considered. The NWS and NOAA records consist of lightning strikes that have caused a significant impact, that is, they damaged property, infrastructure, or harmed people.

Location & Extent

Severe storms are an area-wide hazard as they can strike anywhere in the planning area. Storms, severe or not, are often predicted within a day or multiple days in advance.

The severity of a storm is not as easily predicted and when it is, the window of notification is up to a few hours to under an hour. When a storm is imminent, it is unknown whether or not hail, lightning, or damaging winds will occur until after an incident has been reported. Since severe storms typically affect an area the size of a region, the expected intensity is the same throughout the planning area. Thunderstorms, and the accompanying hail, lightning, and wind, typically last less than an hour. The portions of this timeframe where each storm classification would be considered "severe" should last less than 30 minutes.

Hail regularly falls in the planning area each year and has been recorded up to 2.75 inches in size. A complete hail index with size and typical damages can be found in the table below. Any incidents of hail can cause injury to the planning area's citizens, while anything above 1 inch could cause damage to structures. If windows are broken, some facilities will be rendered unusable until repaired.

Table 3.10 – NOAA/TORRO Hailstorm Intensity Scale

Class	Intensity Category	Diameter (Inches)	Size Comparison	Damage Impacts
H0	Hard Hail	0 – 0.33	Pea	No damage
H1	Potentially Damaging	0.33 – 0.60	Marble/Mothball	Slight damage to crops
H2	Potentially Damaging	0.60 – 0.80	Dime/Grape	Significant damage to crops
H3	Severe	0.80 - 1.20	Nickel to Quarter	Severe damage to crops, damage to glass and plastic, paint and wood scored
H4	Severe	1.20 - 1.60	Half Dollar	Widespread glass damage, vehicle bodywork damage
H5	Destructive	1.60 - 2.00	Silver Dollar to Golf Ball	Damage to tiled roofs, significant risk of personal injury.
H6	Destructive	2.00 - 2.40	Egg	Aircraft bodywork dented, brick walls pitted
H7	Very Destructive	2.40 - 3.00	Tennis Ball	Severe roof damage, risk of serious injuries to persons not protected
H8	Very Destructive	3.00 - 3.50	Baseball to Orange	Severe damage to aircraft bodywork
H9	Super Hailstorms	3.50 - 4.00	Grapefruit	Extensive structural damage, risk of severe injury or fatal injuries to persons not protected
H10	Super Hailstorms	4.00 +	Softball and up	Extensive structural damage, risk of severe injury or fatal injuries to persons not protected

It can safely be assumed any severe storm has the potential to cause a lightning strike. It can happen instantly with no warning and happen anytime throughout the storm's passage. A storm's lightning intensity is measured by lightning activity intensity levels outlined in the table on the following page. A strike could damage structures throughout the planning area and render it unusable for a period of time, or cause it to catch fire and damage it beyond repair. Most lightning strikes do not hit structures or people and therefore go unreported. The planning area can and has experienced lightning of all intensities listed in the table below.

Table 3.11 – Lightning Activity Intensity Scale

Level	Description
LAL 1	No activity
LAL 2	Isolated thunderstorms: Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud-to-ground strikes in a 5-minute period.
LAL 3	Widely scattered thunderstorms: Light to moderate rain will reach the ground. Lightning is infrequent, 6 to 10 cloud-to-ground strikes in a 5-minute period.
LAL 4	Scattered thunderstorms: Moderate rain is commonly produced Lightning is frequent, 11 to 15 cloud-to-ground strikes in a 5-minute period.
LAL 5	Numerous thunderstorms: Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud-to-ground strikes in a 5-minute period.

Strong, high, and thunderstorm winds are classified as winds which occur between 40 and 70 miles per hour lasting for 1 hour or greater or of 58 miles per hour for any duration. The Beaufort Scale shown on the next page displays the ranges of wind speed and correlates them with their typical effects. At a level 7 and 8 citizens should remain indoors and anywhere above a level 8 will cause damage to structures. Damage to any amount of structures can cause serious disruption to the participating governments and community school districts. The scope of damage can range from one residential house up to widespread destruction of homes and reinforced buildings throughout the planning area. The planning area occasionally receives wind events between 50 and 65 miles per hour or a Beaufort level between 9 and 10.

Table 3.12 – Beaufort Scale

Beaufort Number	Wind Speed (MpH)	Seaman's Term	Effects
0	Under 1	Calm	Calm, smoke rise vertically
1	1 – 3	Light Air	Smoke drift indicates wind direction, but vanes do not move
2	4 – 7	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
3	8 – 12	Gentle Breeze	Leaves, small twigs in constant motion, light flags extended
4	13 – 18	Moderate Breeze	Dust, leaves, and loose paper raised up, small branches move
5	19 – 24	Fresh Breeze	Small trees begin to sway
6	25 – 31	Strong Breeze	Large branches of trees in motion, whistling heard in wires
7	32 – 38	Moderate Gale	Whole trees in motion, resistance felt in walking against the wind
8	39 – 46	Fresh Gale	Twigs and small branches brake off of trees
9	47 – 54	Strong Gale	Slight structural damage occurs, slate blown from roofs
10	55 – 63	Whole Gale	Trees broken, structural damage occurs
11	64 – 72	Storm	Widespread damage
12	73 or Higher	Hurricane Force	Violence and destruction

History & Probability

On August 10th, 2020, the costliest thunderstorm in US history swept through eastern Iowa. The 2020 Derecho created wind gusts averaging 70 miles per hour peaking at 100 miles per hour as well as bringing along heavy rain. NOAA estimated the total regionwide cost of the derecho at $7.5 billion.

A Presidential disaster was declared that included Cedar County. Additionally, the Governor of the State of Iowa, Cedar County, and all its municipalities (except West Branch and Durant) declared their own disasters.

