Marion County 2023

HAZARD MITIGATION PLAN

MARION COUNTY
IOWA

Prepared by:

JEO CONSULTING GROUP

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List of Acronyms

ACS – American Community Survey
BNSF – Burlington Northern Sante Fe Railroad
BRIC – Building Resilient Infrastructure and Communities
CDC – Centers for Disease Control and Prevention
CFR – Code of Federal Regulations
COVID-19 – Coronavirus Disease 2019
CROSS – County Rural Offices of Social Services Region
CRP – Conservation Reserve Program
CRS – Community Rating System
CyanoHABs – Cyanobacterial Harmful Algae Blooms
DMA 2000 – Disaster Mitigation Act of 2000
EAB – Emerald Ash Borer
EAP – Emergency Action Plan
EPA – Environmental Protection Agency
ESL – English as Second Language
FBI – Federal Bureau of Investigation
FEMA – Federal Emergency Management Agency
FIRM – Flood Insurance Rate Map
FMA – Flood Mitigation Assistance Program
FR – Final Rule
FRA – Federal Railroad Administration
GIS – Geographic Information Systems
HMA – Hazard Mitigation Assistance
HMGP – Hazard Mitigation Grant Program
HMP – Hazard Mitigation Plan
HPRCC – High Plains Regional Climate Center
HSEMD – Iowa Department of Homeland Security and Emergency Management
HUD – Department of Housing and Urban Development
IDALS – Iowa Department of Agriculture & Land Stewardship
IDNR – Iowa Department of Natural Resources
IDOT – Iowa Department of Transportation
IDPH – Iowa Department of Public Health
JEO – JEO Consulting Group, Inc.
LGA – Liquid Gallons
NCEI – National Centers for Environmental Information
NDMC – National Drought Mitigation Center
NFIP – National Flood Insurance Program
NLD – National Levee Database
NOAA – National Oceanic and Atmospheric Administration
NPI – Nonpharmaceutical Interventions
NRCS – Natural Resources Conservation Service
NRC – National Response Center
NTSB – National Transportation Safety Board
NWS – National Weather Service
PDSI – Palmer Drought Severity Index
PHMSA – U.S. Pipeline and Hazardous Material Safety Administration
Risk MAP – Risk Mapping, Assessment, and Planning
RMA – Risk Management Agency
SBA – Small Business Administration
SHMO – State Hazard Mitigation Officer
SHMT – State Hazard Mitigation Team
SPIA – Sperry-Piltz Ice Accumulation Index
START – National Consortium for the Study of Terrorism and Responses to Terrorism
TORRO – Tornado and Storm Research Organization
USACE – United States Army Corps of Engineers
USDA – United States Department of Agriculture
USGS – United States Geological Survey
WHO – World Health Organization
WMA – Watershed Management Areas
WUI – Wildland Urban Interface

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Executive Summary

Introduction

This plan is an update to the Marion County Hazard Mitigation Plan (HMP) approved in 2016. The plan update was developed in compliance with the requirements of the Disaster Mitigation Act of 2000 (DMA 2000) and under the new guidance of the Federal Emergency Management Agency's (FEMA) March 2023 Hazard Mitigation Assistance Program and Policy Guide.

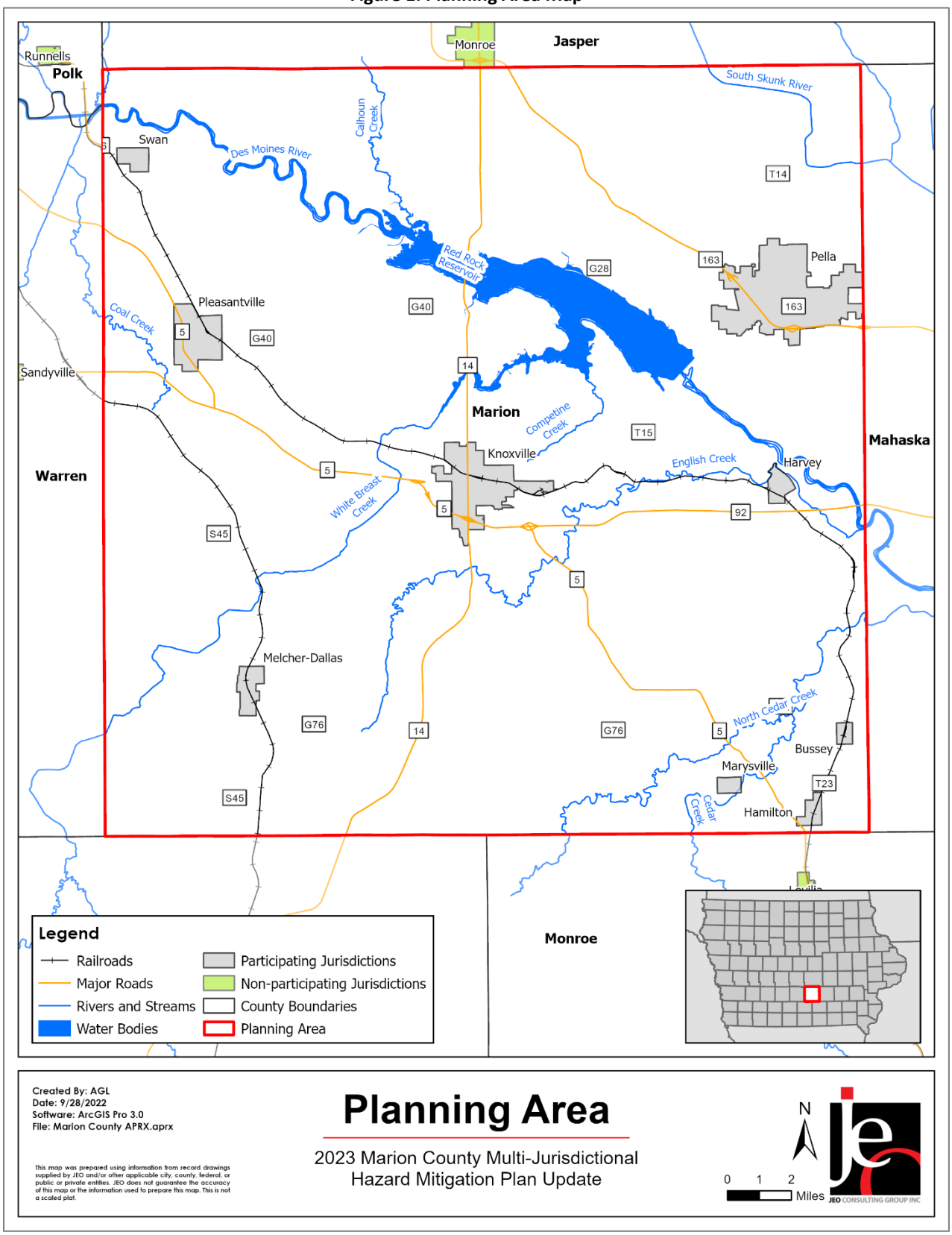
Hazard mitigation planning is a process in which hazards are identified and profiled; people and facilities at-risk are identified and assessed for threats and potential vulnerabilities; and strategies and mitigation measures are identified. Hazard mitigation planning increases the ability of communities to effectively function in the face of natural and human-caused disasters. The goal of the process is to reduce risk and vulnerability to lessen impacts to life, the economy, and infrastructure. All identified communities and special districts in the county were invited and encouraged to participate in the plan update. Jurisdictions who fully participated in the planning process are listed in the following table and illustrated in the following planning area map.

Table 1: Participating Jurisdictions

PARTICIPATING JURISDICTIONS	
Marion County	City of Pleasantville
City of Bussey	Knoxville Community School District
City of Harvey	Melcher-Dallas School District
City of Knoxville	Pella Christian Schools
City of Marysville	Pella Community School District
City of Melcher-Dallas	Twin Cedars Community School District
City of Pella	

Jurisdictions that opted to not participate or did not complete all requirements to participate are the City of Hamilton, City of Swan, Pleasantville School District, and Central College. Reasons these jurisdictions did not participate in this planning process included a lack of local capability and/or disinterest in the process. For a full discussion of the planning process and those encouraged to participate in the planning process, see *Section Two: Planning Process.*

Figure 1: Planning Area Map



Goals and Objectives

The potential for disaster losses and the probability of occurrence of natural and human-caused hazards present a significant concern for the jurisdictions participating in this plan. The driving motivation behind this hazard mitigation plan is to reduce vulnerability and the likelihood of impacts to the health, safety, and welfare of all citizens in the planning area. To this end, the Hazard Mitigation Planning Team reviewed and approved goals which helped guide the process of identifying both broad-based and community-specific mitigation strategies and projects that will, if implemented, reduce their vulnerability, and help build stronger, more resilient communities.

Goals from the 2016 HMP were reviewed, and members of the Hazard Mitigation Planning Team agreed that they are still relevant and applicable for this plan update. Jurisdictions that participated in this plan update agreed that the goals identified in 2016 would be carried forward and utilized for the 2023 plan. The goals for this plan update are as follows:

- **Goal 1**: Protect the Health and Safety of Residents
  - **Objective 1.1**: Reduce or prevent damage to property or prevent loss of life or serious injury
- **Goal 2**: Reduce Future Losses from Hazard Events
  - **Objective 2.1**: Provide protection for existing structures, future development, critical facilities, services, utilities, vulnerable areas or populations, and trees.
  - **Objective 2.2**: Develop hazard specific plans, conduct studies or assessments, and retrofit buildings and facilities to mitigate hazards and minimize their impact.
  - **Objective 2.3**: Minimize the impact of hazard events through enacting or updating ordinances, permits, laws or regulations.
- **Goal 3**: Increase Public Awareness and Education Regarding Vulnerabilities to Hazards
  - **Objective 3.1**: Develop and provide information to the public and property owners about their risk and vulnerability to hazards.
- **Goal 4**: Improve Emergency Management Capabilities
  - **Objective 4.1**: Develop or update City and/or County Emergency Response Plan(s) and procedures and increase the capability to respond.
  - **Objective 4.2**: Develop or improve Evacuation Plans and procedures.
  - **Objective 4.3**: Improve warning systems and ability to communicate to the public during and following a disaster or emergency.
- **Goal 5**: Pursue Multi-Objective Opportunities (whenever possible)
  - **Objective 5.1**: When possible, use existing resources, agencies, and programs to implement the projects.
  - **Objective 5.2**: When possible, implement projects that achieve several goals.
- **Goal 6**: Enhance Overall Resilience and Promote Sustainability
  - **Objective 6.1**: Incorporate hazard mitigation and adaptation into updating other local planning endeavors (e.g. comprehensive plans, zoning ordinance, subdivision regulation, etc.)

Summary of Changes

The hazard mitigation planning process undergoes several changes during each plan update to best accommodate the planning area and specific conditions. Changes from the 2016 Hazard Mitigation Plan and planning process in this update included combined risk assessment for hazards with similar risks, impacts, and mitigation strategies, specifically Flooding which now includes flash flooding and riverine flooding. The hazard Levee Failure was also removed from this HMP. Other changes include the addition of Terrorism & Civil Disorder as a hazard; an included discussion on climate and economic impacts of each hazard to the county; and the incorporation of Plan Maintenance sections for individual community profiles.

This update also works to unify the various planning mechanisms in place throughout the participating communities (i.e., comprehensive plans, local emergency operation plans, zoning ordinances, building codes, etc.) to ensure that the goals and objectives identified in those planning mechanisms are consistent with the strategies and projects included in this plan. Other changes were made based on comments from the previous plan's review guide and the newly established guidance as part of FEMA's Hazard Mitigation Assistance Program and Policy Guide.

Table 2: 2016 Plan Comments and Revisions

Comment from 2016 Review Tool	Location of Revision	Summary of Change
Recommend a consistent name for the planning committee to avoid confusion. Variously called HMPC, Planning Team, Planning Team committee in different parts of the plan.	Throughout	The planning committee will be referred to as the local planning team throughout the plan.
The NCDC previous event narrative information should be shortened to include only information pertaining to the planning area. See, e.g., pages 76 and 77. On the other hand, the NCDC event narratives often include valuable information that was not included in the Marion plan, such as locations for previous events such as flash flooding.	Pages 124, 193-194	Specific events listed from the NCDC (NCEI replaced NCDC since 2016) are updated to focus on event details pertaining to the hazard and the impacts to the planning area.
"The main flooding source in Marion County is the Des Moines River which runs from the north western area of the county to the south west border of the county. The Little Sioux River also passes through the northwestern tip of the county. Numerous creeks and streams bisect the county as shown in the maps provided at the end of this hazard discussion. Historical cresting data for either of these rivers within the planning area was not available." The Little Sioux River is not in Marion County, the Des Moines River runs to the south east corner of the county.	Flooding Location – Page 121	The location of rivers within the planning area has been revised to exclude the Little Sioux River and include the South Skunk River as well as accurate locations of the South Skunk River and Des Moines River.
Many maps could be eliminated because they provide no substantive information (land use maps in particular) and other maps could be combined (flood plain maps and critical facility maps) This would more	Section 3 and Participant Sections	Critical facility maps and 1% flood risks have been combined into one map. Current land use maps were removed from the plan.

Comment from 2016 Review Tool	Location of Revision	Summary of Change
effectively communicate risk and support a more efficient and effective document.		
The Plan must identify and analyze a comprehensive range of specific mitigation actions/projects addressing the hazards identified for each jurisdiction. This ensures the hazard mitigation actions are based on the identified hazard vulnerabilities. Review of the proposed actions for each jurisdiction revealed a lack of correlation between hazards chosen as most problematic and the proposed strategy. For example, Knoxville identified three hazards as being their highest concern. One of the hazards was not addressed by proposed strategy. Thirteen of Knoxville's proposed action strategies did not involve any of the top three.	Section 4, Section 7	The plan follows new guidance requiring each jurisdiction to identify at least one mitigation action/project for each hazard identified.
Pella Health actions are confusing: why would a health center or hospital conduct a jurisdictional plan review or back up municipal records? Why would they have alert sirens? Wouldn't those be city functions?	Section 7	Mitigation actions have been reviewed and tailored to specific jurisdiction types.

Plan Implementation

Various communities across the planning area have implemented hazard mitigation and strategic projects following the 2016 Hazard Mitigation Plan. A few examples of completed projects include backup generators, storm water drainage improvements, safe room, emergency preparedness drills, and others. To build upon these prior successes and to continue implementation of mitigation and strategic projects, despite limited resources, communities will need to continue relying upon multi-agency coordination as a means of leveraging resources. Communities across the region have been able to work with a range of entities to complete projects and potential partners for future project implementation include but are not limited to: Iowa Department of Homeland Security and Emergency Management (HSEMD), Iowa Department of Transportation (IDOT), Iowa Department of Natural Resources (IDNR), United States Department of Agriculture (USDA), and United States Army Corps of Engineers (USACE).

Hazard Profiles

The hazard mitigation plan includes a description of the hazards considered, including a risk and vulnerability assessment. Data considered during the risk assessment process included: historic occurrences and recurrence intervals; historic losses (physical and monetary); impacts to the built environment (including privately-owned structures as well as critical facilities); and the local risk assessment. The following tables provide an overview of the risk assessment for each hazard and the losses associated with each hazard. See *Section Four: Risk Assessment* for further discussion of counts, probabilities, and likely extent.