The derecho caused extensive tree and structural damage blocking roadways, taking down power lines and communications towers and cell phone repeaters throughout the county. The lack of communications infrastructure and roadway blockages made response and recovery operations incredibly difficult. The northern 2/3 of the county were the worst impacted, the following table outlines the damage assessment following the Derecho.

Table 3.13 – 2020 Derecho Damage Assessment

Community	Homes Affected	Homes Destroyed	Homes w/ Major Damage	Homes w/ Minor Damage	Infrastructure Damage
Cedar County	209	2	4	31	Unknown
Bennett	17	0	0	1	Unknown
Clarence	69	2	4	16	Unknown
Durant	0	0	0	0	$76,000
Lowden	53	0	4	6	$92,000
Mechanicsville	48	0	0	1	Unknown
Stanwood	34	0	2	6	Unknown
Tipton	75	0	2	8	Unknown
West Branch	0	0	0	0	$27,900
Totals =	505	4	16	69	$195,900

*The data are from the Cedar County Emergency Management Agency.

Additionally, the Bennett, North Cedar, Tipton, and West Branch Community School Districts each reported between $1,000 and $100,000 in damage.

Since 1957, NOAA has recorded 105 hailstorms in the planning area. In most of these cases the hail remained under 1.5 inches in size. This hailstorm did not cause any personal injuries or deaths in the planning area, but has caused $377,000 in property damage and $97,000 in crop damage.

Since 1996, NOAA has recorded 7 significant lightning strikes in the planning area. These events did not cause any injuries or deaths, but caused $163,250 in property damage.

Since 1956, NOAA has recorded 227 wind events in the planning area. Most of these events have been measured at between 50 to 60 miles per hour, but have a few have been measured in the upper 60s. There are 2 recorded injuries from wind events, but fortunately there have not been any fatalities. Wind events have caused a total of $15,160,600 in property damage throughout the planning area.

Based on the data recorded by NOAA, the planning area should expect a lightning strike in rarity, about once every 33 years while it should experience a significant hailstorm about twice per year. Additionally, the planning area should expect 9 significant wind events per year or at a rate of 9.46 events per year.

For a complete list of NOAA recorded hail, high wind, lightning, and thunderstorm winds, please reference Appendix C.

Vulnerability of and Impact on Facilities

Structural vulnerability to severe storms is the same throughout the planning area. Hail can be costly by damaging rooftops, outdoor equipment, and windows. Lightning can strike anything with the potential to significantly damage electrical infrastructure or ignite a fire. Wind events create flying debris which can damage infrastructure and buildings. Strong enough wind can cause structure damage to older,

less well constructed buildings even toppling or leveling them. A FEMA Code 361 Tornado Safe Room will provide more than sufficient protection and resistance to any form of severe storm as they are designed and constructed above the standard metrics of a severe storm. NOAA records catalog that the planning area regularly reports severe storm damage to roofs, chimneys, commercial signs, silos, and barns. On one occasion, high winds derailed a coal train while travelling between Lowden and Clarence. Additionally, numerous semi-trucks and high profiled vehicles have been blown over.

Significant changes to national building codes were implemented in 1999, and structures built before then are considered to be more vulnerable than those constructed afterwards. The majority of the planning area's structures were constructed before 1999.

The average hailstorm in the planning area costs $3,590, while the existing range of a single incident has been from $0 to $250,000.

The average lightning strike in the planning area costs $23,321, while the existing range of a single incident has been from $0 to $100,000.

The average wind event in the planning area costs $66,787, while the existing range of a single incident has been from $0 to $8,000,000.

Cedar County, the participating municipal structures are valued at $1,493,180,000 and the participating community school district structures are valued at $150,252,558. Since severe storms threaten the entire planning area equally, all structures are considered exposed and vulnerable.

Vulnerability of and Impact on Critical Facilities

All infrastructure and the planning area's 91 critical facilities within the planning are equally vulnerable and at risk since severe storms can affect any portion of the planning area and damage indiscriminately.

Vulnerability of and Impact on Population

In the absence of proper shelter, hail can cause serious injury to an unprotected person. As long as the planning area's citizens stay indoors and away from windows, they will be protected against hail injury and death. Similarly, they can avoid being struck by lightning by staying indoors. Although lightning may strike a structure sheltering people, it is extremely unlikely that the strike itself will directly injure or kill a sheltered person. As long as a structure is able to maintain its integrity during high speed winds, it will protect people from wind injury or death. However, old or poorly constructed facilities are not good shelters as previously mentioned, flying debris can break windows or cause structural damage. Either of these instances have the potential to seriously injure or kill anyone taking shelter in older, less well constructed building.

Cedar County and its municipalities have a total population of 18,627 in 8,308 housing units all of which are vulnerable and at risk to severe storms. Similarly, all of the participating community school districts' 3,253 students, 614 faculty and staff are vulnerable and at risk.

Historically, there have been no fatalities, but 2 recorded injuries from severe storms in the planning area.

Vulnerability of and Impact on Systems

The planning area's assets and systems' vulnerability to severe storms is directly correlated to its population density throughout the planning area with its power grid being the most likely to suffer damage. Where there are people, there are power related infrastructure.

Hail damage is typically superficial and does not hamper a community's assets, systems, or activities. Lightning strikes can destroy or damage a community asset, but since their strikes are typically isolated and rarely hit anything, it is unlikely to significantly impact a larger system. Wind events can destroy and damage multiple structures and points of infrastructure. It has the potential to significantly impact a community's power grid compounding the effects of other hazards such as tornadoes, and winter storms. NOAA records catalog multiples storms have caused regionwide power outages affecting 65,000 residents while West Branch specifically has reported having an outage affecting 1,000.

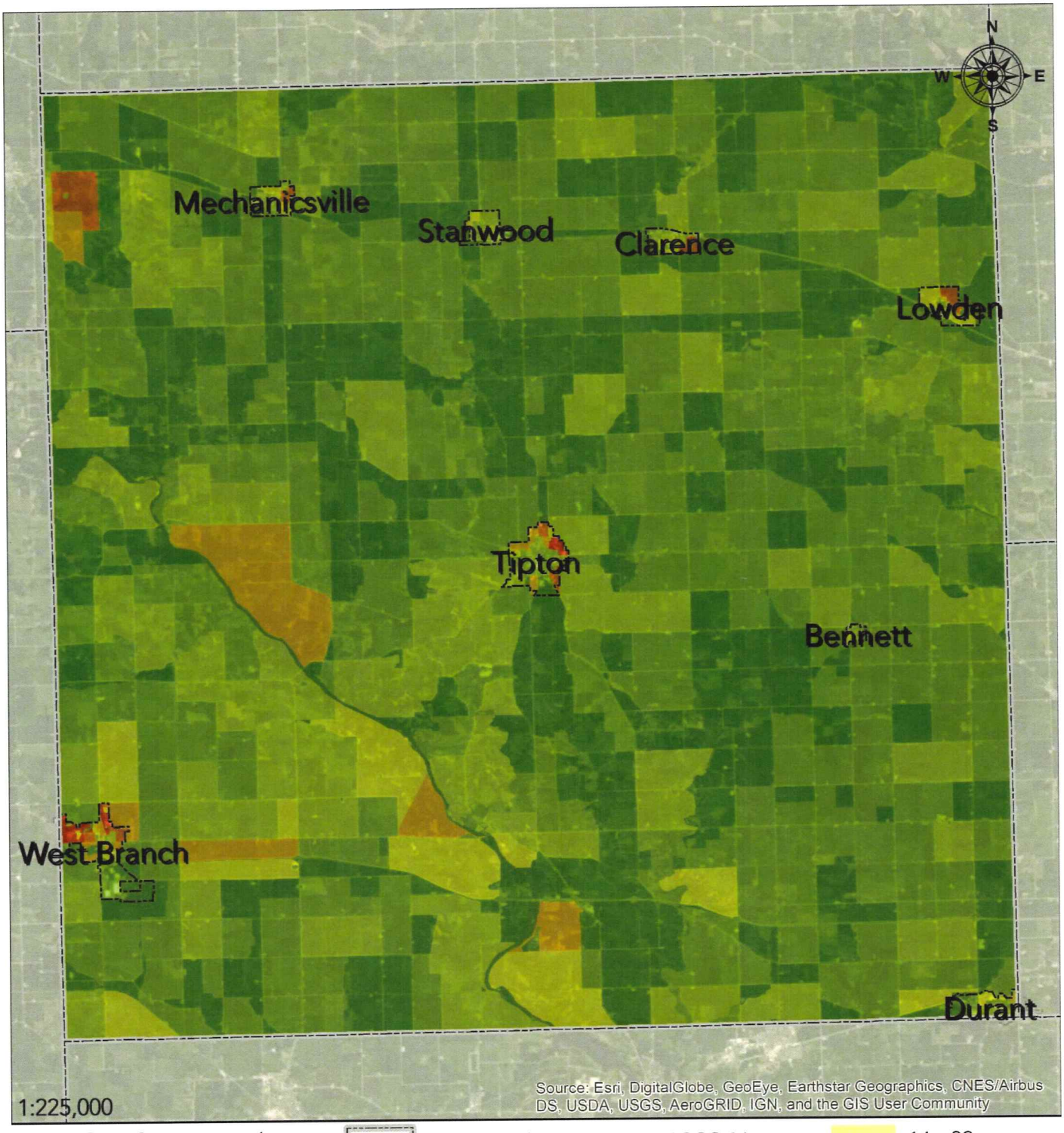
Key Considerations

Since severe storms strike over large areas and indiscriminately, there is not any particular portion of the planning area that is more likely than another to experience a severe storm. However, there are portions of the planning area that are more vulnerable to hail and wind related damage due to the age of a significant portion of their building stock.

As previously mentioned, the majority of the planning area's structures were built prior to 1999 and thus are more vulnerable and at risk to severe storms. The maps on the following pages depict the density and areas where these buildings exist in greater numbers in relation to structures built after 1999.

Every municipality throughout the planning area retain significant level of building stock constructed prior to the 1960s. These buildings were generally constructed to lower wind resistant standards and codes and thus these jurisdictions are considered more vulnerable.

Map 3.13 – Pre-1999 Built Structures



3.6 – Severe Winter Storms

A severe winter storm encompasses multiple effects caused by winter weather. Included are ice storms, heavy or prolonged snow, sleet, and extreme temperatures.

This plan defines severe winter storms as a combination of the following winter weather effects as defined by NOAA and the NWS.

Ice Storm: An ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater.

Heavy Snow: This generally means snowfall accumulating to 4" or more in depth in 12 hours or less; or snowfall accumulating to 6" or more in depth in 24 hours or less. In forecasts, snowfall amounts are expressed as a range of values, e.g., "8 to 12 inches." However, in heavy snow situations where there is considerable uncertainty concerning the range of values, more appropriate phrases are used, such as "...up to 12 inches..." or alternatively "...8 inches or more."

Winter Storm: Hazardous winter weather in the form of heavy snow, heavy freezing rain, or heavy sleet. May also include extremely low temperatures and increased wind.

Location & Extent

Winter storms are an area-wide hazard as they can strike anywhere in the planning area. Winter storms can range from moderate snow over a few hours to blizzard conditions with high winds, freezing rain or sleet, heavy snowfall with blinding wind-driven snow and extremely cold temperatures that last several days.

Winter storms typically form with warning and are often anticipated. Like other large storm fronts, the severity of a storm is not as easily predicted and when it is, the window of notification is up to few hours to under an hour. Although meteorologists estimate the amount of snowfall a winter storm will drop, it is not known exactly how many feet of snow will fall, whether or not it will form an ice storm, or how powerful the winds will be until the storm is already affecting a community.