Table 3: Regional Risk Assessment

Hazard	Previous Occurrences	Approximate Annual Probability*	Likely Extent
Agricultural Plant and Animal Disease	Animal Disease: Unavailable	Unknown	Unknown
	Plant Disease: 18	Plant Disease 9/22 = 41%	Crop damage or loss
Dam Failure	0	Less than 1%	Varies by structure Inundation of floodplain downstream from dam
Drought	489/1,532 months	28%	Mild Drought (D1)
Earthquakes	0	Less than 1%	Less than 5.0 on the Richter Scale
Expansive Soils	Unknown	Unknown	Varies by event
Extreme Heat	Heat: Avg 2 day/year	29/84 = 35%	Max Temp ≥100°F
Flooding	133	21/27 =78%	Some inundation of structures and road closures. Some evacuations of people may be necessary.
Grass and Wildland Fire	39	5/15 = 33%	Avg 6 acres
Hazardous Materials Release	Fixed Site Spill: 25	17/33 = 52%	Avg Liquid Spill: 125 gallons Avg Gas Spill: 3,057 lbs.
	Transportation Spill: 6	5/52 = 10%	Avg Spill: 3,358 lbs of product
Human Infectious Diseases	2 major outbreaks	Unknown	Unknown
Infrastructure Failure	Unknown	Likely to occur annually	Varies by event
Landslide	Unknown	Less than 1%	Varies by event
Severe Thunderstorms	428	27/27= 100%	>1" rainfall Avg 75 mph winds Avg. hail 1.2"
Severe Winter Storms & Extreme Cold	Storms: 72	24/27 = 89%	1-8" snow 25-35 mph winds
	Cold: Avg 4 days/year	68/84 = 81%	Max Temp ≤ 10°F
Sinkhole	Unknown	Less than 1%	Varies by location/event
Terrorism and Civil Disorder	0	Less than 1%	Varies by event
Tornado and High Winds	Tornadoes: 25	13/27 = 48%	Mode: EF1 Range: EF0-EF3
	High Winds: 31	19/27 = 70%	Avg: 56 mph Range 40-73 mph
	Auto: 5,640	11/11 = 100%	

Hazard	Previous Occurrences	Approximate Annual Probability*	Likely Extent
Transportation Incident	Aviation: 22	16/61 = 26%	Damages incurred to vehicles involved and traffic delays; substantial damages to aircrafts involved with some aircrafts destroyed
	Rail: 46	18/48 = 38%	

** Annual Probability = Total Years with an Event Occurrence / Total Years of Record*

The following table provides loss estimates for hazards with sufficient data. Description of major events are included in *Section Seven: Community Profiles.*

Table 4: Hazard Loss Estimates for the Planning Area

Hazard Type		Count	Property ($)	Crop ($)[2]
Agricultural Plant and Animal Disease	Animal Disease	Unknown	N/A	N/A
	Agricultural Plant Disease[1]	18	N/A	$705,024
Dam Failure[3,11]		0	-	N/A
Drought[4,7]		489/1,532 months	$12,650,000	$22,863,238
Earthquake[5]		0	-	$0
Expansive Soils		Unknown	N/A	N/A
Extreme Heat[6]	Heat (≥100°F)	Avg 2 day /year	$135,000	$190,811
Flooding[7]	Flash Flood	34	$2,117,000	$4,759,233
	Flood	99	$5,037,070	
Grass and Wildland Fire[8] 1 injury		39	209 Acres	-
Hazardous Materials Release	Fixed Site[9] 3 injuries	25	$200,000	N/A
	Transportation[10]	6	$885,874	N/A
Human Infectious Diseases[16]		8,784 COVID cases; 133 fatalities	N/A	N/A
Infrastructure Failure		Unknown	N/A	N/A
Landslide		Unknown	N/A	N/A
Severe Thunderstorms[7]	Hail	144	$755,000	$22,844,644
	Heavy Rain	93	$0	
	Lightning	6	$117,000	
	Thunderstorm Wind 1 injury	185	$3,503,000	
	Blizzard	11	$335,000	$971,532

Hazard Type		Count	Property ($)	Crop ($)[2]
Severe Winter Storms and Extreme Cold[7]	Extreme Cold/ Wind Chill (≤10°F)[6]	310 days	N/A	
	Heavy Snow	24	$861,560	
	Ice Storm	11	$323,330	
	Winter Storm	25	$564,900	
	Winter Weather	1	$0	
Sinkhole		Unknown	N/A	N/A
Terrorism and Civil Disorder[12]		0	-	N/A
Tornado and High Winds[7]	Tornadoes: Average: EF1 Range: EF0-EF3 24 injuries	25	$121,535,000	$537,598
	High Winds: Average: 56 mph Range: 40-73 mph	31	$879,110	$144,633
Transportation Incident	Auto[13] 1,649 injuries, 38 deaths	5,640	$34,979,475	N/A
	Aviation[14] 4 injuries, 4 deaths	22	N/A	N/A
	Rail[15] 18 injuries, 1 death	46	$65,850	N/A
Total		**13,068***	**$369,683,338**	**$106,043,108**

**does not include counts for Animal Disease, Drought, Expansive Soils, Extreme Heat, Human Infectious Diseases, Infrastructure Failure, Landslide, or Sinkholes*
N/A: Data not available
1 USDA RMA, 2000 - 2021
2 U.S. Department of Agriculture - Risk Management Agency. 2022.
3 IDNR Communication, 2022
4 NOAA, 1895 - August 2022
5 USGS, 1900 - April 2022
6 NOAA Regional Climate Center, 1939 - 2022
7 NCEI, 1996 - 2022
8 IDNR, 2019 - 2021
9 NRC, 1990 - 2022
10 PHMSA 1971 - October 2022
11 USACE NLD, 1900 - October 2022
12 University of Maryland, 1970 - 2018
13 IDOT, 2012 - October 2022
14 NTSB, 1962 - December 2022
15 FRA, 1975 - 2021
16 IDPH, as of 6/15/22

Events like extreme temperatures, grass/wildland fires, severe thunderstorms, severe winter storms, and transportation incidents will occur annually. Other hazards like dam and levee failure, earthquakes, and terrorism/civil unrest will occur less often. The scope of events and how they will manifest themselves locally is not known regarding hazard occurrences. Historically, drought, severe thunderstorms, severe winter storms, tornadoes/windstorms, and transportation incidents have resulted in the most significant damages within the planning area. Current trends show an increase in event magnitude and a higher number of occurrences for several hazards, as will be explained in *Section Four: Risk Assessment*.

Mitigation Strategies

There are a wide variety of strategies that can be used to reduce the impacts of hazards for the built environment and planning area residents. *Section Five: Mitigation Strategy* shows the mitigation and strategic actions chosen by the participating jurisdictions to assist in preventing future losses. The following table shows the most common mitigation actions that can be implemented to prevent future losses.

Table 5: Key Mitigation Strategies

HAZARD	MITIGATION STRATEGIES
Agricultural Plant and Animal Disease	-Geographic Information Systems (GIS) Mapping -Public education and awareness
Dam Failure	-Emergency Preparedness Drills and Preparedness Program -Public education and awareness -Install Standby Pumps -Upgrade Radios
Drought	-Public education and awareness
Earthquake	-Emergency Preparedness Drills and Preparedness Program -Public education and awareness
Expansive Soils	-Public education and awareness
Extreme Heat	-Preparedness Program -Public education and awareness
Flooding	-Uphold Building Codes and Ordinances -Install Backflow Devices -Flood-Prone Structures -Public education and awareness -Install impervious manhole covers and perform water and sewer line maintenance -Standby Pumps -Stream Modifications -Study Illegal Sump Pumps
Grass and Wildland Fire	-Emergency Vehicle Tracking -Multi-Family Fire Extinguishers -New Fire Truck and Ambulance -Upgrade Equipment, Fire Station, and Radios
Hazardous Materials Release (Fixed Site and Transportation Spills)	-Emergency Preparedness Drills and Preparedness Program -Chemical Container Removal -Improve Hazardous Incident Response -Public education and awareness

HAZARD	MITIGATION STRATEGIES
Human Infectious Diseases	-Emergency Preparedness Drills -Public education and awareness
Infrastructure Failure	-GIS Mapping -Storm Water Drainage -Public education and awareness
Landslides	-Emergency Preparedness Drills -Public education and awareness
Severe Thunderstorms	-Backup jurisdictional files and records in alternative locations -Bury power lines or harden critical infrastructure -Civil Service Improvements -Design and construct storm shelters and safe rooms -Emergency Preparedness Drills and Preparedness Program -Install Backflow Devices -Public education and awareness -Purchase and install backup power generators for redundant power -Storm Water Controls
Severe Winter Storms and Extreme Cold	-Backup jurisdictional files and records in alternative locations -Bury power lines or harden critical infrastructure -Civil Service Improvements -Incorporate use of snow fences to protect vulnerable transportation routes -Purchase and install backup power generators for redundant power -Public education and awareness
Sinkholes	-Emergency Preparedness Drills -Public education and awareness
Terrorism and Civil Disorder	-Emergency Preparedness Drills and Preparedness Program -Improve local security systems for critical facilities -Public education and awareness
Tornadoes and High Winds	-Bury power lines or harden critical infrastructure -Design and construct storm shelters and safe rooms -Emergency Preparedness Drills and Preparedness Program -Public education and awareness
Transportation Incidents	-Emergency Preparedness Drills and Preparedness Program -Road Bypass Projects -Public education and awareness

Section One
Introduction

Hazard Mitigation Planning

Severe weather and hazardous events are occurring more frequently in our daily lives. Pursuing mitigation strategies reduces these risks and is socially and economically responsible to prevent long-term risks from natural and human-caused hazard events.

FEMA definition of Hazard Mitigation

"Any sustained action taken to reduce or eliminate the long-term risk to human life and property from [natural] hazards."

Natural hazards, such as severe winter storms, high winds and tornadoes, severe thunderstorms, flooding, extreme heat, drought, agriculture diseases, and wildfires are part of the world around us. Human-caused hazards are a product of the society and can occur with significant impacts to communities. Human-caused hazards can include dam failure, hazardous materials release, transportation incidents, and terrorism. These hazard events can occur as a part of normal operation or as a result of human error. All jurisdictions participating in this planning process are vulnerable to a wide range of natural and human-caused hazards that threaten the safety of residents and have the potential to damage or destroy both public and private property, cause environmental degradation, and disrupt the local economy and overall quality of life.

Marion County has prepared this multi-jurisdictional hazard mitigation plan to reduce impacts from natural and human-caused hazards and to better protect the people and property of the region from the effects of these hazards. This plan is an update to the 2016 FEMA approved Marion County Hazard Mitigation Plan (HMP). The plan update was developed in compliance with the requirements of the Disaster Mitigation Act of 2000 (DMA 2000). This plan demonstrates a broad commitment to reducing risks from hazards and serves as a tool to help decision makers establish mitigation activities and resources. Further, this plan was developed to ensure the county and participating jurisdictions are eligible for federal Hazard Mitigation Assistance (HMA) programs and to accomplish the following objectives:

- Minimize the disruption to each jurisdiction following a disaster.
- Establish actions to reduce or eliminate future damages to efficiently recover from disasters.
- Investigate, review, and implement activities or actions to ensure disaster related hazards are addressed by the most efficient and appropriate solution.
- Educate citizens about potential hazards.
- Facilitate development and implementation of hazard mitigation management activities to ensure a sustainable community.

Disaster Mitigation Act of 2000

The U.S. Congress passed the Disaster Mitigation Act 2000 to amend the Robert T. Stafford Disaster Relief and Emergency Assistance Act[1]. Section 322 of the DMA 2000 requires that state and local governments develop, adopt, and routinely update a hazard mitigation plan to remain eligible for pre- and post-disaster mitigation funding.[2] These funds currently include the Hazard Mitigation Grant Program (HMGP)[3], Building Resilient Infrastructure and Communities (BRIC)[4], and the Flood Mitigation Assistance Program (FMA)[5]. The Federal Emergency Management Agency (FEMA) administers these programs under the Department of Homeland Security.[6]

This plan was developed in accordance with current state and federal rules and regulations governing local hazard mitigation plans. The plan shall be monitored and updated on a routine basis to maintain compliance with the legislation – Section 322, Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the DMA 2000 (P.L. 106-390)[7] and by FEMA's Final Rule (FR)[8] published in the Federal Register on November 30, 2007, at 44 Code of Federal Regulations (CFR) Part 201.

Hazard Mitigation Assistance

On June 1, 2009, FEMA initiated the Hazard Mitigation Assistance (HMA) program integration, which aligned certain policies and timelines of the various mitigation programs. These HMA programs present a critical opportunity to minimize the risk to individuals and property from hazards while simultaneously reducing the reliance on federal disaster funds.

Each HMA program is funded by separate legislative actions, and as such, each program differs slightly in scope and intent.

FEMA MITIGATION DIRECTORATE

Mitigation is the cornerstone of emergency management. Mitigation focuses on breaking the cycle of disaster damage, reconstruction, and repeated damage. Mitigation lessens the impact disasters have on people's lives and property through damage prevention, appropriate development standards, and affordable flood insurance. Through measures such as avoiding building in damage-prone areas, stringent building codes, and floodplain management regulations, the impact on lives and communities is lessened.

- **HMGP:** To qualify for post-disaster mitigation funds, local jurisdictions must have adopted a mitigation plan that is approved by FEMA. HMGP provides funds to states, territories, tribal governments, local governments, and eligible private non-profits following a presidential disaster declaration. The DMA 2000 authorizes up to seven

[1] Federal Emergency Management Agency, Public Law 106-390. 2000. "Disaster Mitigation Act of 2000." https://www.fema.gov/sites/default/files/2020-11/fema_disaster-mitigation-act-of-2000_10-30-2000.pdf.

[2] Federal Emergency Management Agency. 2021. "Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, and Related Authorities." Federal Emergency Management Agency 592: 22. Sec. 322. Mitigation Planning (42 U.S.C. 5165). https://www.fema.gov/sites/default/files/documents/fema_stafford_act_2021_vol1.pdf.

[3] Federal Emergency Management Agency. "Hazard Mitigation Grant Program." Last modified August 6, 2021. https://www.fema.gov/grants/mitigation/hazard-mitigation.

[4] Federal Emergency Management Agency. "Building Resilient Infrastructure and Communities." Last modified December 1, 2021. https://fema.gov/bric.

[5] Federal Emergency Management Agency. "Flood Mitigation Assistance Grant Program." Last modified August 6, 2021. https://www.fema.gov/flood-mitigation-assistance-grant-program.

[6] Federal Emergency Management Agency. "Hazard Mitigation Assistance." Last modified September 30, 2021. https://www.fema.gov/grants/mitigation.

[7] Federal Emergency Management Agency: Federal Register. 2002. "Section 104 of Disaster Mitigation Act 2000: 44 CFR Parts 201 and 206: Hazard Mitigation Planning and Hazard Mitigation Grant Programs; Interim Final Rule." https://www.fema.gov/pdf/help/fr02-4321.pdf.

[8] Federal Emergency Management Agency: Federal Register. 2002. "44 CFR Parts 201 and 206: Hazard Mitigation Planning and Hazard Mitigation Grant Programs; Interim Final Rule." https://www.fema.gov/pdf/help/fr02-4321.pdf.

percent of HMGP funds available to a state after a disaster to be used for the development of state, tribal, and local mitigation plans.

- **FMA:** To qualify to receive FMA funds to reduce or eliminate risk of repetitive flood damage to buildings and structures, local jurisdictions must have an adopted and approved mitigation plan. Furthermore, local jurisdictions must be participating communities in the National Flood Insurance Program (NFIP). The goal of FMA is to reduce or eliminate claims under the NFIP.

- **BRIC:** To qualify for funds, local jurisdictions must adopt a mitigation plan that is approved by FEMA. BRIC assists states, territories, tribal governments, and local governments in implementing a sustained pre-disaster hazard mitigation program.

Plan Financing

Regarding the plan financing, Marion County Emergency Management applied for Pre-Disaster Mitigation grant funding in fiscal year 2019, which was awarded to fund this planning process. Due to the COVID-19 pandemic, the plan update process was delayed until 2022. Marion County as the “sub-applicant”, is the eligible entity that submits a sub-application for FEMA assistance to the “Applicant”, which is the State of Iowa. If HMA funding is awarded, the sub-applicant becomes the “sub-grantee” and is responsible for managing the sub-grant and complying with program requirements, such as quarterly reporting and reimbursement requests, as well as other applicable federal, state, territorial, tribal, and local laws and regulations.

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Section Two
Planning Process

Introduction

The process utilized to develop a hazard mitigation plan is often as important as the final planning document. For this planning process, Marion County adapted the four-step hazard mitigation planning process outlined by FEMA to fit the needs of the participating jurisdictions. The following pages will outline how the Hazard Mitigation Planning Team was established; the function of the Hazard Mitigation Planning Team; critical project meetings and community representatives; outreach efforts to the general public; key stakeholders and neighboring jurisdictions; general information relative to the risk assessment process; general information relative to local/regional capabilities; plan review and adoption; and ongoing plan maintenance.

Requirement §201.6(b): Planning process. An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

Requirement §201.6(b)(1): An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;

Requirement §201.6(b)(2): An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and

Requirement §201.6(b)(3): Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

Requirement §201.6(c)(1): The plan shall document the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

Multi-Jurisdictional Approach

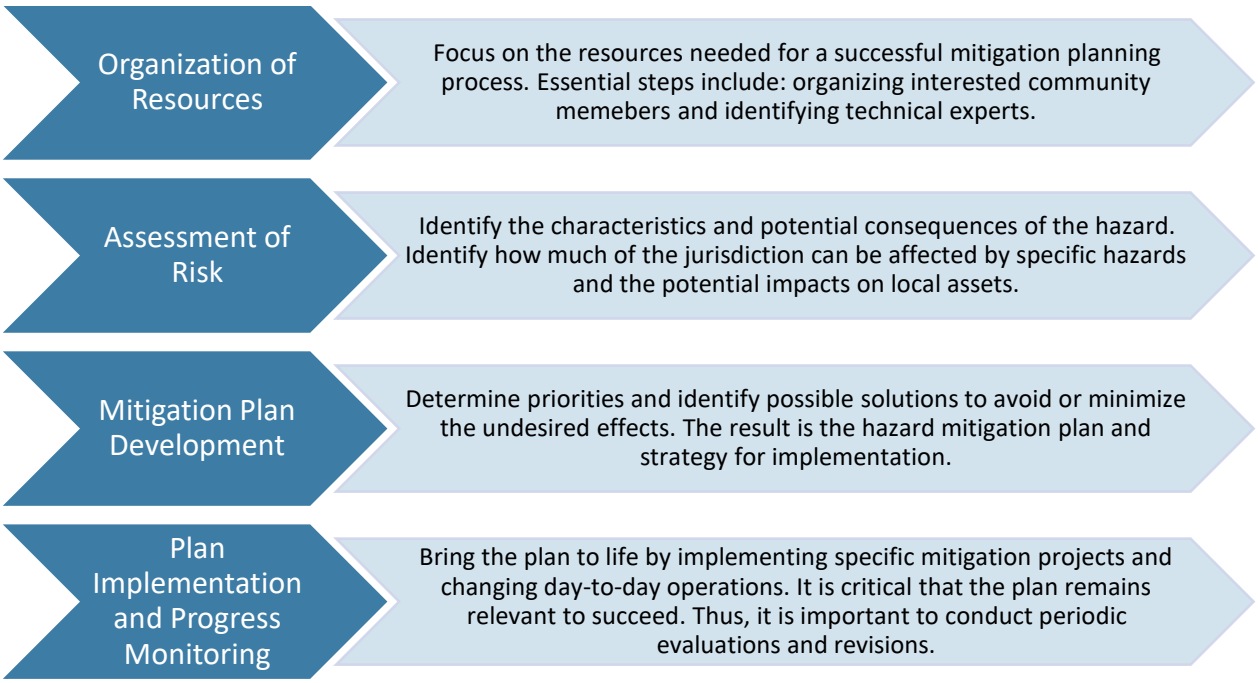
According to FEMA, "A multi-jurisdictional hazard mitigation plan is a plan jointly prepared by more than one jurisdiction." The term 'jurisdiction' means 'local government.' Title 44 Part 201, Mitigation Planning in the CFR, defines a 'local government' as "any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments, regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, any rural community, unincorporated town or village, or other public entity." For the purposes of this plan, a 'taxing authority' was utilized as the qualifier for jurisdictional participation. FEMA recommends the multi-jurisdictional approach under the DMA 2000 for the following reasons.