Cedar County and its participating jurisdictions will typically receive 4 to 6 inches of snow during a winter storm, but a single storm in the planning area has managed to accumulate up to a reported 15.5 inches. Additionally, Cedar County and its participating jurisdictions have seen up to 1 inch of accumulated ice. They should be prepared for the typical average of anywhere between 0.1 to 0.25 inches of ice during a winter storm.

History & Probability

Since 1996, NOAA has recorder 115 winter storms in the planning area. Most ice storms leave under 0.50 inches of accumulation, however, on one occasion the planning area has seen ice accumulation as much

as 1 inch. Snowfall from winter storms has varied greatly ranging from just a few inches to greater than a foot of snow accumulation.

These winter storms have not caused any recorded direct injuries, but have reported to have caused one fatality. They have been responsible for $1,202,000 in property damage. For a complete list of NOAA recorded winter storms, please reference Appendix C.

Based on the data recorded by NOAA, the planning area should expect a winter storm at a rate of 4.83 per year.

Vulnerability of and Impact on Facilities

Structural vulnerability to winter storms is the same throughout Cedar County and its participating jurisdictions. Heavy snow accumulation can cause roofing to collapse on old or poorly constructed facilities. Ice storms will coat a facility's exterior, but is unlikely to cause anything more than superficial damage. Prolonged, extremely cold temperatures can cause significant damage to poorly insulated or heated facilities. The cold temperatures can cause a facility's water pipes and plumbing systems to freeze. As the water in these systems turns to ice it expands and eventually will cause pipes to burst.

Cedar County and its participating jurisdictions' municipal and community school district structures are valued at a total of $1,643,432,558. Since winter storms threaten the entire planning area equally, all municipal and community school district structures are considered exposed and vulnerable.

The average winter storm in Cedar County and its participating jurisdictions costs $10,443, while the existing range of a single incident has been from $0 to $1,000,000.

Vulnerability of and Impact on Critical Facilities

All infrastructure and the planning area's 91 critical facilities within the planning are equally vulnerable and at risk since winter storms can affect any portion of the planning area and damage indiscriminately.

Vulnerability of and Impact on Population

Cedar County and its participating jurisdictions' population are equally vulnerable throughout the planning area. Cedar County and its participating jurisdictions' citizens are at risk from prolonged, cold temperatures if they fail to be sheltered in an adequately heated structure or are unable to reach shelter. Some structures are dependent on electricity or steam for their heating making them vulnerable if a winter storm causes a power outage. Additionally, if a winter storm restricts travel, people may become immobile on roadways and be at the mercy of their vehicle's fuel supply. Exposure from winter storms in any of these cases can lead to frostbite and hypothermia. Both of these conditions if untreated can lead to death.

Cedar County and its participating jurisdictions have a total population of 18,627 in 8,308 housing units all of which are vulnerable and at risk to winter storms. Additionally, all 3,253 CSD students and their 614 faculty and staff are considered exposed and vulnerable.

Historically, there have been 1 recorded fatality and 0 injuries relating to winter storms across region wide fronts in Cedar County and its participating jurisdictions.

Vulnerability of and Impact on Systems

Cedar County and its participating jurisdictions' assets and systems vulnerability to winter storms is the roughly same throughout the planning area. Winter storms create havoc on roads impacting travel from decreased speeds and traffic jams to an ice storm or blowing snow drifts making any travel impossible or extremely dangerous. Additionally, ice storms and snow accumulation can directly bring down power lines or bring down vegetation onto power lines. From these scenarios, Cedar County and its participating jurisdictions can suffer power outages making it difficult to heat structures and exposing its citizens to prolonged cold temperatures. Winter storms can cause a problem for school districts in lost education days and transportation to and from their schools. Winter storms can trap students and staff on roadways exposing them to hazardous conditions and cold temperature.

Key Considerations

Winter storms have ability to affect a portion of or the entire planning area. Unfortunately, there is no way to predict ahead of time which areas will likely be more or less adversely directly affected. In regards to winter storm impacts, the rural municipalities of the planning area are less dense than a metro area and rely on a more decentralized power grid. Residents of these communities stand to last without out power for a greater period of time caused by a debilitating ice storm or blizzard. Further, the CSDs stand to be affected by more days of cancelled school due to power outages or unplowed transportation infrastructure.

3.7 – Tornadoes

A tornado is a violent, dangerous, rotating column of air that is in contact with both the surface of the earth and a cumulonimbus cloud or, in rare cases, the base of a cumulus cloud. Often referred to as a twister or a cyclone, they can strike anywhere and with little warning. Tornadoes come in many shapes and sizes, but are typically in the form of a visible condensation funnel, whose narrow end touches the earth and is often encircled by a cloud of debris and dust.

Tornadoes can cause several kinds of damage to buildings. Tornadoes have been known to lift and move objects weighing more than 3 tons, toss homes more than 300 feet from their foundations, and siphon millions of tons of water. However, less spectacular damage is much more common. Houses and other obstructions in the path of the wind cause the wind to change direction. This change in wind direction increases pressure on parts of the building. The combination of increased pressures and fluctuating wind speeds creates stress on the building that frequently causes connections between building components, roofing, siding, windows, etc., to fail. Tornadoes can also generate a tremendous amount of flying debris. If wind speeds are high enough, airborne debris can be thrown at buildings with enough force to penetrate windows, roofs, and walls.

Location & Extent

Many tornadoes only exist for a few seconds in the form of a touchdown. A tornado may arrive with a storm front and touchdown in a matter of seconds without warning. Other times tornado watches and sirens will alert communities of high potential tornado producing weather or an already formed tornado and its likely path.

The most extreme tornados can attain wind speeds of more than 200 mph, stretch more than two miles across, and travel dozens of miles. Tornadoes are an area-wide hazard as they can strike anywhere in the planning area.