- It provides a comprehensive approach to the mitigation of hazards that affect multiple jurisdictions.
- It allows economies of scale by leveraging individual capabilities and sharing cost and resources.
- It avoids duplication of efforts.
- It imposes an external discipline on the process.

Both FEMA and the Iowa Department of Homeland Security and Emergency Management (HSEMD) recommend this multi-jurisdictional approach through the cooperation of counties, communities, local

stakeholders, and local emergency management. Marion County utilized the multi-jurisdiction planning process recommended by FEMA (Local Mitigation Plan Review Guide[9], Local Mitigation Planning Handbook[10], and Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards[11]) to develop this plan.

The hazard mitigation planning process as outlined by FEMA has four general steps which are detailed below. The mitigation planning process is rarely a linear process. It's common that ideas developed during the initial risk assessment may need revision later in the process, or that additional information may be identified while developing the mitigation plan or during plan implementation that results in new goals or additional risk assessments.



Organization of Resources

Plan Update Process

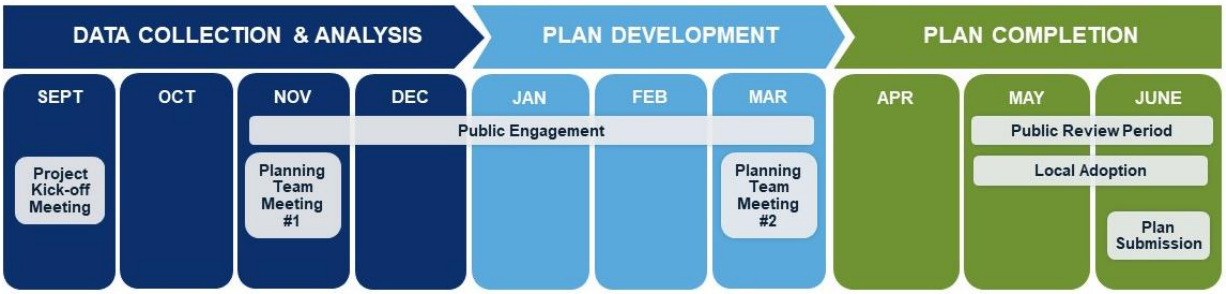
Marion County secured a FEMA PDM planning grant funding for their multi-jurisdictional hazard mitigation plan in 2019. JEO Consulting Group, Inc. (JEO) was contracted in July 2022 to guide and facilitate the planning process and write and assemble the multi-jurisdictional hazard mitigation plan. For the planning area, Jeff Anderson (Emergency Management Director) with Marion County led the development of the plan and served as the primary point of contact throughout the project. A clear timeline of this plan update process is provided in Figure 2.

[9] Federal Emergency Management Agency. 2011. "Local Mitigation Plan Review Guide." https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-plan-review-guide_09_30_2011.pdf.

[10] Federal Emergency Management Agency. 2013. "Local Mitigation Planning Handbook." https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-planning-handbook_03-2013.pdf.

[11] Federal Emergency Management Agency. 2013. "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards." https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf.

Figure 2: Project Timeline



Hazard Mitigation Planning Team

At the beginning of the planning process, Marion County Emergency Management and JEO staff identified who would serve as part of the county and local Hazard Mitigation Planning Teams. The county planning team was established to guide the planning process, review the existing plan, and serve as a liaison to plan participants throughout the planning area. This Hazard Mitigation Planning Team comprised of county representatives, state agencies, and the consultant, was established to guide the planning process; review the 2016 HMP and discuss planning process changes or plan requirements; and serve as liaisons between specific county departments, communities, or other local stakeholders. Those invited to be a part of the Hazard Mitigation Planning Team included contacts from the Marion County Board of Supervisors, county department directors, community mayors, hospital directors, school superintendents, USACE, and State of Iowa. A list of planning team members who attended meetings or provided input can be found in Table 6.

Table 6: Hazard Mitigation Planning Team

NAME	TITLE	JURISDICTION
Carla Eysink	Economic Development	Marion County
Cassi Pearson	Superintendent	Knoxville Community Schools
Emily Feagins	Deputy EM/Public Information Officer	Marion County EMA
Jeff Anderson	Emergency Management Director	Marion County EMA
Kim Dorn	Public Health	Marion County
Missy Poffenbarger	Zoning Administrator	Marion County
Nathalie McCollam	Facilities Specialist	Pella Regional Health Center
Troy Fisher	Chief Deputy	Marion County Sheriff's Office
Becky Appleford*	Project Manager	JEO Consulting Group
Brooke Seachord*	Project Coordinator	JEO Consulting Group

**Served in a consultant or advisory role.*

A kick-off meeting was held on September 19, 2022, to discuss an overview of the planning process between JEO staff and members of the Hazard Mitigation Planning Team. Preliminary discussion was held over hazards to be included in this plan, changes to be incorporated since the last plan, goals and objectives, identification of key stakeholders to include in the planning process, and a general schedule for the plan update. This meeting also assisted in clarifying the role and responsibilities of the Hazard Mitigation Planning Team and strategies for public engagement throughout the planning process. Table 7 shows kick-off meeting attendees.

Table 7: Kick-off Meeting Attendees

NAME	TITLE	JURISDICTION
Knoxville, Iowa – Monday, September 19, 2022		
Carla Eysink	Economic Development	Marion County
Cassi Pearson	Superintendent	Knoxville Community Schools
Emily Feagins	Deputy EM/Public Information Officer	Marion County EMA
Jeff Anderson	Emergency Management Director	Marion County EMA
Kim Dorn	Public Health	Marion County
Missy Poffenbarger	Zoning Administrator	Marion County
Nathalie McCollam	Facilities Specialist	Pella Regional Health Center
Tony Aylsworth	Superintendent	Pleasantville Community Schools
Troy Fisher	Chief Deputy	Marion County Sheriff's Office
Becky Appleford*	Project Manager	JEO Consulting Group
Brooke Seachord*	Project Coordinator	JEO Consulting Group

Table 8 shows the date, location, and agenda items of for the kick-off meeting.

Table 8: Kick-off Meeting Location and Time

LOCATION AND TIME	AGENDA ITEMS
Knoxville, Iowa **September 19, 2022** **1:00 PM**	-Consultant and planning team responsibilities -Overview of plan update process and changes from 2016 HMP -Review and adoption of goals and objectives -Plan goals/objectives -Hazard identification -Project schedule and dates/locations for public meetings

Public Involvement and Outreach

To notify and engage the public in the planning process, a wide range of stakeholder groups were contacted and encouraged to participate. There were 23 stakeholder groups or entities that were identified and sent letters to participate. Of the 23 invited, Knoxville Hospitals, Marion County Conservation, Marion County Rural Water, County Rural Offices of Social Services (CROSS) Mental Health/Disability Services, Pella Cooperative Energy, Rathburn Rural Water Association, and Iowa Regional Utility Association attended meetings or provided input. Any comments these stakeholders provided were incorporated into the appropriate sections throughout the HMP upfront and community profiles as appropriate (see *Section Seven*).

Table 9: Notified Stakeholder Groups

ORGANIZATIONS		
County Rural Offices of Social Services	Knoxville Hospitals & Clinic	Pella Medical Clinic
E.J. McKeever Medical Center (Melcher)	Knoxville Municipal Airport	Pella Municipal Airport
Good Samaritan Free Clinic	Marion County Conservation	Pella Regional Health Care
Iowa Department of Homeland Security and Emergency Management	Medical Clinic in Bussey	Pleasantville Clinic

ORGANIZATIONS		
Iowa Finance Authority	Medical Clinic in Knoxville	Red Rock Healthcare Pella
Iowa Regional Utilities	Pella Aquatic Center	The Well Resource Center
Knoxville Airport Commission	Pella Athletic Facilities	VA Central Iowa Health Care System
Knoxville Clinic	Pella Cooperative Energy	

Neighboring Jurisdictions

Neighboring jurisdictions were notified and invited to participate in the planning process. The following table indicates which neighboring communities or entities were notified of the planning process. Invitation and informational letters were sent to city administrators, county clerks, and county and regional emergency managers. No jurisdictions outside of the planning area participated in the planning process.

Table 10: Notified Neighboring Jurisdictions

NOTIFIED NEIGHBORING JURISDICTIONS	
Appanoose County	Mahaska County
City of Monroe	Monroe County
Davis County	Polk County
Jasper County	Warren County
Lucas County	

Participant Involvement

Participants play a key role in identifying hazards, providing a record of historical disaster occurrences and localized impacts, identifying and prioritizing potential mitigation projects and strategies, and developing plan maintenance procedures.

To be a participant in the development of this HMP update, jurisdictions were required to:

- Attend Round 1 and Round 2 meetings or a one-on-one meeting with JEO staff,
- Provide relevant information throughout the plan update process, and
- Pass an Adoption Resolution for the approved HMP.

Jurisdictions had to have at least one representative present at meetings. Some jurisdictions sent multiple representatives to meetings. For jurisdictions who had only one representative, they were encouraged to bring meeting materials back to their governing bodies, to collect diverse input on their jurisdiction's meeting documents. Sign-in sheets from all public meetings can be found in *Appendix A.* Jurisdictions that were unable to attend the scheduled public meetings were able to watch a recording of the meetings or request a meeting with JEO staff to satisfy the meeting attendance requirements. This effort enabled jurisdictions which could not attend a scheduled public meeting to participate in the planning process.

Representatives from the Marion County Emergency Management Department served as the local contact and spearheaded local outreach to eligible jurisdictions, including notification prior to all public meetings, phone calls and email reminders of upcoming meetings, and reminders to complete worksheets required for the planning process.
Table 11 provides a summary of outreach activities utilized in this process.

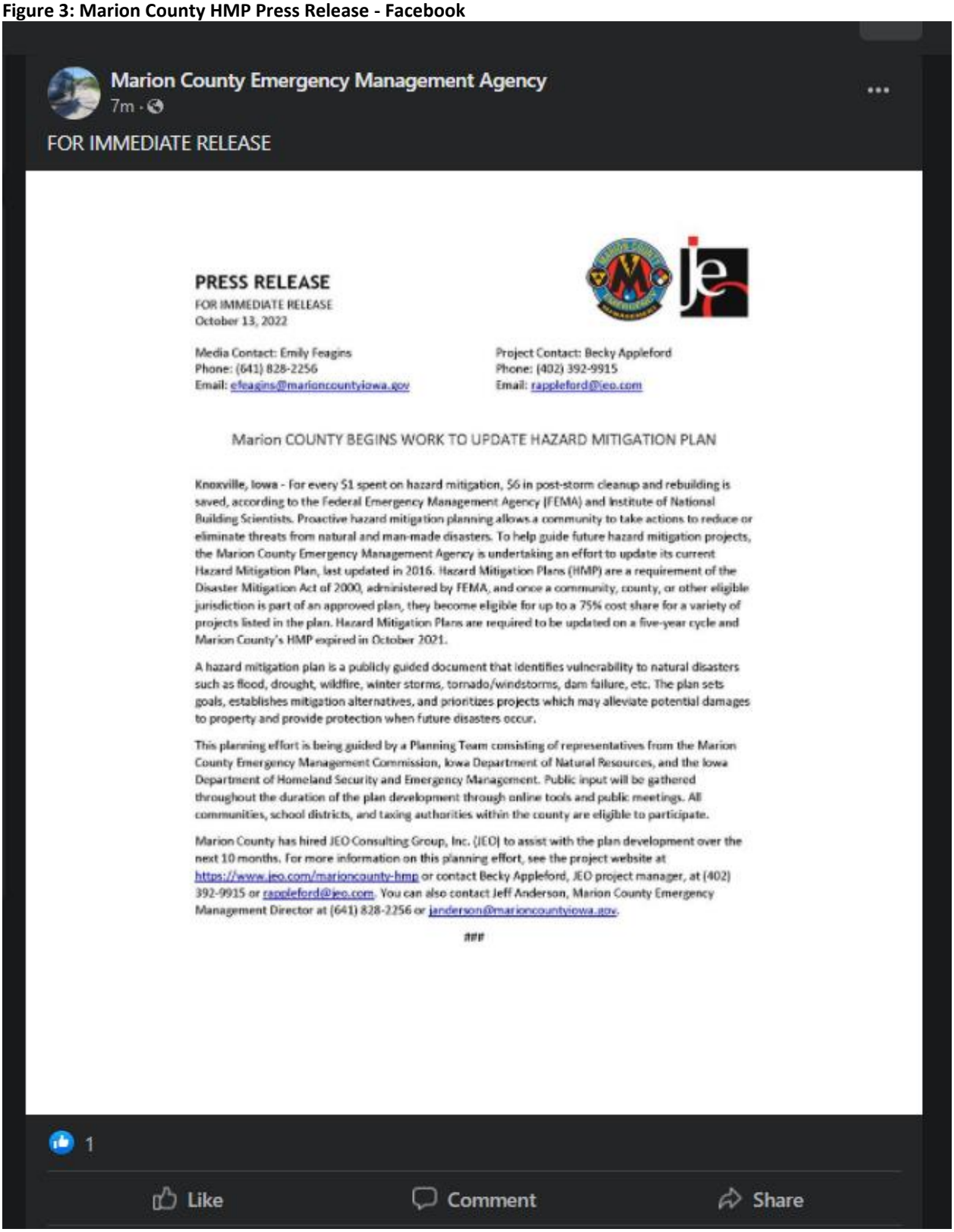
Table 11: Outreach Activity Summary

ACTION	INTENT
Project Website	Informed the public and local/planning team members of past, current, and future activities (https://www.jeo.com/Marioncounty-hmp).
Press Release	Shared with Hazard Mitigation Planning Team and sent to local media outlets for dispersal.
Round 1 Meeting Letters and Emails (30-day notification)	Sent to participants, stakeholders, and neighboring jurisdictions to discuss the agenda/dates/times/ locations of the first round of public meetings.
Round 2 Meeting Letters and Emails (30-day notification)	Sent to participants to discuss the agenda/dates/times/locations of the second round of public meetings.
Notification Phone Calls	Called potential participants to remind them about upcoming meetings.
Follow-up Emails and Phone Calls	Correspondence was provided to remind and assist participating jurisdictions with the collection and submission of required local data.
Project Flyer	Flyers were posted about the Marion County HMP and how to get involved. Flyers were shared with all Hazard Mitigation Planning Team members to distribute.
Word-of-Mouth	Staff discussed the plan with jurisdictions throughout the planning process.

Notifying and engaging the public was conducted throughout the plan drafting process. All meeting dates, times, and locations were posted online on the project website. A press release about the process was shared on local social media sites (see figure below) and to local news stations. Project flyers were shared with local planning team representatives and were posted at community hubs including local post offices, city hall buildings, local libraries, and coffee shops. Letters and/or emails with pertinent information or meeting invitations were shared with all participants, neighboring jurisdictions, and stakeholder groups including vulnerable populations such as care facilities and schools.

Participating jurisdictions also discussed and reviewed HMP materials at local council meetings which are open to the public. Comments or revisions regarding the plan were collected and shared with Marion County Emergency Management and/or JEO staff for inclusion in the HMP. No major comments (i.e. comments other than minor grammatical corrections) were reported.

Figure 3: Marion County HMP Press Release - Facebook



Marion County Emergency Management Agency
7m ·
FOR IMMEDIATE RELEASE

PRESS RELEASE
FOR IMMEDIATE RELEASE
October 13, 2022

Media Contact: Emily Feagins
Phone: (641) 828-2256
Email: efeagins@marioncountyiowa.gov

Project Contact: Becky Appleford
Phone: (402) 392-9915
Email: rappleford@jeo.com

Marion COUNTY BEGINS WORK TO UPDATE HAZARD MITIGATION PLAN

Knoxville, Iowa - For every $1 spent on hazard mitigation, $6 in post-storm cleanup and rebuilding is saved, according to the Federal Emergency Management Agency (FEMA) and Institute of National Building Scientists. Proactive hazard mitigation planning allows a community to take actions to reduce or eliminate threats from natural and man-made disasters. To help guide future hazard mitigation projects, the Marion County Emergency Management Agency is undertaking an effort to update its current Hazard Mitigation Plan, last updated in 2016. Hazard Mitigation Plans (HMP) are a requirement of the Disaster Mitigation Act of 2000, administered by FEMA, and once a community, county, or other eligible jurisdiction is part of an approved plan, they become eligible for up to a 75% cost share for a variety of projects listed in the plan. Hazard Mitigation Plans are required to be updated on a five-year cycle and Marion County's HMP expired in October 2021.

A hazard mitigation plan is a publicly guided document that identifies vulnerability to natural disasters such as flood, drought, wildfire, winter storms, tornado/windstorms, dam failure, etc. The plan sets goals, establishes mitigation alternatives, and prioritizes projects which may alleviate potential damages to property and provide protection when future disasters occur.

This planning effort is being guided by a Planning Team consisting of representatives from the Marion County Emergency Management Commission, Iowa Department of Natural Resources, and the Iowa Department of Homeland Security and Emergency Management. Public input will be gathered throughout the duration of the plan development through online tools and public meetings. All communities, school districts, and taxing authorities within the county are eligible to participate.

Marion County has hired JEO Consulting Group, Inc. (JEO) to assist with the plan development over the next 10 months. For more information on this planning effort, see the project website at https://www.jeo.com/marioncounty-hmp or contact Becky Appleford, JEO project manager, at (402) 392-9915 or rappleford@jeo.com. You can also contact Jeff Anderson, Marion County Emergency Management Director at (641) 828-2256 or janderson@marioncountyiowa.gov.

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Like Comment Share

Figure 4: HMP Project Flyer

Round 1 Meetings: Local Plan Review and Capabilities Discussion

At the Round 1 meetings, jurisdictional representatives (i.e., the local planning teams) are familiarized with the HMP update process, review information from the previous HMP, and update the general overview of the community's capabilities. Table 12 shows the date and location of meetings held for the Round 1 meeting phase of the project.

Table 12: Round 1 Meeting Dates and Locations

AGENDA ITEMS	
General overview of the HMP planning process; discussion of participation requirements; review jurisdiction profile draft; begin risk assessment and impact reporting discussion; update capability assessment and plan integration; review and identification of critical facilities.	
Location and Time	**Date**
Marion County Public Health Department Knoxville, Iowa – 9:00 AM	Thursday, November 3rd, 2022
Marion County Public Health Department Knoxville, Iowa – 5:30 PM	Thursday, November 3rd, 2022

The intent of these meetings was to familiarize local planning team members with the plan update process, expected actions for the coming months, the responsibilities of being a participant, and to collect preliminary information to update the HMP. Round 1 meetings are also used as an opportunity to discuss Plan Integration components. Each participating jurisdiction was asked to either describe or provide a copy of other planning mechanisms which support the goals and intent of the HMP for inclusion. These included Comprehensive Plans, 1- & 6-Year Plans, Zoning Ordinances, Floodplain Ordinances, Building Codes, or other plans used by the jurisdiction.

The following tables show the attendees for each jurisdiction who attended a Round 1 meeting or had a one-on-one discussion with JEO staff. Follow-up one-on-one meetings were held for communities who did not have representatives present at public meetings either through watching a recording of the meeting or via conference call with a JEO staff member or representative from Marion County Emergency Management.

Table 13: Round 1 Meeting Attendees

NAME	TITLE	JURISDICTION
Knoxville, Iowa – Thursday, November 3rd, 2022, 9:00 AM		
Amber Hall (virtual)		Pella Cooperative Electric
Andrew De Haan	Director of IT	Marion County
Angela Fee	Operations Manager	Marion County Rural Water District
Brian Hatch	Mayor	City of Knoxville
Carla Eysink	Director	Marion County Development Commission
Craig Mobley (virtual)	Business Manager, Board Secretary/Treasurer	Knoxville Community Schools
Dan Zylstra	Head of Schools	Pella Christian Schools
Emily Feagins	Assistant EMA	Marion County
John Steddom (virtual)	Madison Elementary Principal	Pella Community Schools
Kevin Herdegen (virtual)	Principal	Pella Christian High School
Larry Pineger (virtual)	Mayor	City of Bussey

Laurie Lenertz	Social Worker	CROSS MHDS Region
Melissa Poffenbarger	Zoning Administrator	Marion County
Michael Nicodemus (virtual)	Superintendent	Southeast Polk School District
Michael Wildung (virtual)	Distribution Manager	Iowa Regional Utilities Association
Michaela Bigaouette	County Treasurer	Marion County
Naomi Ellis	County Recorder	Marion County
Nicole Beary (virtual)	City Clerk	City of Bussey
Steve Edwards	Conservation Director	Marion County Conservation
Troy Fisher	Chief Deputy	Marion County Sheriff's Department
Tyler Christian	County Engineer	Marion County
Becky Appleford	Project Manager	JEO Consulting Group, Inc.
Brooke Seachord	Project Coordinator	JEO Consulting Group, Inc.
Knoxville, Iowa – Thursday, November 3rd, 2022, 5:30 PM		
Mike Wildung	Distribution Manager	Iowa Regional Utilities
Dennis Seibert	Mayor	City of Harvey
Leonard Geery	City Council Member	City of Harvey
Jeff Anderson	Emergency Manager	Marion County EMA
Wendy Hopkins	Emergency and Trauma Services Manager	Knoxville Hospital
Becky Appleford	Project Manager	JEO Consulting Group, Inc.
Brooke Seachord	Project Coordinator	JEO Consulting Group, Inc.

Round 2 Meeting: Hazard Identification and Mitigation Strategy Development

The identification and prioritization of top hazards of concern and respective mitigation measures is an essential component in developing effective hazard mitigation plans. At this meeting, the local jurisdictional representatives reviewed the hazards to be profiled in this HMP update (as established at the Kick-off Meeting) and provide information about local impacts, historical occurrences, and overall community exposure to the various hazards. For a complete list of hazards reviewed, see *Section Four Risk Assessment.* Round 2 meetings are designed to allow participating jurisdictions an opportunity to identify which hazards pose the most local risks; update mitigation actions from the previous Marion County HMP (as applicable); and identify and describe new mitigation strategies to address prioritized hazards or identified gaps in planning, response, or resiliency from Round 1 meetings (refer to *Appendix B*).

Participating jurisdictions were also asked to review the information collected from Round 1 meetings related to their community through this planning process to ensure all information included was up-to-date and accurate. Information/data reviewed include but was not limited to identified critical facilities and their location within the community; future development areas; and overall growth trends. Newly added to Round 2 meetings also included a discussion of Plan Maintenance and the importance of updating local profiles as priorities change, mitigation actions are completed, or after a disaster event.

A brief status update on project schedule, public review period, final local adoption, and the approval and grant opportunities available once the plan is approved by HSEMD and FEMA was also provided to all participants. Table 14 shows the date and location of the Round 2 Meeting. Meeting attendees are identified in
Table 15 and
Table 16. Follow up one-on-one meetings were held for communities who did not have representatives present at public meetings through conference calls with a JEO staff member or representative from Marion County Emergency Management.

Table 14: Round 2 Meeting Dates and Locations

AGENDA ITEMS	
Identify hazards of top concern and new mitigation and strategic actions for each hazard, review of local data and community profile, discuss review process, discuss available grants and eligibility, and complete plan integration tool.	
Location and Time	**Date**
Marion County Public Health Department Knoxville, Iowa – 10:00 AM	Thursday, March 2, 2023

Table 15: Round 2 Meeting Attendees

NAME	TITLE	JURISDICTION
Knoxville, Iowa – March 2, 2023		
Adam Windle	Melcher-Dallas Zoning	City of Melcher-Dallas
Andrew De Haan	Director of IT	Marion County
Ben Dirksen	Principal	Pella Christian Grade School
Craig Mobley	Business Manager, Board Secretary/Treasurer	Knoxville Schools
Dennis Seibert	Mayor	City of Harvey
Emily Feagins	Public Information Officer - EMA	Marion County
Jake Grandia	County Auditor	Marion County

NAME	TITLE	JURISDICTION
Jeff Anderson	Emergency Manager	Marion County
John Steddom	Madison Elementary Principal	Pella Community Schools
Kim Dorn	Public Health Director	Marion County
Larry Pinegar	Mayor	City of Bussey
Marcia Slycord	Administrative Services Manager	City of Pella
Melissa Poffenbarger	Zoning Administrator	Marion County
Naomi Ellis	County Recorder	Marion County
Nicole Beary	City Clerk	City of Bussey
Rachel Cecil	Chief Executive Officer	CROSS Mental Health and Disability Services
Scott Bridges	Superintendent	Melcher-Dallas Schools and Twin Cedar Schools
Shane McSheeny	Police Chief	City of Pella
Sarah Willoughby	Deputy City Clerk	Marion County
Steve Edwards	Conservation Director	Marion County
Troy Fisher	Chief Deputy	Marion County Sheriff's Department
Tyler Christian	County Engineer	Marion County
Wendy Hopkins	ED/Trauma Services Manager	Knoxville Hospital
Becky Appleford	Project Manager	JEO Consulting Group, Inc.
Brooke Seachord	Project Coordinator	JEO Consulting Group, Inc.

Table 16: Round 2 One-on-One Meeting Attendees/Follow Up

NAME	TITLE	JURISDICTION
Knoxville, Iowa – March 2, 2023		
Brian Hatch	Mayor	City of Knoxville
Brooke Seachord	Project Manager	JEO Consulting Group

Data Sources and Information

Effective hazard mitigation planning requires the review and inclusion of a wide range of data, documents, plans, and studies. The following table identifies many of the sources utilized during this planning process. Specific references are included as footnotes when used as applicable. The following table is not exhaustive as many studies, plans, and data resources at the local level are not publicly available. Individual examples of plan integration are identified in *Section Seven: Community Profiles*.

Table 17: General Plans, Documents, and Information

DOCUMENTS	
Disaster Mitigation Act of 2000 DMA https://www.fema.gov/sites/default/files/2020-11/fema_disaster-mitigation-act-of-2000_10-30-2000.pdf	Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards (2013) https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf
Final Rule (2007) https://www.fema.gov/emergency-managers/risk/hazard-mitigation/regulations-guidance/archive	National Flood Insurance Program Community Status Book (2020) https://www.fema.gov/flood-insurance/work-with-nfip/community-status-book
Hazard Mitigation Assistance Unified Guidance (2015) https://www.fema.gov/sites/default/files/2020-07/fy15_HMA_Guidance.pdf	National Response Framework (2019) https://www.fema.gov/emergency-managers/national-preparedness/frameworks/response
Hazard Mitigation Assistance Guidance and Addendum (2015) https://www.fema.gov/sites/default/files/2020-07/fy15_hma_addendum.pdf	Robert T. Stafford Disaster Relief and Emergency Assistance Act (2021) https://www.fema.gov/disasters/stafford-act
Local Mitigation Plan Review Guide (2011) https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-plan-review-guide_09_30_2011.pdf	The Census of Agriculture (2017) https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Census_by_State/Iowa/
Local Mitigation Planning Handbook (2013) https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-planning-handbook_03-2013.pdf	What is a Benefit: Guidance on Benefit-Cost Analysis on Hazard Mitigation Projects https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis
Plans and Studies	
Marion County Hazard Mitigation Plan (2018)	Iowa Hazard Mitigation Plan (2018) https://homelandsecurity.iowa.gov/wp-content/uploads/2020/09/IowaHMPSection5-508-Compliant.pdf
Flood Insurance Studies https://msc.fema.gov/portal/home	National Climate Assessment (2014) https://nca2014.globalchange.gov/
Fourth National Climate Assessment (2018) https://nca2018.globalchange.gov/	
Data Sources/Technical Resources	
Arbor Day Foundation – Tree City Designation https://www.arborday.org/programs/treecityusa/directory.cfm	National Drought Mitigation Center – Drought Monitor http://droughtmonitor.unl.edu/
Environmental Protection Agency - Chemical Storage Sites https://www.epa.gov/toxics-release-inventory-tri-program	National Environmental Satellite, Data, and Information Service http://www.nesdis.noaa.gov/

DOCUMENTS	
Federal Emergency Management Agency http://www.fema.gov	National Fire Protection Association https://www.nfpa.org/
FEMA Flood Map Service Center https://msc.fema.gov/portal/advanceSearch	National Flood Insurance Program https://www.fema.gov/flood-insurance
High Plains Regional Climate Center http://climod.unl.edu/	National Flood Insurance Program https://www.iowadnr.gov/environmental-protection/land-quality/flood-plain-management/national-flood-ins-program
Iowa Climatology Bureau https://iowaagriculture.gov/climatology-bureau	National Historic Registry https://www.nps.gov/subjects/nationalregister/index.htm
Iowa Department of Education https://educateiowa.gov/	National Oceanic Atmospheric Administration (NOAA) http://www.noaa.gov/
Iowa Department of Homeland Security and Emergency Management https://homelandsecurity.iowa.gov/	National Weather Service http://www.weather.gov/
Iowa Department of Human Services https://dhs.iowa.gov/	Natural Resources Conservation Service www.ne.nrcs.usda.gov
Iowa Department of Natural Resources https://www.iowadnr.gov/	State Historical Society of Iowa https://iowaculture.gov/history
Iowa Department of Natural Resources – Dam Inventory https://iowadnr.knack.com/dams	Stanford University - National Performance of Dams Program https://npdp.stanford.edu/
Iowa Department of Natural Resources - Environmental Protection https://www.iowadnr.gov/environmental-protection	Storm Prediction Center Statistics http://www.spc.noaa.gov
Iowa Department of Revenue – Property Tax Overview https://tax.iowa.gov/iowa-property-tax-overview	United States Army Corps of Engineers – National Levee Database https://levees.sec.usace.army.mil/#/
Iowa Department of Transportation https://iowadot.gov	United States Census Bureau http://www.census.gov
Iowa Energy Office https://www.iowaeda.com/iowa-energy-office/	United States Census Bureau https://data.census.gov/cedsci/
Iowa Forest Service https://www.iowadnr.gov/conservation/forestry	United States Department of Agriculture http://www.usda.gov
Iowa Forest Service – Fire Protection and Prevention https://www.iowadnr.gov/Conservation/Forestry/Fire-Prevention/Fire-Protection-Prevention	United States Department of Agriculture – Risk Management Agency http://www.rma.usda.gov
Iowa Geospatial Data https://geodata.iowa.gov/	United States Department of Agriculture – Web Soil Survey https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Iowa Public Power Service https://www.publicpower.org/public-power-iowa	United States Department of Commerce http://www.commerce.gov/
ISU – College of Agriculture and Life Sciences https://www.cals.iastate.edu/	United States Department of Transportation – Pipeline and Hazardous Materials Safety Administration https://www.phmsa.dot.gov/
ISU – Extension and Outreach https://www.extension.iastate.edu/	United States Geological Survey http://www.usgs.gov/

Documents	
National Agricultural Statistics Service http://www.nass.usda.gov/	United States National Response Center https://nrc.uscg.mil/
National Centers for Environmental Information https://www.ncei.noaa.gov/	United States Small Business Administration http://www.sba.gov
National Consortium for the Study of Terrorism and Responses to Terrorism (START) http://www.start.umd.edu/gtd/	Watershed Management Authorities of Iowa https://www.iowadnr.gov/Environmental-Protection/Water-Quality/Watershed-Management-Authorities
National Drought Mitigation Center – Drought Impact Reporter http://droughtreporter.unl.edu/map/	

Public Review

Once the HMP draft was completed, a public review period was opened to allow for participants and community members at large to review the plan, provide comments, and request changes. The public review period was open from May 26, 2023, through June 12, 2023. Participating jurisdictions and relevant stakeholders were emailed and mailed a letter notifying them of this public review period. The draft HMP was also made available on the project website (https://www.jeo.com/marioncounty-hmp) for download. Jurisdictions and the public could provide comments via mail, fax, email, or by using the comment box on the project website. Communities were encouraged to share or post information about the public review period to local websites and through local news media. Jurisdictions including City of Pella, City of Knoxville, Knoxville Public Schools, Melcher Dallas School District, and Twin Cedars School District all brought and discussed the HMP at board or council meetings to adopt the plan prior to plan approval. All meetings were open to the public. No comments from the public were received during such meetings to be incorporated into the HMP.

A review of the comments and who they were from can be found below. All changes and comments from participating jurisdictional representatives (i.e., local planning teams) and stakeholders were incorporated into the plan.

Table 18: Public Review Revisions

Plan Section	Name, Title, and/or Agency	Comment/Revision
Pella Community Profile	Marcia Slycord, Administrative Services Manager Pella Police Department	General grammatical revisions Updates to Pella boundary map Additional information for mitigation actions

Plan Adoption and Implementation

Based on FEMA requirements, this multi-jurisdictional hazard mitigation plan must be formally adopted by each participant through approval of a resolution. This approval will create individual ownership of the plan by each participant. Formal adoption provides evidence of a participant's full commitment to implement the plan's goals, objectives, and action items. A copy of the resolution draft submitted to participating jurisdictions is in *Appendix A*. Copies of adoption

Requirement §201.6(c)(5): For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.

resolutions may be requested from the HSEMD's State Hazard Mitigation Officer.

Hazard mitigation plans are living documents. Once an HMP has been adopted locally, participants are responsible for implementing identified projects, maintaining the plan with relevant information, and fully updating the plan every five years. The plan must be monitored, evaluated, and updated on a five-year or less cycle. Those who participated directly in the planning process would be logical champions during the annual reviews and five-year cycle update of the plan. It is critical the plan be reviewed and updated annually or when a hazard event occurs that significantly affects the area or individual participants. These annual reviews are the responsibility of each jurisdiction's representatives and community governments and should be documented and reflected in the plan via amendments. However, participants are encouraged to work alongside the plan sponsor, Marion County, or the consultant, JEO, to document updates and revise the HMP as needed.

Additional implementation of the mitigation plan should include integrating HMP goals, objectives, and mitigation and strategic actions into local comprehensive or capital improvement plans as they are developed or updated. *Section Six* describes the system that jurisdictions participating in the HMP have established to monitor the plan; provides a description of how, when, and by whom the HMP process and mitigation and strategic actions will be evaluated; presents the criteria used to evaluate the plan; and explains how the plan will be maintained and updated.

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Section Three
County Profile

Introduction

To identify jurisdictional vulnerabilities, it is vitally important to understand the people and built environment of the county. The following section provides a description of the characteristics of the county to create a profile specific to Marion County. As many characteristics are covered in each jurisdiction's community profile including demographics, employment, and transportation routes, redundant information is not included in this section. Therefore, this section highlights county specific information and will also serve as the county's profile. Jurisdictional specific information can be found in applicable profiles in *Section Seven*.