Until 2007 the Fujita Tornado Scale ranked the severity of tornadoes. The Fujita scale assigned a numerical F value, F0 through F5, based on the wind speeds and estimated damage. Since 2007 the U.S. switched over to the Enhanced Fujita Scale. The altered scale adjusted the wind speed values per F level and introduced a rubric for estimating damage. Most tornados have wind speeds less than 110 miles per hour, and travel a few miles before dissipating. The planning area should expect to see tornadoes of EF0 or EF1, but should be prepared for a tornado up to an EF5.

Table 3.14 – Fujita Scale & Damage Descriptions

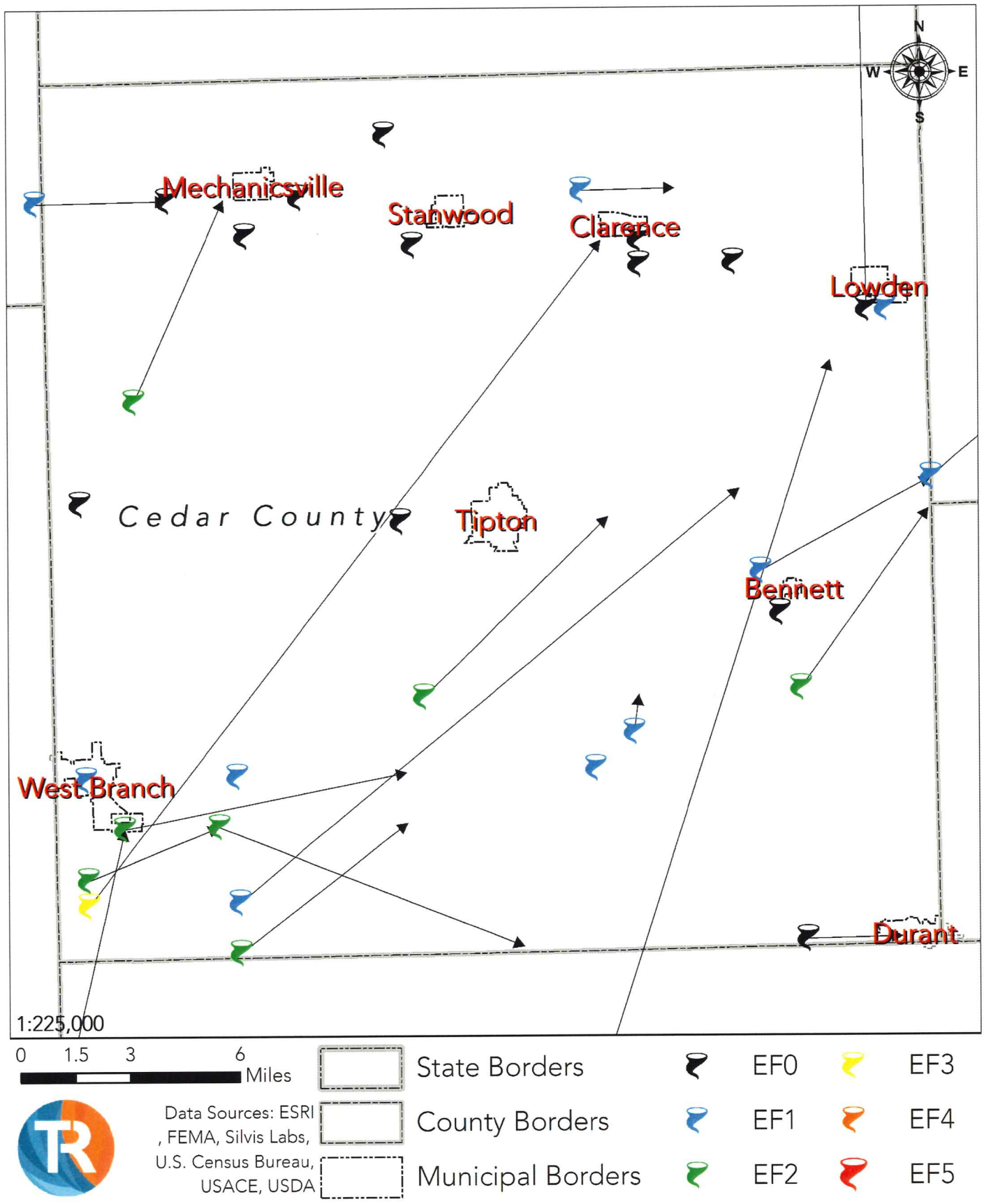
	SCALE	WIND SPEED	DESCRIPTION
	EF-0	65-85 MPH	'Minor' damage: shingles blown off or parts a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.
	EF-1	86-110 MPH	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, 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 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, to story exterior wall 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.

History & Probability

Since 1957, the NWS has recorded 35 tornadoes in the planning area. Most have been EF0 or EF1 while the most intense has been an EF4. These tornadoes have caused 20 recorded injuries, 1 death, and an estimated $8,781,530 in property damage. For a complete list of NWS recorded tornadoes, please reference Appendix C.

Based on the data recorded by the NWS, the planning area should expect a tornado at a rate of 0.56 tornadoes per year.

Map 3.14 – Historical Tornadoes



Vulnerability of and Impact on Facilities

Most tornadoes are in the EF0 – EF2 class. Building to modern wind standards and state codes provides significant protection from these hazard events; however, a community in the direct path of a violent, high scale tornado can do little to prevent significant property damage. Designing buildings to protect against extreme wind speeds, such as those associated with an EF4 or EF5 is extremely challenging and cost prohibitive. Anything less than a FEMA Code 361 compliant structure is susceptible to significant damage or complete destruction. A comparison of EF scale to the expected impact on facilities can be seen in Table 3.13

The average tornado event in the planning costs $141,638, while the existing range of a single incident has been between and EF0 and EF4 costing between $0 and $2,500,000.

Cedar County and its participating jurisdictions' municipal and community school district structures are valued at a total of $1,643,432,558. Since tornadoes threaten the entire planning area equally, all municipal and community school district structures are considered exposed and vulnerable.