County Geographic Summary

The project area is comprised of Marion County, which is located in the south-central portion of Iowa and covers an area of 571 square miles. Marion County resides in the Southern Iowa Drift Plain landform region as shown in Figure 5. The Southern Iowa Drift Plain region is noted for its numerous rills, creeks, and river branches shaping old a glacier deposits from over 500,000 years ago into steeply rolling hills and valleys.[12] [13] There are nine incorporated communities in the county, with the City of Knoxville being the county seat. Figure 6 shows the county, incorporated communities, and location within the state.

Major waterways within the area include Lake Red Rock, which is located approximately one mile north of Knoxville. This is the largest lake in the State of Iowa, and is located entirely within the boundries of Marion County. The Des Moines River is the largest river in the county, entering the county in the northwest before merging with Lake Red Rock. The river then reemerges in the southeast below Lake Red Rock and exits the county just east of Harvey. White Breast Creek is another notable waterway. The creek emerges out of Lake Red Rock just northwest of Knoxville and meanders in a southwesterly direction before exiting the county west of Melcher-Dallas. This area is not heavily forested, nor is it located in a geographic area of the state prone to landslides. Most of Marion County lies in the plains topographic region and is comprised of agricultural fields.

Climate

Marion's climate is classified as humid continental, which is marked by variable weather patterns and a large seasonal temperature variance. The average high temperature in Marion County for the month of July is 84.6 degrees and the average low temperature for the month of January is 12.5 degrees. The following table compares these climate indicators with those of the entire planning area and the State of Iowa. Climate data is helpful in determining if certain events are higher or lower than normal. For example, if the high temperatures in the month of July are running well into the 90s, high heat events may be more likely which could impact vulnerable populations.

[12] Iowa State University Geographic Information Systems Support & Research Facility. 2022. "Iowa – Landforms Regions and Features." https://www.arcgis.com/apps/mapviewer/index.html?layers=6e1858f40e6545ec9f15538cc8c65180.

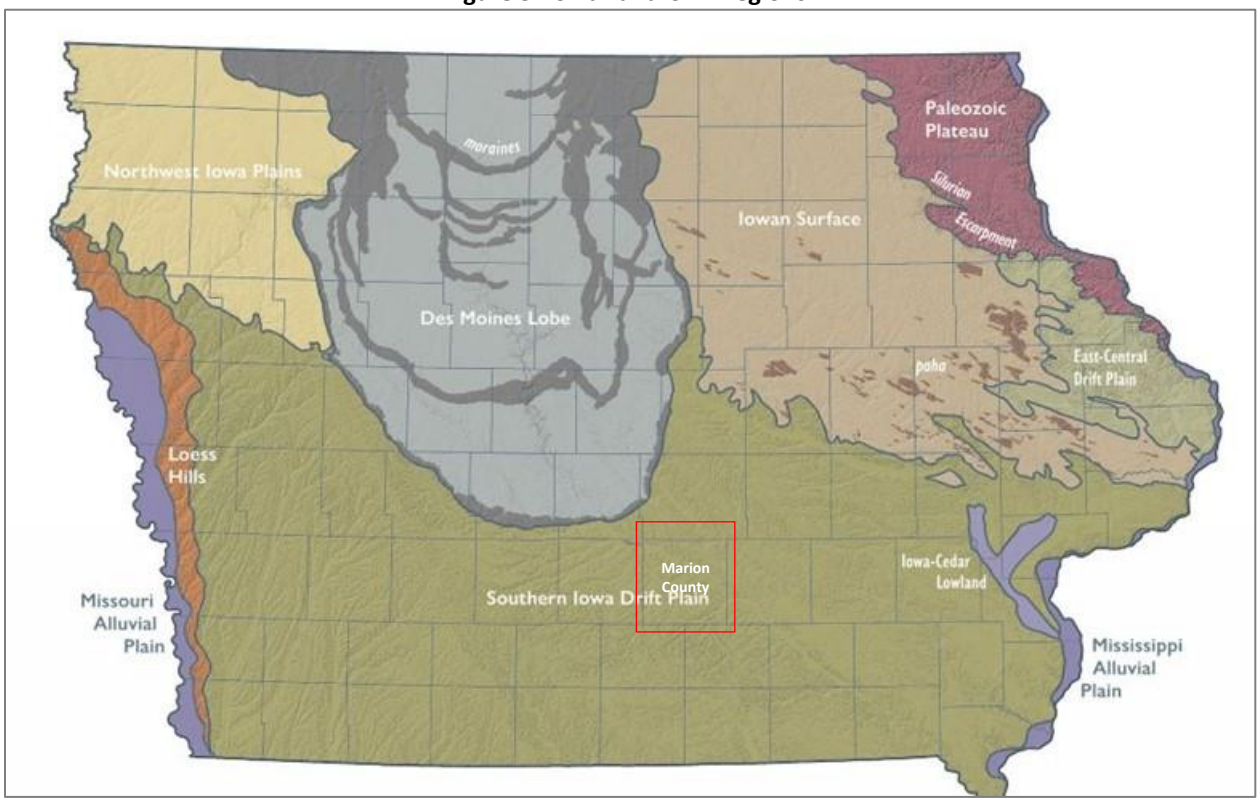
[13] Iowa Geological Survey. 2017. "Landform Regions of Iowa." https://www.iihr.uiowa.edu/igs/publications/uploads/2017-04-27_15-04-11_em44.pdf.

Table 19: Marion County Climate

	Marion County	State of Iowa
January Normal Low Temp	12.5°F	14.7°F
July Normal High Temp	84.6°F	83.8°F
Annual Normal Precipitation	37.45”	32.66”

Source: NCEI U.S. Climate Normals[14],
Precipitation includes all rain and melted snow and ice.

Figure 5: Iowa Landform Regions

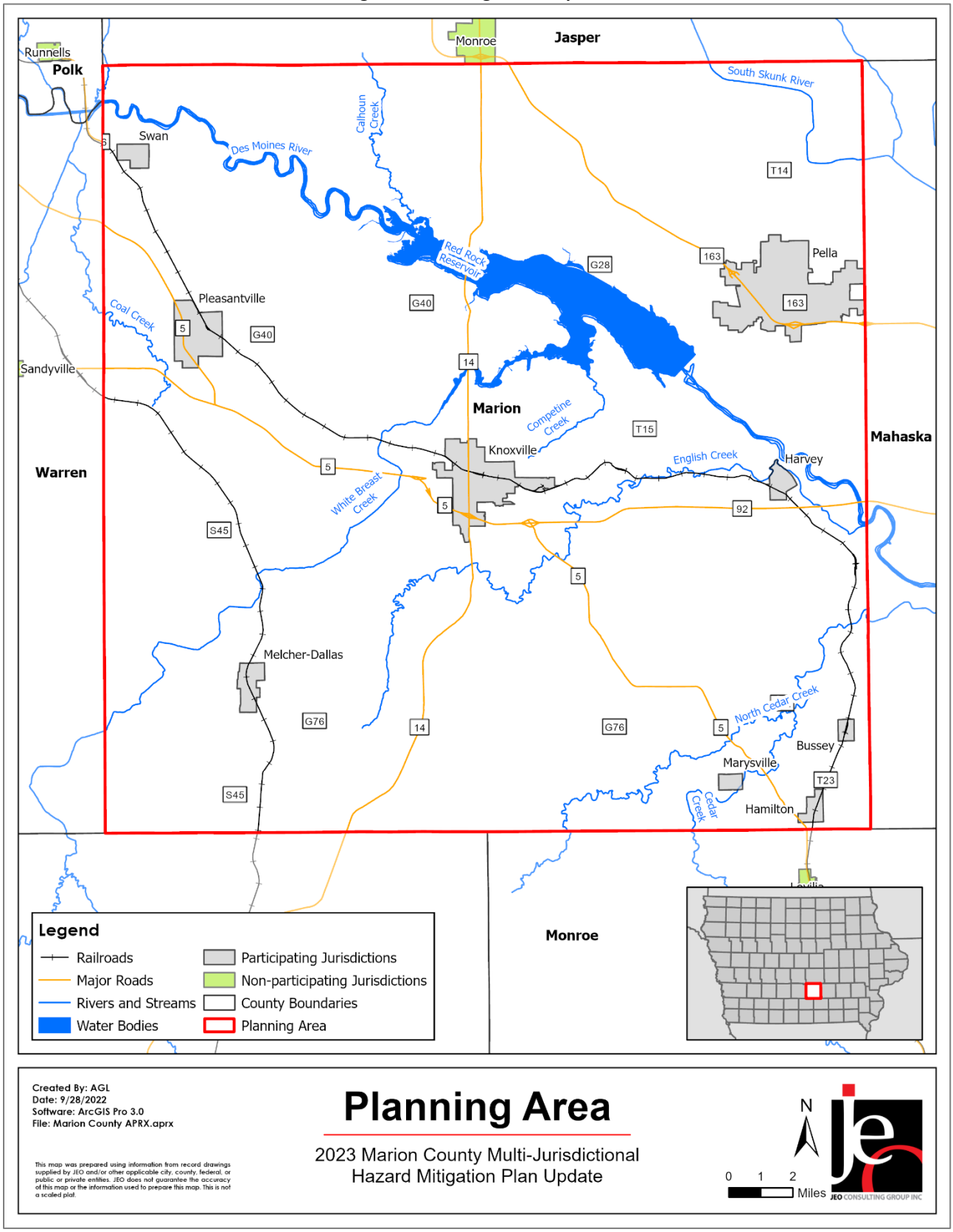


Source: Iowa State University, 2017[15]

[14] National Centers for Environmental Information. “1991-2020 U.S. Climate Normals.” Accessed December 2022. https://www.ncei.noaa.gov/access/us-climate-normals/.

[15] Iowa Geological Survey. 2017. “Landform Regions of Iowa.” https://www.iihr.uiowa.edu/igs/publications/uploads/2017-04-27_15-04-11_em44.pdf.

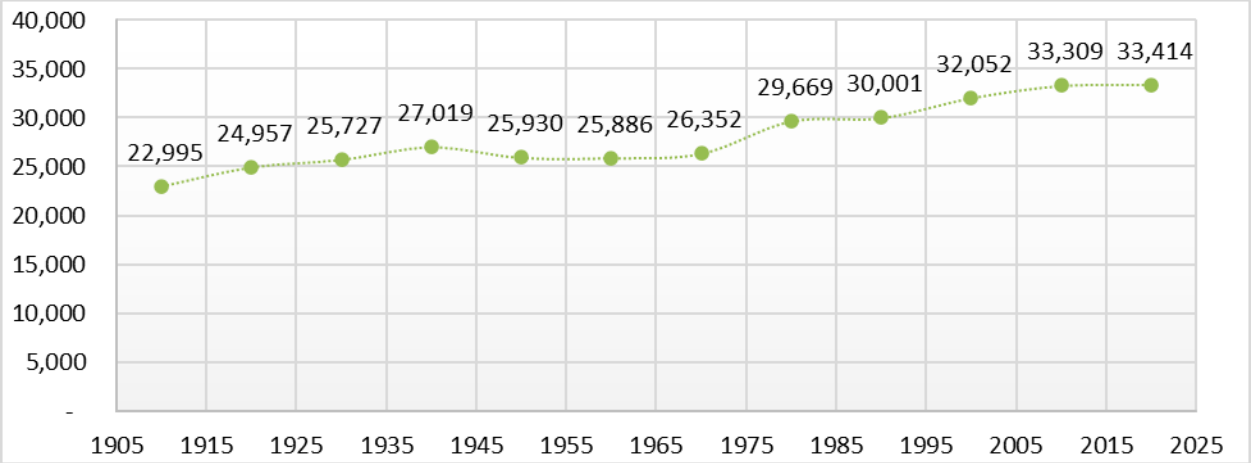
Figure 6: Planning Area Map



Demographics

Demographic and asset information can be used to determine levels of vulnerability via population and housing, structural inventories and valuations, critical facilities, and other vulnerable areas analysis. This population includes a range of demographic cohorts and persons at risk to natural and man-made disasters. Figure 7 displays the historical population trend from 1910 to 2020. This figure indicates that the population of Marion County has experienced two decades of slight decline and eight decades of growth. This is reflected in housing development as well, which saw development during decades of growth. Over the past decade, the population has increased by approximately 105 people, or by 0.3 percent. Population trends are notable for hazard mitigation because areas with increasing population often have a higher stress on county resources and infrastructure. Increasing populations are associated with increased hazard mitigation and emergency planning requirements for development. Increasing populations can also contribute to increasing tax revenues, allowing communities to pursue additional mitigation projects. Marion County's population accounted for 1.1% of Iowa's population in 2020.[16]

Figure 7: County Population 1910-2020



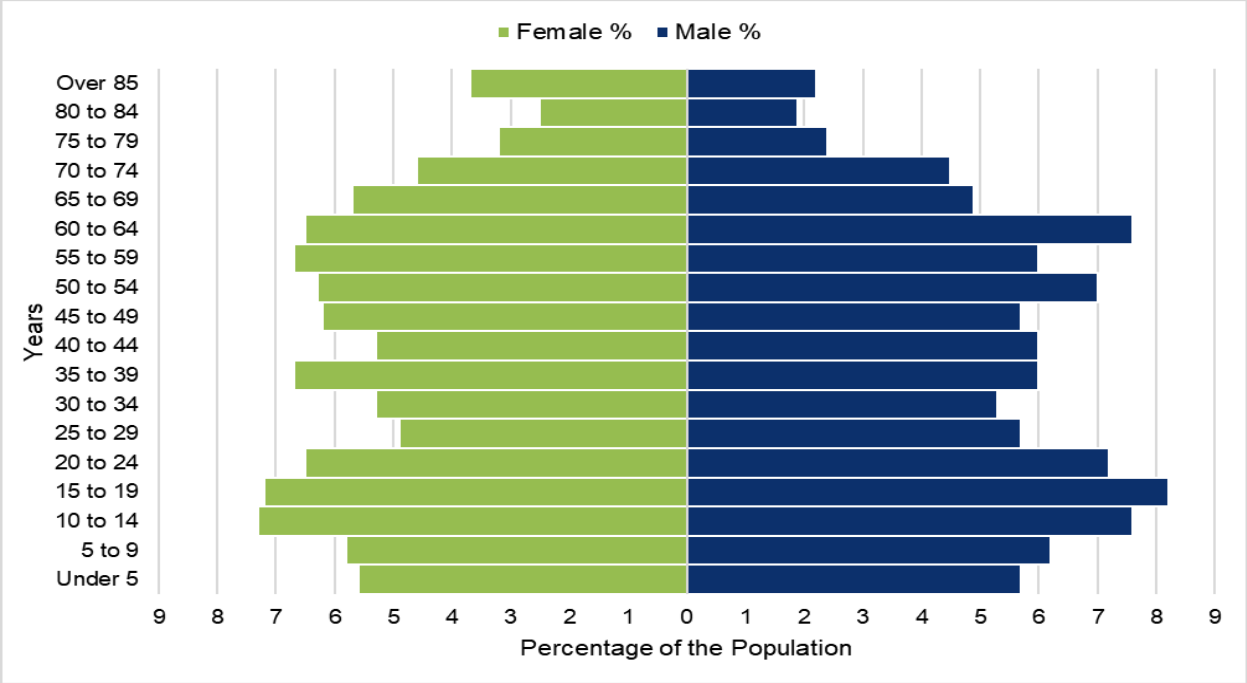
Source: U.S. Census Bureau

The young and elderly population may be at greater risk from certain hazards than other age groups. Figure 8 shows Marion County's population percentage broken down by sex and five-year age groups.[17] Marion County's population is equally spread out between different age groups. This indicates that the population is likely to remain stable in the future.

[16] United States Census Bureau. "2020 Census Bureau Decennial Census: P1: Race." https://data.census.gov/.

[17] United States Census Bureau. "2021 Census Bureau American Community Survey: S0101: Age and Sex." https://data.census.gov/.

Figure 8: County Population by Age Cohort and Sex (2020)



Source: U.S. Census Bureau

Table 20: Population Change within the County (2020)

Jurisdiction	2010 Population	2020 Population
City of Bussey	422	387
City of Hamilton	130	119
City of Harvey	235	236
City of Knoxville	7,313	7,595
City of Marysville	66	44
City of Melcher-Dallas	1,288	1,195
City of Pella	10,352	10,464
City of Pleasantville	1,694	1,676
City of Swan	72	76
Unincorporated Marion County	11,737	11,622
Total	**33,309**	**33,414**

Source: U.S. Census Bureau

The population for the county has remained relatively the same with a slight increase since the 2010 census (33,309 persons to 33,414 persons). Population levels are likely to remain the same as the county has an even distribution of the population across all age groups. The median age for the county is 39.6 which is older than the State of Iowa at 38.5. The county accounts for approximately 1.1% of the total population for the state in 2020. Since 2010, the majority of cities in the county have remained the same. Stable populations are associated with providing a known basis of tax revenue, allowing communities to accurately plan for required mitigation projects and allocating the available funds to put towards the projects.

At-risk Populations

In general, at-risk populations may have difficulty with medical issues, poverty, extremes in age, and communication issues due to language barriers. Several outliers may be considered when discussing potentially at-risk populations, including:

- Not all people who are considered "at-risk" are at risk;
- Outward appearance does not necessarily mark a person as at-risk;
- A hazard event will, in many cases, impact at-risk populations in different ways.

The National Response Framework defines at-risk populations as "…populations whose members may have additional needs before, during, and after an incident in functional areas, including but not limited to: maintaining independence, communication, transportation, supervision, and medical care."[18]

Dependent children under 18 years old are one of the most vulnerable populations to disasters.[19] The majority of people in this age group do not have access to independent financial resources and transportation. They lack practical knowledge necessary to respond appropriately during a disaster. Despite this vulnerability, children are generally overlooked in disaster planning because the presence of a caretaker is assumed. With approximately 26% of the planning area's population younger than 20, children are a key vulnerable group to address in the planning process.

Schools house a high number of children within the county during the daytime hours of weekdays, as well as during special events on evenings and weekends. The following table identifies the various public school districts located within the county, and Figure 9 displays a map of the school district boundaries. Note there are additional private school districts throughout the county which also house students at risk.

Table 21: School Inventory

School District	Total Enrollment (2021-2022)	Total Teachers
Knoxville Community School District	1,700	132
Melcher-Dallas Community School District	340	31
Pella Community School District	2,463	163
Pleasantville Community School District	769	59
Twin Cedars Community School District	335	30

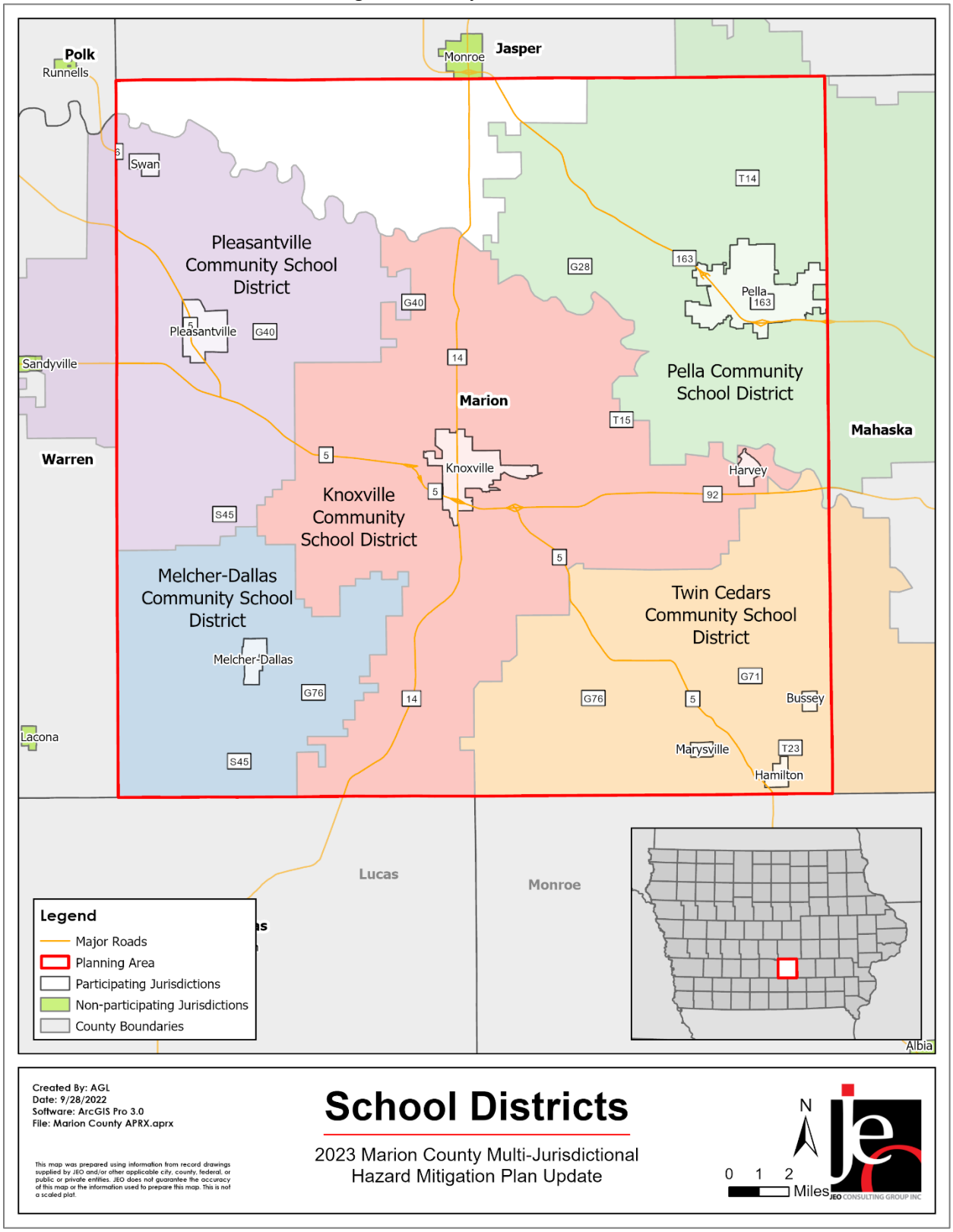
Source: Iowa Department of Education[20]

[18] United States Department of Homeland Security. October 2019. "National Response Framework Third Edition." https://www.fema.gov/media-library/assets/documents/117791.

[19] Flanagan, Gregory, Hallisey, Heitgerd, & Lewis. 2011. "A Social Vulnerability Index for Disaster Management." Journal of Homeland Security and Emergency Management, 8(11): Article 3.

[20] Iowa Department of Education. "Iowa Public School and AEA Teacher and Teacher Leader Information." Accessed December 2022. https://educateiowa.gov/documents/iowa-public-school-and-aea-teacher-counts-and-salaries-district/2022/05/2021-2022-iowa

Figure 9: County School Districts



Like minors, seniors (age 65 and greater) are often more significantly impacted by storm events and temperature extremes. During prolonged heat waves or periods of extreme cold, seniors may lack resources to effectively address hazard conditions and as a result may incur injury or potentially death. Prolonged power outages (either standalone events or as the result of other contributing factors) can have significant impacts on any citizen relying on medical devices. One study conducted by the Center for Injury Research and Policy found that increases in vulnerability related to severe winter storms (with significant snow accumulations) begin at age 55.[21] The study found that on average there are 11,500 injuries and 100 deaths annually related to snow removal. Men over the age of 55 are over four times as likely to experience cardiac events during snow removal. On the other hand, women can have a more difficult time during post-disaster recovery than men, often due to sector-specific employment, lower wages, and family care responsibilities.

Residents below the poverty line may lack resources to prepare for, respond to, or recover from hazard events. Residents with limited economic resources will struggle to prioritize the implementation of mitigation measures over more immediate needs. Further, residents with limited economic resources are more likely to live in older, more vulnerable structures. These structures could be mobile homes, located in the floodplain, located near known hazard sites (e.g., chemical storage areas), or older poorly maintained structures. Residents below the poverty line will be more vulnerable to all hazards within the county.

Residents who speak English as a second language may struggle with a range of issues before, during, and after hazard events. General vulnerabilities revolve around what could be an inability to effectively communicate with others or an inability to comprehend materials aimed at notification and/or education if a hazard event. When presented with a hazardous situation it is important that all community members be able to receive, decipher, and act on relevant information. An inability to understand warnings and notifications may prevent non-native English speakers from reacting in a timely manner. Further, educational materials related to regional hazards are most often developed in the dominant language for the area, for the county that would be English. Residents who struggle with English in the written form may not have sufficient information related to local concerns to effectively mitigate potential impacts. Residents with limited English proficiency would be at an increased vulnerability to all hazards within the county. Table 22 provides statistics for the county regarding individuals who speak English as a second language (ESL) and families reported as in poverty in the last 12 months.

Table 22: ESL and Poverty At-Risk Populations

Percent that speak English as second language	People below poverty level
3.3%	7.3%

Source: U.S. Census Bureau[22] [23]

21 Center for Injury Research and Policy. 2011. "Snow Shoveling Safety." Accessed December 2022. http://www.nationwidechildrens.org/cirp-snow-shoveling.

22 U.S. Census Bureau. 2021. "Language Spoken at Home: 2021 American Community Survey (ACS) 5-year estimates." https://data.census.gov/cedsci/.

23 U.S. Census Bureau. 2021. "Selected Economic Characteristics: 2021 ACS 5-year estimate." https://data.census.gov/cedsci/.

Similar to residents below the poverty line, racial minorities tend to have access to fewer financial and systemic resources that would enable them to implement hazard mitigation and strategic projects and to respond and recover from hazard events, including residence in standard housing and possession of financial stability. The county is primarily White, non-Hispanic; however, racial diversity has significantly increased since 2010, which could affect the county's vulnerability to hazards (Table 23).

Table 23: Racial Composition Trends

Race	2010		2020		% Change
	Number	% of Total	Number	% of Total	
White, Not Hispanic	32,203	96.68%	31,156	93.24%	-3.44%
Black	225	0.68%	292	0.87%	+0.20%
American Indian and Alaskan Native	60	0.18%	69	0.21%	+0.03%
Asian	379	1.14%	401	1.2%	+0.06%
Native Hawaiian and Other Pacific Islander	6	0.02%	21	0.06%	+0.04%
Other Races	91	0.27%	217	0.65%	+0.38%
Two or More Races	345	1.04%	1,258	3.76%	+2.73%
Total Population	33,309	-	33,414	-	-

Source: U.S. Census Bureau[24] [25]

Governance

The county's governmental structure impacts its capability to implement mitigation actions. Marion County is governed by a three-member board of county supervisors. The county also has the following offices and departments.

- Assessor
- Attorney
- Auditor & Elections
- Conservation
- CROSS Mental Health and Disability Services
- Development Commission
- Emergency Management Agency (EMA)/Public Information Officer (PIO)
- Environmental Health
- Human Resources
- Information Technology (IT)/Geographic Information Systems (GIS)
- Maintenance
- Public Health
- Recorder
- Road Department
- Sheriff's Office
- Treasurer
- Veterans Affairs
- Zoning

Capability Assessment

The capability assessment consisted of a review of local existing policies, regulations, plans, and programs with hazard mitigation capabilities. The following tables summarize the county's planning and regulatory

[24] United States Census Bureau. "2010 Census Redistricting Data (Public Law 94-171): P1: Race." https://data.census.gov.

[25] United States Census Bureau. "2020 Census Redistricting Data (Public Law 94-171): P1: Race." https://data.census.gov.

capability; administrative and technical capability; fiscal capability; educational and outreach capability; and overall capability to implement mitigation projects.

Funding has increased slightly over the past few years, but the trend is not keeping up with inflation. In order to improve on existing capabilities, the county anticipates planning and budgeting for resiliency in new infrastructure projects and establishing a Council of Governments and Continuity of Operations Plans. For the county roads department, funds are mostly limited to maintaining current facilities. As such, maintenance is becoming increasingly reactive (instead of proactive). Capital Improvement Plans currently only include replacement or rehabilitation of existing infrastructure. The Conservation Department has completed most capital projects with revenue generated through camping/cabin/shelter house fees. A large portion of Conservation funds are currently dedicated to new office construction, cabin renovations, and new cabin construction.

Table 24: Capability Assessment

Survey Components/Subcomponents		Existing (Yes/No)
Planning Capability	Comprehensive Plan	Yes
	Capital Improvements Plan	Yes
	Hazard Mitigation Plan	Yes
	Economic Development Plan	No
	Emergency Support Functions Plan	Yes
	Debris Management Plan	Yes
	Natural Resources Protection Plan	No
	Transportation Plan	Yes
	Watershed Plan	No
	Open Space Preservation Plan	Yes
	Floodplain Management Plan	No
	Storm Water Management Plan	No
Policies / Ordinances	Storm Water Ordinance	No
	Tree Trimming Ordinance	No
	Zoning Ordinance	Yes
	Subdivision Regulation/Ordinance	Yes
	Site Plan Review Requirements	Yes
	Historic Preservation Ordinance	No
	Floodplain Ordinance	Yes
	Building Codes	Yes
	National Flood Insurance Program	Yes
	Regional Community Wildfire Protection Plan	No
	Community Rating System	No
Staffing	Planning Commission	Yes
	Hazard Mitigation Planning Commission	Yes
	Floodplain Administration	Yes
	Emergency Manager	Yes
	GIS/Mapping Coordinator	Yes
	Chief Building Official/Inspector	No
	Engineer	Yes

Survey Components/Subcomponents		Existing (Yes/No)
	Grant Manager	No
	Public Works Official	No
	Sanitation Department	Yes
	Housing Program Staff	No
	Historic Preservation Staff	Yes
Studies and Maps	Flood Insurance Rate Maps	Yes
	Flood Insurance Study	Yes
	Critical Facilities Inventory	Yes
	Land Use Map	Yes
	Evacuation Plan	Yes
Fiscal Capability	Capital Improvement Project Funding	Yes
	Community Development Block Grant	No
	Authority to Levy Taxes for Specific Purposes	Yes
	Gas/Electric Service Fees	No
	Storm Water Service Fees	No
	Water/Sewer Service Fees	No
	Development Impact Fees	No
	General Obligation Revenue or Special Tax Bonds	Yes
Education and Outreach Programs	Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc. Please list.	Yes
	Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	No
	Natural Disaster or Safety related school programs	No
	StormReady Certification	Yes
	Firewise Communities Certification	No
	Public-private partnership initiatives addressing disaster-related issues	No
	Mutual Aid Agreements	Yes

Table 25: Overall Capability

Overall Capability	Limited/Moderate/High
Financial resources to implement mitigation projects	Limited
Staff/expertise to implement projects	Moderate
Public support to implement projects	Moderate
Time to devote to hazard mitigation	Limited

National Flood Insurance Program (NFIP)

Marion County is a member of the NFIP having joined on 10/18/1977. The initial Flood Insurance Rate Maps (FIRM) for the county was delineated on 11/7/2001 and the current effective map date is 2/16/2018(M) which has been adopted and incorporated into the local floodplain management regulations. The current floodplain ordinance was adopted on 12/26/2017, with an effected date of 2/5/2018. No amendments have been made since.

As of October 2022, there are 12 NFIP policies in-force for the county covering $2,315,000. Marion County currently has two repetitive loss structures, located in unincorporated areas of the county. Both properties are single-family homes with no mitigation work currently planned per property owner desires. The planning team indicated that Marion County follows Iowa DNR's requirements for permitting structures in the floodplain. When a violation of floodplain regulation occurs, the county works with the entity first to attain compliance with the ordinance and floodplain regulations. If that fails, the county will then pursue actionable steps of enforcement. However, the county has not yet had to go that far. The planning team indicated that the county intends to continue involvement and remain in good standing with the NFIP.

Plan Integration

Marion County has several planning documents that discuss or relate to hazard mitigation. Each plan is listed below along with a short description of how it is integrated with the hazard mitigation plan or how it contains hazard mitigation principles. When the county updates these planning mechanisms, the local planning team will review the hazard mitigation plan for opportunities to incorporate the goals and objectives, risk and vulnerability data, and mitigation actions into the plan update.

Comprehensive Plan

The comprehensive plan is designed to guide the future actions and growth of the county. The county's plan limits development in areas adjacent to known hazardous areas. Areas near rivers and streams are zoned as open space. The plan was last update in 2013. The county intends to update the comprehensive plan in 2023-2024 and will review the goals and projects identified in the HMP during its update.

Zoning Ordinance (2023), Floodplain Ordinance (2017), Subdivision Regulations (2017)

The county's floodplain ordinance, zoning ordinance, and subdivision regulations outline where and how development should occur in the future. These documents contain floodplain maps, provide a framework and regulations for development within the floodplain (as required by Iowa DNR and FEMA), and limit development in the floodplain and wildland urban interface. A review and update of subdivision regulations will start in 2023. While Marion County does not do building inspections, pre-construction site visits may be required to ensure all new developments are compliant with minimum setback requirements.

Economy

The U.S. Census Bureau indicates that Marion County and the State's median household income are nearly the same; however, the county's per capita income and median rent are lower compared to the state. Employment rates are similar, while the county (9.7%) has a lower proportion of people living in poverty and living alone compared to the state (11.7%). Economic indicators are relevant to hazard mitigation because they indicate the relative economic strength of an area. Economic indicators may also influence the county's level of resiliency during hazardous events.

Table 26: Housing and Income Statistics

	Marion County	State of Iowa
Median Household Income	$58,492	$58,580
Per Capita Income	$28,832	$31,085
Median Home Value	$152,400	$142,300
Median Rent	$699	$766

Source: U.S. Census Bureau[26],[27]

According to 2020 Business Patterns Census Data, Marion County had a total of 836 business establishments.

Table 27 presents the number of establishments, number of paid employees, and the annual payroll in thousands of dollars per sector.

Table 27: Business in Marion County

	Total Businesses	Number of Paid Employees	Annual Payroll (In Thousands)
Total for All Sectors	836	32,094	794,659
Accommodation and food services	72	263	11,984
Administrative and support and waste management and remediation services	36	142	9,290
Arts, entertainment, and recreation	22	411	2,382
Construction	93	1,146	30,794
Educational services	9	279	22,139
Finance and insurance	45	2,085	17,091
Health care and social assistance	99	191	97,286
Information	21	20	8,869
Management of companies and enterprises	4	7,894	670
Manufacturing	43	38	480,748
Mining, quarrying, and oil and gas extraction	3	408	2,347
Other services (except public administration)	103	372	11,115

[26] United States Census Bureau. "2020 Census Bureau American Community Survey: DP03: Selected Economic Characteristics." https://data.census.gov/.

[27] United States Census Bureau. "2020 Census Bureau American Community Survey: DP04: Selected Housing Characteristics." https://data.census.gov/.