Vulnerability of & Impact on Critical Facilities

All infrastructure and the planning area's 91 critical facilities within the planning are equally vulnerable and at risk since tornadoes can affect any portion of the planning area and damage indiscriminately.

Vulnerability of and Impact on Population

An EF4 or EF5 tornado has the potential to level the smaller jurisdictions and kill everyone in them while being able to do nearly the same in the larger ones. A lesser magnitude tornado has the ability to kill and injure citizens as it rips off the roofs and walls of its structures while launching airborne missiles born from debris.

Cedar County and its participating municipal jurisdictions have a total population of 18,627 in 8,308 housing units all of which are vulnerable and at risk to tornadoes. Additionally, all 3,253 CSD and their 614 staff and faculty are considered exposed and vulnerable.

Vulnerability of and Impact on Systems

All of the planning area's community assets and systems' vulnerability to tornadoes is equal throughout the planning area. A small magnitude tornado will not significantly damage a community and its systems, but a larger magnitude tornado can impact a community for weeks, months, or years and even destroy a city completely. Significant damage to any portion of the planning area would hinder the community's economy and increase its social vulnerability.

Key Considerations

Since tornadoes affect large areas and indiscriminately, there is not any particular portion of the planning area that is more likely than another to experience a severe storm. However, there are

portions of the planning area that are more vulnerable to wind related damage due to the age of a significant portion of their building stock.

All plan participants retain significant levels of building stock constructed prior to the 1960s. These buildings were generally constructed to lower wind resistant standards and codes and thus these jurisdictions are considered more vulnerable.

3.8 – Wildfires

The NWS defines a wildfire as: Any free burning uncontainable wildland fire not prescribed for the area which consumes the natural fuels and spreads in response to its environment. They can occur naturally, by human accident, and on rare occasions by human action. Typically, their point of origin is far from human development with the exception of roads, power lines, and similar rural infrastructure. There is a constant threat to hikers, campers, and other people engaging in outdoor activities. Significant danger to life and property occurs when human development meets and becomes intertwined with wildland's vegetation. The threat of wildfire and grass fires increases in areas prone to intermittent drought, or are generally arid or dry.

Population de-concentration in the U.S. has resulted in rapid development in the outlying fringe of metropolitan areas and in rural areas with attractive recreational and aesthetic amenities, especially forests, communities bordering forests and prairies where fires branch off. This demographic change is increasing the size of the wildland-urban interface (WUI), defined as the area where structures and other human development meet or intermingle with undeveloped wildland. Its expansion has increased the likelihood that wildland and grass fires will threaten life and property.

Location & Extent

Cedar County and the planning area's fire response efforts are not inhibited by mountainous or significantly vegetated large areas that traditionally make it difficult to extinguish fires. Due to this, wildland and grass fires are usually extinguished in relatively short amounts of time when compared to larger wildfires in the western United States. Additionally, although wildfires can occur almost anywhere throughout the planning area, the fuel available for a fire to burn and spread is less dense and thus does not create fires that have momentum that they do throughout the western United States.

The vast majority of wildfires that occur in the planning area occur in areas containing brush, grass, and crops. Although these types of fuel do not pose as intense a level of a fire as does heavily vegetated forests, nearly every acre of undeveloped land in the planning area is covered in by some form of vegetation that could act as fuel for a fire. The map on the following page depicts the basic varieties of vegetation throughout the planning area.

The planning area is most often affected by grass and brush fires, which are usually contained and extinguished before there is a threat to life and developed property. Most grass fires are contained to highway and rail right-of-way ditches and are less than a few acres in size. Fires often burn large portions of field crops during harvest. Given the conditions present in the planning area, a fire should not be expected to supersede Rank 2 on the burn severity index.