	Total Businesses	Number of Paid Employees	Annual Payroll (In Thousands)
Professional, scientific, and technical services	66	67	17,789
Real estate and rental and leasing	31	1,630	1,994
Retail trade	125	16,508	43,645
Transportation and warehousing	22	377	9,179
Wholesale trade	38	263	24,337

Source: U.S Census Bureau [28]

Agriculture is important to the economic fabric of the State of Iowa as well. Marion County's 1,030 farms cover 255,013 acres of land, about 70% of the county's total area. Crop and livestock production are the visible parts of the agricultural economy, but many related businesses contribute to agriculture by producing, processing, transporting, and marketing farm products. These businesses generate income, employment, and economic activity throughout the region.

Table 28: Agricultural Inventory

	Agricultural Inventory
Number of Total Operations	1,030
Farm Operations – Acres Operated	255,013
Number of Farms with Harvested Cropland	688
Acres of Harvested Cropland	163,839

Source: USDA Census of Agriculture, 2017 [29]

Built Environment and Structural Inventory

Data related to the built environment is an important component of a hazard mitigation plan. It is essential that during the planning process communities and participating jurisdictions display an understanding of their built environment and work to identify needs that may exist within the county. The United States Census Bureau provides information related to housing units and potential areas of vulnerability. The selected characteristics examined below include lacking complete plumbing facilities; lacking complete kitchen facilities; no telephone service available; housing units that are mobile homes; and housing units with no vehicles.

[28] United States Census Bureau. "County Business Patterns and 2020 Nonemployer Statistics." https://data.census.gov/.

[29] United States Department of Agriculture. "2017 Census of Agriculture." https://www.nass.usda.gov/Publications/AgCensus/2017/.

Table 29: Selected Housing Characteristics

	Marion County
Occupied Housing Units	13,532 (94.8%)
Lacking Complete Plumbing Facilities	32 (0.2%)
Lacking Complete Kitchen Facilities	227 (1.7%)
No Telephone Service Available	224 (1.7%)
No Vehicles Available	614 (4.5%)
Mobile Homes	741 (5.2%)

Source: U.S. Census Bureau[30]

Less than two percent of housing units lack access to landline telephone service. This does not necessarily indicate that there is not a phone in the housing unit, as cellular telephones are increasingly a primary form of telephone service. However, this lack of access to landline telephone service does represent a population at increased risk to disaster impacts. Reverse 911 systems are designed to contact households via landline services and as a result, some homes in hazard prone areas may not receive notification of potential impacts in time to take protective actions. Emergency managers should continue to promote the registration of cell phone numbers with emergency alert systems and utilize systems which automatically ping cellphones by triangulating cell towers.

Counties with a substantial number of mobile homes may have a higher number of residents vulnerable to the impacts of high winds, tornadoes, and severe winter storms. Mobile homes have a higher risk of sustaining damages during high wind events, tornadoes, severe thunderstorms, and severe winter storms. Mobile homes that are either not anchored or are anchored incorrectly can be overturned by 60 mph winds. A thunderstorm is classified as severe when wind speeds exceed 58 mph, placing improperly anchored mobile homes at risk. According to the local planning team, Marion County does not have a large number of mobile homes in the unincorporated areas of the county at just over five percent.

Over five percent of the homes in the county are unoccupied. Unoccupied homes may not be maintained as well as occupied housing, thus adding to their vulnerability. Also, over four percent of households in the county report no available vehicles. Households without vehicles may have difficulty evacuating during a hazardous event and a reduced ability to access resources in time of need.

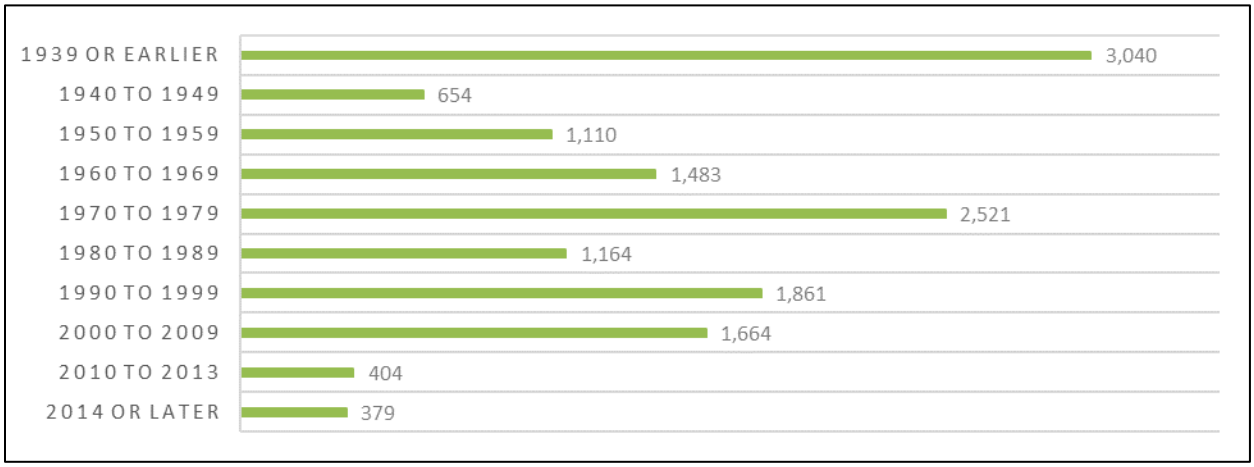
The State of Iowa's Building Code is based on the 2015 editions of the International Building Codes (IBC), except for the International Mechanical Code (IMC) which is the 2021 edition and the International Energy Conservation Code (IECC) which is the 2012 edition. The state IFC and IECC are required for all construction. Iowa is a home-rule state and there is no law forcing local jurisdictions to update their codes. When they do update their codes, local jurisdictions with populations of more than 15,000 have the option of adopting the prevailing state adopted codes or a stricter code as determined by the jurisdiction.

The majority of the housing in Marion County was built prior to 1980, with the largest sector of homes built prior to 1939 as shown in Figure 10. According to the U.S. Census Bureau 2020 American Community Survey (ACS) 5-year estimates, the county has 14,280 total housing units; with 94.8 percent of those units occupied. There are approximately 741 mobile homes in the county and 44.1 percent of the county's housing was built before 1960. Housing age can serve as an indicator of risk, as structures built prior to state or local building codes being developed may be more vulnerable. According to the Department of

[30] United States Census Bureau. "2020 Census Bureau American Community Survey: DP04: Selected Housing Characteristics." https://data.census.gov.

Housing and Urban Development (HUD), older homes are at greater risk of poor repair and dilapidation resulting in blighted or substandard properties. Residents living in these homes may be at higher risk of the impacts of high winds, tornadoes, severe winter storms, and thunderstorms. Housing age can serve as an indicator of risk, as structures built prior to the development of state building codes may be at greater risk.

Figure 10: Housing Age in Marion County



Source: U.S. Census Bureau[31]

Utilities and utility access is a top priority for residents and community leaders across the county. The Iowa Regional Utilities Association provides community and rural wastewater services and serves approximately 1,850 customers in Marion County from the Marion/Jasper County line on the north, the Marion/Mahaska County line on the east, the Des Moines River on the south, and the Marion/Polk County line on the west. IRUA also serves the communities Attica and Pershing and the South Shore Homeowners Association.

Iowa Regional Utilities Association currently contracts with Newton, Marshalltown, and Pella Waterworks to provide water supply. As noted on IRUA's website about the Pella Waterworks system "Pella Waterworks has provided a continued supply of water to the southern portion of Iowa Regional Utilities Association's system. Pella's raw water is drawn from the Cambrian-Jordan and Cambrian-Ordovician aquifers and from Alluvial wells along the Des Moines River. Pella uses a lime softening treatment process which provides for similar water quality to that of Newton and Marshalltown. IRUA also utilizes this dependable source to continuously provide water to a portion of the southern service area and also as a redundant source for the portion of the system supplied by Newton Waterworks."

Broadband Access

Internet access or access to broadband has become a critical resource to share and receive information regarding hazardous events. Wi-Fi, internet, and cell coverage are the primary methods of dissemination and retrieval of key hazard related information including storm warnings, evacuation orders, or weather updates. Rural communities often struggle to have adequate internet or broadband access. However,

[31] United States Census Bureau. "2020 Census Bureau American Community Survey: DP04: Selected Housing Characteristics." https://data.census.gov.

internet access is as vital a utility as electricity, as seen through the COVID-19 pandemic when many residents worked from home or attended school from home.

- **76% of households have a broadband internet subscription**. Marion County has a slightly smaller share of households with broadband (76%) compared to the state (78.8%).[32]

Parcel Assessment and Valuation

The planning team acquired GIS parcel data from the County Assessor to analyze the location, number, and value of property improvements (e.g. buildings, garages, sheds etc.) at the parcel level. The data did not contain the number of structures on each parcel. A summary of the results of this analysis is provided in the following table. A summary of the results of this analysis is provided in the following table. Additional flood map products for Marion County can be found in the table below.

Table 30: Parcel Improvements and Value in the 1% Annual Flood Risk Area

Total Number of Improvements	Total Improvement Value	Number of Improvements in Floodplain	Value of Improvements in Floodplain	% of Improvements in Floodplain
25,874	$3,723,466,390	4,541	$297,663,107	18%

Source: County Assessor, 2022

Table 31: Parcel Improvements and Value in the 0.2% Annual Flood Risk Area

Total Number of Improvements	Total Improvement Value	Number of Improvements in Floodplain	Value of Improvements in Floodplain	% of Improvements in Floodplain
25,874	$3,723,466,390	4,320	$300,728,135	17%

Source: County Assessor, 2022

Table 32: County Flood Map Products

Type of Product	Product ID	Effective Date	Details
Revalidation	16-07-0209V-190889	2/17/2018	Reviewed and validated all prior LOMAs and LOMCs within county.

Source: FEMA Flood Map Service Center[33]

Future Development Trends

The future development trends discussed are specific to Marion County as outlined within the county's Comprehensive Plan. For a discussion of trends within individual communities, see *Section Seven: Community Profiles*. Figure 11 illustrates that Marion County intends to develop land away from the 1% Annual Flood Risk Area by zoning these lands for Open Space. There have been multiple development changes over the last five years. Examples include a handful of new housing that has been developed in the Knoxville and Pleasantville areas, as well as continued housing growth and business development in Pella. The VA Hospital in Knoxville was demolished,

Requirement §201.6(c)(2)(ii)(C): [The plan should provide] a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

[32] United States Census Bureau. "2020 Census Bureau American Community Survey: DP02: Selected Social Characteristics in the United States." https://data.census.gov/.

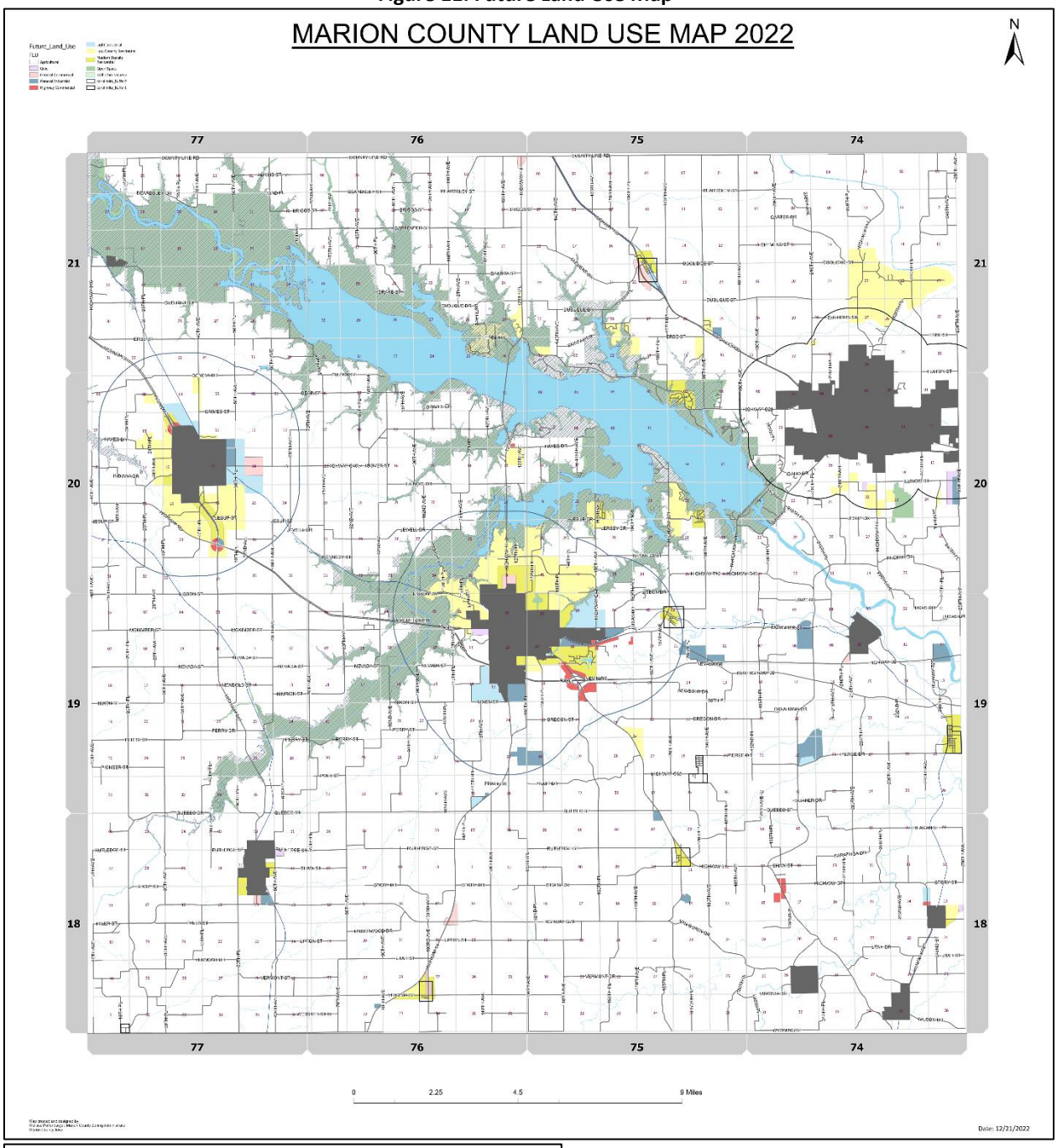
[33] Federal Emergency Management Agency. 2022. "FEMA Flood Map Service Center." Accessed December 2022. https://msc.fema.gov/portal/advanceSearch

opening the area up for redevelopment. A new middle school was also built in Knoxville, and Weiler has continued to expand. Regarding future development, there are several proposed subdivisions in the unincorporated Marion County. There are also land divisions mostly by plat of survey going on all over the county.

The City of Knoxville implemented new landlord policies in recent years. The planning team indicated that many landlords have gotten out of business or sold out to larger management companies, that have in turn evicted many low-income renters so they can remodel units and bring them up to code. While there was a need for this, the county now has an issue with increased homelessness and insecure housing arrangements (such as doubling up with friends/family).

Over the past five years, Marion County issued between 30 to 60 new home building permits a year, with 2020 and 2021 being the highest. Overall building permits range from 130 to 175 over the past five years. Land divisions range from 50 to 75, with 2022 having 75. During the same timeframe, the county issued a total of five floodplain permits. There were 45 properties which were partly within the floodplain, but the structures themselves were not built in the floodplain, so permits were not needed. Development in the floodplain is regulated by the county floodplain ordinance and the Iowa DNR regulations, in compliance with 44CFR. The county zoning department verifies if there is floodplain on the property during the building permit process and will not issue a permit until they obtain any required permit from the County Engineer.

Figure 11: Future Land Use Map



Social Vulnerability Index

All communities have some vulnerability to natural and man-made hazard events. Various social conditions such as poverty rates, vehicle access, language, or housing stock contribute to a community's overall social vulnerability. According to FEMA's National Risk Index, the overall Risk Index for Marion County, Iowa is Very Low (7.64).[34]

- Social Vulnerability – Social groups in Marion County, IA have a Relatively Low (31.73) susceptibility to the adverse impacts of natural hazards when compared to the rest of the U.S.
- Community Resilience – Communities in Marion County, IA have a Very High (58.88) ability to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions when compared to the rest of the U.S.

An additional tool developed by Headwaters Economics evaluated communities and counties across the country for local capacity. Capacity includes the staffing, resources, and expertise to both apply for funding, fulfill reporting requirements, and design, build, and maintain infrastructure products over the long term. Communities which lack local capacity often have the greatest need for infrastructure investments, particularly rural communities and communities of color. To help identify communities with limited capacity, Headwaters Economics created a new Rural Capacity Index on a scale of 0 (low capacity) to 100 (high capacity). The Index is based on 10 variables that can function as proxies for community capacity. The following table lists out the components and scores for the county.