Map 3.15 – Vegetative Fuel

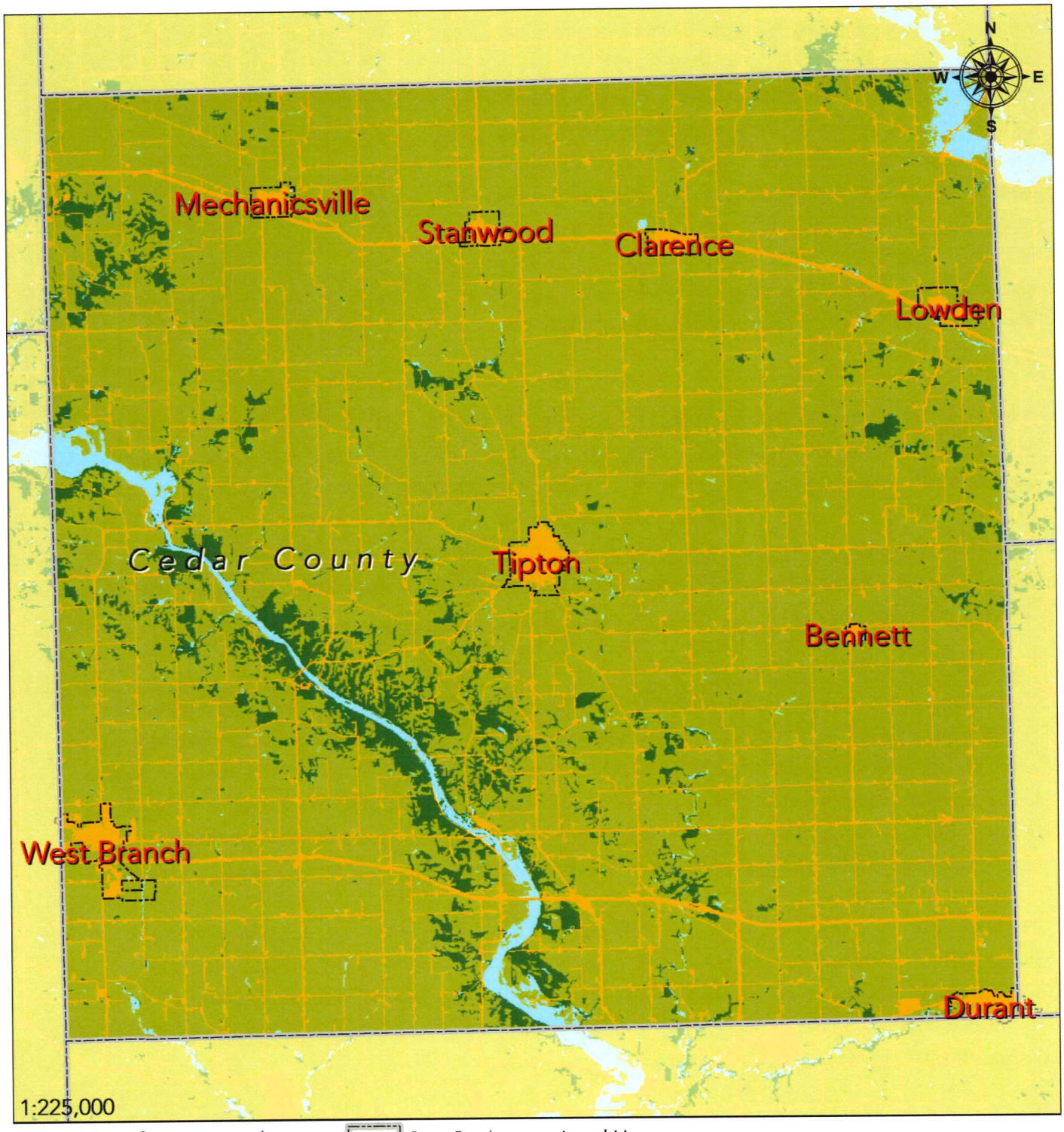


Table 3.15 – Burn Severity Index

BURN SEVERITY	RANK	DESCRIPTION	CHARACTERISTICS
 Unburned	RANK 0	Fire extinguished before reaching microsite	• Leaf litter from previous years intact and uncharted • No evidence of char around base of trees and shrubs • Pre-burn seedlings and herbaceous vegetation present
 Low Severity Burn	RANK 1	Surface fire which consumes litter yet has little effect on trees and understory vegetation	• Burned with partially consumed litter present • Evidence of low flame heights around base of trees and shrubs (<0.5 m) • No significant decreases in overstory & understory basal area, diversity or species richness from pre-burn assessments • Usually burning below 80 degrees Celcius
 Medium-Low Severity Burn	RANK 2	No significant differences in overstory density and basal area, & no significant differences in species richness. However, understory density, basal area, and species richness declined.	• No litter present and 100% of the area covered by duff • Flame lengths < 2 m • Understory mortality present, little or no overstory mortality
 Medium-High Severity Burn	RANK 3	Flames that were slightly taller than those of Medium-low intensity fires, but these fires had occasional hot spots that killed large trees, with a significant reduction in the understory.	• Soil exposure on 1-50% of the area • Flame lengths < 6 m • High understory mortality with some overstory trees impacted
 High Severity Burn	RANK 4	Crown fires, usually a stand-replacing burn with relatively high overstory mortality.	• Soil exposure > 50% • Flame lengths > 6m • Higher overstory mortality 20% • Usually burning above 800 degrees Celcius

Most wildfires occur without warning and spread quickly but the event depends upon a number of conditions. Wind can turn a small flame into a multi-acre grassfire within a matter of minutes, while this can be further compounded by the level of moisture and available fuel based on the area's land use.

History & Probability

There have not been any wildfires in the planning area that would be considered historically significant. Manageable wildland and grass fires will occur in Cedar County on a regular basis throughout the year. However, it is highly unlikely that they will occur in an urban area, within municipal borders.

Since 1984, the planning area has experienced 16 significant wildfires (those burning greater than 1 acre of land). In total, these fires have burned 375 acres of land. These occur at a yearly rate of 0.65 significant (burning over 1 acre) wildfires per year in which an average of 10.42 acres will be burnt per year.

Although wildfires occur, and although it is possible, it is unlikely that will directly affect the participating municipalities. The greater planning area however should except to see the historical trend of 0.65 wildfires per year to continue.

Vulnerability of and Impact on Facilities

A wildfire burning near a jurisdiction may cover it in soot, cause secondary fires from traveling coals, or directly engulf facilities burning them to the ground. Properties located in some rural areas can prove more difficult to reach by first responders. Additionally, many of these rural locations do not have adequate water supplies for first responders to utilize in extinguishing these fires, causing them to spread farther than they normally would. Facilities can be protected by creating defensible spaces or buffer zones, maintaining a fuel free environment, and structural modifications to prevent the growth of a wildfire.

Grass and brush fires threaten almost every structure that exists in a vegetated area as depicted in Vegetative Fuel map located earlier in this hazard profile. Cedar County and its participating jurisdictions' 8,631 municipal structures are valued at $1,493,180,000. A GIS analysis of the identified WUI puts a total of 149 of the planning area's municipal structure inventory worth $23,237,000 vulnerable to and at high risk to wildfires. None of the CSD locations are located within WUI zones. Please see following table for a breakdown of these values by jurisdiction and maps located at the end of this hazard profile for depictions of the WUI zones.

Table 3.16 – Vulnerable Municipal Structures by Count, Wildfires

Municipality	Ag	Com	Gov	Ind	Res	Res-M	Total
Cedar County	1	4	0	4	140	0	149
Bennett	0	0	0	0	0	0	0
Clarence	0	0	0	0	0	0	0
Durant	0	0	0	0	0	0	0
Lowden	0	0	0	0	0	0	0
Mechanicsville	0	0	0	0	0	0	0
Stanwood	0	0	0	0	0	0	0
Tipton	0	0	0	0	0	0	0
West Branch	0	0	0	0	0	0	0
Total =	1	4	0	4	140	0	149

*Multi-Unit Residential is defined as a structure with 5 or more residential units.
**The data are from the U.S. Census Bureau and FEMA.

Table 3.17 – Vulnerable Municipal Structures by Value, Wildfires

Municipality	Ag	Com	Gov	Ind	Res	Res-M	Total
Cedar County	$210,000	$1,317,000	$0	$1,781,000	$19,913,000	$16,000	$23,237,000
Bennett	$0	$0	$0	$0	$0	$0	$0
Clarence	$0	$0	$0	$0	$0	$0	$0
Durant	$0	$0	$0	$0	$0	$0	$0
Lowden	$0	$0	$0	$0	$0	$0	$0
Mechanicsville	$0	$0	$0	$0	$0	$0	$0
Stanwood	$0	$0	$0	$0	$0	$0	$0
Tipton	$0	$0	$0	$0	$0	$0	$0
West Branch	$0	$0	$0	$0	$0	$0	$0
Total =	$210,000	$1,317,000	$0	$1,781,000	$19,913,000	$16,000	$23,237,000

*Multi-Unit Residential is defined as a structure with 5 or more residential units.
**The data are from the U.S. Census Bureau and FEMA.

Vulnerability of and Impact on Critical Facilities

Of the planning area's 91 critical facilities, none are located in identified WUI zones and are therefore not considered at a reasonable risk.

Vulnerability of and Impact on Population

An inability to properly evacuate is a populations greatest vulnerability. They can be caught off guard due to improper warning systems and become trapped in a growing wildland fire. Cedar County and its participating jurisdictions have a population of 18,627 of which 280 are considered vulnerable and at high risk to wildfires. Similarly, of the total 8,631 housing units in the planning area, 141 are considered vulnerable and at high risk to wildfires. None of the CSD locations are at a high risk to wildfires.

Table 3.18 – Vulnerable Municipal Populations, Wildfires

Municipality	Population	Housing Units
Cedar County	280	141
Bennett	0	0
Clarence	0	0
Durant	0	0
Lowden	0	0
Mechanicsville	0	0
Stanwood	0	0
Tipton	0	0
West Branch	0	0
Total =	280	141

**Multi-Unit Residential is defined as a structure with 5 or more residential units*
***The data are from the U.S. Census Bureau and FEMA*

Vulnerability of and Impact on Systems

It is unlikely that a single wildfire will grow large enough to cause significant or long-lasting damage to Cedar County and this plan's participating jurisdictions' economies, education services, or hinder the local governments' ability to provide services to their communities. However, a potent enough incident may cause short-term problems for their transportation systems in regards to response operations.

In the event a wildfire begins to burn and grow, evacuation routes may become blocked by the fire or by other people attempting to evacuate. The impingement of the local transportation system makes appropriate warning and information paramount in mitigating Cedar County and its participating jurisdictions' systems vulnerability to wildfires. It is unlikely that any of the participating school districts buses would become trapped by wildfires since exceptional care will be taken by Cedar County EMA to reroute these buses and the large number of alternative roadways available in the planning area.

3.9 – Excluded Hazards

There exists a slim chance that any type of natural hazard could occur in any location throughout the United States. However, the probability of them occurring is so infinitesimally small and their impact so slight that it is not considered reasonable to develop a fully-profiled risk assessment for them. Additionally, without historical information or data to drive an analysis, it is unlikely that their conclusions would yield functional or practical strategies to mitigate them.

Dam & Levee Failure

The planning area does not contain any USACE designated high hazard dams or levees.

Earthquakes

The State of Iowa has been affected by a few sporadic earthquakes over the last century, it is not considered to be at risk by any reasonable means or the USGS.

Expansive Soils

No portion of the planning area is considered an area with expansive soils issues. Although clay soil deposits might exist in isolate places, simply the existence of clay soil deposits does not correlate to an expansive soils problem. There are no documented cases of clay soils shrinking and expanding that have directly caused property damage.

Landslides

There is not a significant threat from landslides to the planning area or throughout Iowa. There are not any areas that are considered to have steep slopes and the climatic and topographic conditions are not present to consider them a reasonable or measurable threat to people or property.

Sinkholes

Historically, no sinkholes have formed in Cedar County. Typically, sinkholes only occur in areas that have what is called "Karst Formations," but the existence of a Karst Formation does not guarantee a sinkhole will ever form.

Other than their formation occurring where Karst Formations also exist, sinkholes are extremely difficult to pinpoint and predicting them based on a general historical precedent is best.
Areas of Cedar County have potential karst topography so there is a potential, but due to the lack of historical precedence, they are unlikely to form.

3.10 – Risk Summary

The table below outlines each participating jurisdiction's general risk to this plan's profiled hazards. The rankings are based on a composite evaluation of this plan's risk assessment, namely, a hazard's probability of occurring in the future, the vulnerability of a jurisdiction to a particular hazard, the intensity of past hazard impacts, and a joint evaluation of local experts and stakeholders.

Each participating jurisdiction was assessed against each hazard on a scale of 0 to 6, 0 meaning there is no reasonable risk, 1 being the lowest level of reasonable risk, and 6 being the highest level of risk.

Table 3.19 – Hazard Risk Summary

Jurisdiction	Droughts	Floods	Severe Storms	Severe Winter Storms	Tornadoes	Wildfires
Cedar County	3	4	4	3	4	2
Bennett	2	3	4	3	4	1
Clarence	2	2	4	3	4	1
Durant	2	3	4	3	4	1
Lowden	2	4	4	3	4	1
Mechanicsville	2	2	4	3	4	1
Stanwood	2	2	4	3	4	1
Tipton	2	3	4	3	4	1
West Branch	2	5	4	3	4	1
Bennett CSD	0	2	4	3	4	1
Durant CSD	0	3	4	3	4	1
North Cedar CSD	0	3	4	3	4	1
Tipton CSD	0	3	4	3	4	1
West Branch CSD	0	2	4	3	4	1

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