Table 33: Marion County's Rural Capacity Index

Components of Index	Marion County
COUNTY IS METROPOLITAN?	No
HAS HEAD OF PLANNING?	Yes
HAS COLLEGE OR UNIVERSITY?	Yes
ADULTS WITH HIGHER EDUCATION	29%
FAMILIES BELOW POVERTY LEVEL:	5%
HOUSEHOLDS WITH BROADBAND	79%
PEOPLE WITHOUT HEALTH INSURANCE	3%
VOTER TURNOUT	78%
INCOME STABILITY SCORE (0 TO 100)	57
POPULATION CHANGE (2000 TO 2019)	1,201
OVERALL RURAL CAPACITY INDEX SCORE	81 out of 100

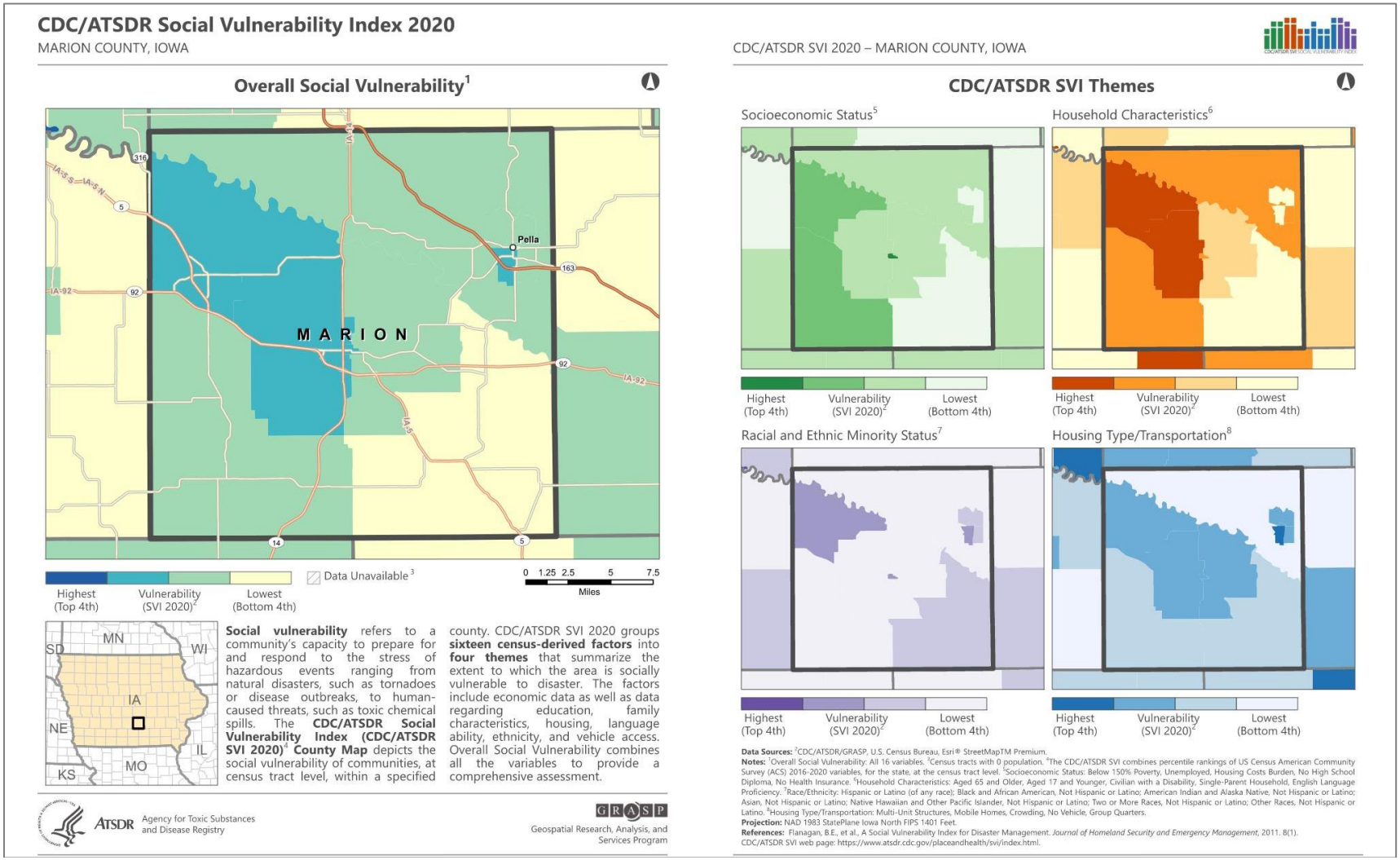
Source: Headwaters Economics[35]

The Centers for Disease Control (CDC) has developed a Social Vulnerability Index to help public health officials and emergency responders identify communities at greater risk before, during, and after major hazardous events. The index evaluates 15 social factors and breaks down vulnerability into four domains: socioeconomic status; household composition and disability; minority status and language; housing and transportation. Figure 12 illustrates the overall Social Vulnerability Index for Marion County.

[34] FEMA National Risk Index. Accessed December 2022. https://hazards.fema.gov/nri/map.

[35] Headwaters Economics. Accessed December 2022. "Rural Capacity Map." https://headwaterseconomics.org/equity/rural-capacity-map/.

Figure 12: Social Vulnerability Index



Source: CDC Social Vulnerability Index, 2018[36]

[36] Centers for Disease Control Social Vulnerability Index. 2020. "CDC's Social Vulnerability Index (SVI): County Map" https://svi.cdc.gov/prepared-county-maps.html.

Community Lifelines

Community lifelines enable the continuous operation of critical government and business functions and are essential to human health and safety and economic security. When disrupted, decisive intervention is required for stabilization. FEMA has identified seven types of community lifelines: Safety and Security (law enforcement, fire service, search and rescue); Food, Water, Shelter; Health and Medical (medical care, public health, patient movement); Energy; Communications (infrastructure, responder communications, alerts warning, 911, dispatch); Transportation (highway, roadway, mass transit, railway, aviation); and Hazardous Material (facilities, HAZMAT, pollutants, contaminants).

Community lifelines identified in this plan were based off the categories identified by FEMA. Each participant identified their own community lifelines specific to their jurisdiction, which are discussed in greater detail in *Section Seven: Community Profiles*. Marion County lifelines are discussed below.

Table 34: Marion County Lifelines

Lifeline	Components	#	Critical Facility Name	Generator (Y/N)	Shelter (Y/N)	Hazard Type Concerns and Notes
Safety and Security	Law Enforcement Security	1	Marion County Sheriff's Department	N	N	
		2	Knoxville Police Department	Y	N	
		3	Melcher-Dallas Police Department	N	N	
		4	National Guard Armory	N	N	
		5	Pella Police Department	N	N	
		6	Pleasantville Police Department	N	N	
	Fire Service	7	Bussey Fire Department/Ambulance	Y	Y	
		8	Knoxville Fire Station	Y	N	
		9	Melcher-Dallas Fire Station	Y	Y	
		10	Pella Ambulance	N	N	
		11	Pella Fire Department	N	N	
		12	Pleasantville Fire Station	Y	N	
	Search and Rescue	-	None Identified	-	-	
	Government Service	13	Marion County Courthouse	Y	N	Wind/Tornado/ Flood/Terrorism
		14	County Park Office and Maintenance Shop	N	N	
		15	County Engineers Office	N	N	
	Community Safety	16	3014 County Building/DR Data Center	Y	N	

Lifeline	Components	#	Critical Facility Name	Generator (Y/N)	Shelter (Y/N)	Hazard Type Concerns and Notes
		17	Sheriff's Office Data Center	Y	N	
		18	Public Health Data Center	Y	N	
Food, Water, and Shelter	Shelters	-	None Identified	-	-	
	Food	-	None Identified	-	-	
	Water	19	County Well	N	N	In floodplain
		20	Harvey Water Plant	Y	N	
		21	Harvey Water Tower	N	N	
		22	Knoxville Reclamation Facility	Y	N	
		23	Knoxville Water Department	N	N	
		24	Knoxville Water Tower	N	N	
		25	Melcher-Dallas Water Plant	N	N	
		26	Melcher-Dallas Water Tower	N	N	
		27	Pella Water Distribution Plant	N	N	
		28	Pella Water Treatment Plant	N	N	
		29	Pella Water Tower	N	N	
		30	Pella Water Tower	N	N	
		31	Pella Wastewater Plant	N	N	
		32	Pleasantville Water Plant	Y	Y	
		33	Pleasantville Water Tower	Y	N	
		34	Pleasantville Wastewater Plant	Y	N	
Communications	Alerts, Warning, and Messages/911 and Dispatch	-	None Identified	-	-	
	Infrastructure	35	3M Water Tower Radio Repeater	N	N	Wind/Tornado/Ice/ Terrorism
		36	Mediacom Communications	-	-	
Energy	Power Grid	37	County Hydroelectric Plant	N	N	In floodplain
		38	Knoxville Power Substation	N	N	
		39	Pella City Electric	N	N	
		40	Pella Substation	N	N	
		41	Pella Substation	N	N	
		42	Pella Substation	N	N	
		43	Pella Substation	N	N	
		44	Pella Substation 1011	N	N	

Lifeline	Components	#	Critical Facility Name	Generator (Y/N)	Shelter (Y/N)	Hazard Type Concerns and Notes
		45	Pleasantville Power Transformers	N	N	
	Fuel	46	Pleasantville Casey's Gas Station	Y	N	
Health and Medical	Medical Care Facilities	47	Knoxville Hospital & Clinic	N	N	
		48	Knoxville Clinic	N	N	
		49	Pleasantville Clinic	N	N	
		50	E.J. McKeever Medical Center (Melcher)	N	N	
		51	Red Rock Healthcare Pella	N	N	
		52	Pella Regional Health Center	N	N	
		53	Pella Medical Clinic	N	N	
		54	Medical Clinic in Knoxville	N	N	
		55	Medical Clinic in Bussey	N	N	
		56	Vermeer Family Clinic	N	N	
		57	Good Samaritan Free Clinic	N	N	
		58	The Well Resource Center	N	N	
		59	VA Central Iowa Health Care System	N	N	
	Fatality Management	60	Comfort House/Hospice of Pella	N	N	
		61	EveryStep Hospice	N	N	
		62	Wesley Hospice	N	N	
	Public Health	63	Accura Healthcare of Knoxville	N	N	
		64	Accura HealthCare of Pleasantville	N	N	
		65	The Cottages at Hearthstone	N	N	
		66	Fair Haven East	N	N	
		67	First Resource Corp	N	N	
		68	Hearthstone – Pella	N	N	
		69	Homestead Assisted Living & Memory Care	N	N	
		70	Jefferson Place at Hearthstone	N	N	
		71	Knoxville Residential	N	N	
		72	Lodge of Westridge, LLC	N	N	

Lifeline	Components	#	Critical Facility Name	Generator (Y/N)	Shelter (Y/N)	Hazard Type Concerns and Notes
		73	Pella Manor at Hearthstone	N	N	
		74	Vriendschap Village	N	N	
		75	West Ridge Specialty Care	N	N	
		76	Windsor Ridge Apartments	N	N	

Source: Marion County Department of Public Health[37,38,]

Of note, IRUA owns and maintains three critical facilities to operate their water distribution services in Marion County. These facilities have not been mapped here but do have their general locations provided in the table below.

Table 35: IRUA Critical Facilities

Critical Facility Name	Community	Generator (Y/N)	Shelter (Y/N)	Hazard Type Concerns and Notes
Otley Water Tower	Otley	No	No	Power Failure
Pella Booster	Pella	No	No	Power Failure
Park Hills Wastewater	Otley	No	No	Power Failure

Marion County identified lifelines that did not fit into the seven lifeline categories but are considered lifelines by the community. These other community lifelines are listed in the table below.

Table 36: Other Critical Facilities or Lifelines

Critical Facility Name	#	Community	Generator (Y/N)	Shelter (Y/N)	Hazard Type Concerns and Notes
Cordova Park Office and Maintenance Shop	77	Otley	N	N	
Roberts Creek Park Office and Maintenance Shop	78	Otley	N	N	
County Central Shop	79	Knoxville	N	Y	Wind/Tornado
Junction 92 Shop and Stockpile	80	Knoxville	Y	Y	Wind/Tornado
Clay Shop and Stockpile	81	Tracy	N	N	
Pella Shop	82	Pella	N	N	
Franklin Shop and Stockpile	83	Knoxville	N	Y	Wind/Tornado
Columbia Shop	84	Columbia	N	N	
Bussey Shop	85	Bussey	N	N	
Harvey Shop	86	Harvey	N	N	
Otley Shop	87	Otley	N	N	
Dunreath Shop and Stockpile	88	Monroe	N	N	
Sully Road Stockpile	89		N	N	

[37] Marion County Department of Public Health. 2022. "Hospitals & Clinics." https://marionph.org/marion/hospitals-clinics/

[38] Marion County Department of Public Health. 2022. "Nursing Homes, Assisted & Independent Living." https://marionph.org/marion/nursing-homes-assisted-independent-living/.

Critical Facility Name	#	Community	Generator (Y/N)	Shelter (Y/N)	Hazard Type Concerns and Notes
Hwy T-14 Stockpile	90		N	N	
Hwy 163 Otley Stockpile	91		N	N	
Hwy 163 Park Hills Stockpile	92		N	N	
Melcher Stockpile	93	Melcher-Dallas	N	N	
S45 & Newbold Stockpile	94		N	N	
G40 Stockpile	95		N	N	
Knoxville NorthStar Elementary School	96	Knoxville	N	N	
Knoxville West Elementary	97	Knoxville	N	N	
Knoxville Middle School	98	Knoxville	Y	Y	
Knoxville High School	99	Knoxville	Y	N	
Melcher-Dallas Elementary School	100	Melcher-Dallas	N	Y	
Melcher-Dallas Junior/Senior High	101	Melcher-Dallas	N	Y	
Pella Christian Elementary School	102	Pella	N	Y	
Pella Christian High School	103	Pella	N	Y	
Pella Career Academy	104	Pella	N	N	
Pella Madison Elementary	105	Pella	N	N	
Pella Lincoln Elementary	106	Pella	N	N	
Pella Middle School	107	Pella	N	N	
Pella Jefferson Intermediate	108	Pella	N	N	
Pella High School	109	Pella	N	N	
Pleasantville Elementary School	110	Pleasantville	N	N	
Pleasantville Middle School	111	Pleasantville	N	N	
Pleasantville High School	112	Pleasantville	N	N	
Twin Cedars Elementary School	113	Twin Cedars	N	Y	
Twin Cedars High School	114	Twin Cedars	N	Y	

Figure 13: Critical Facilities Map of Safety and Security Lifelines

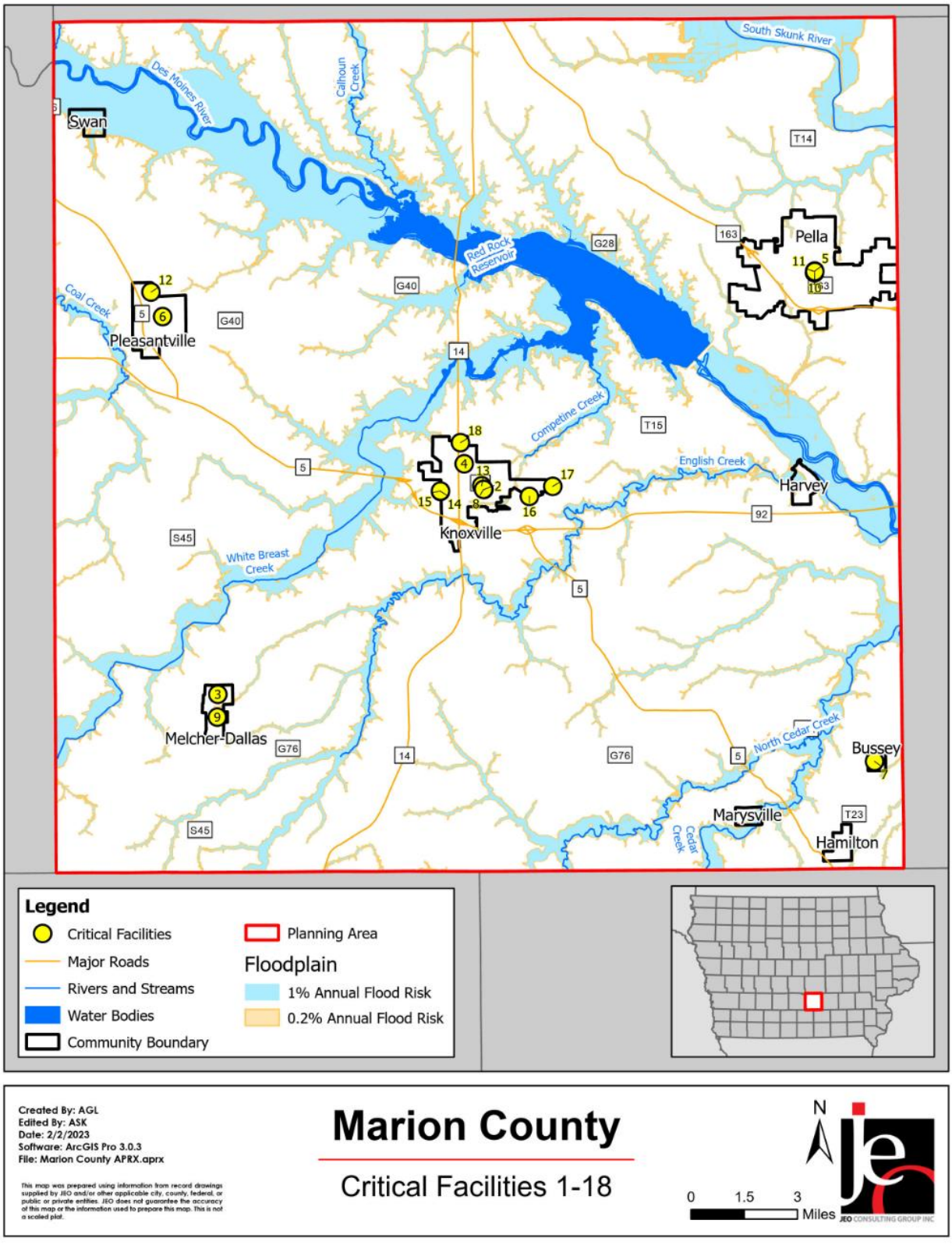


Figure 14: Critical Facilities Map of Food, Water, and Shelter Lifelines

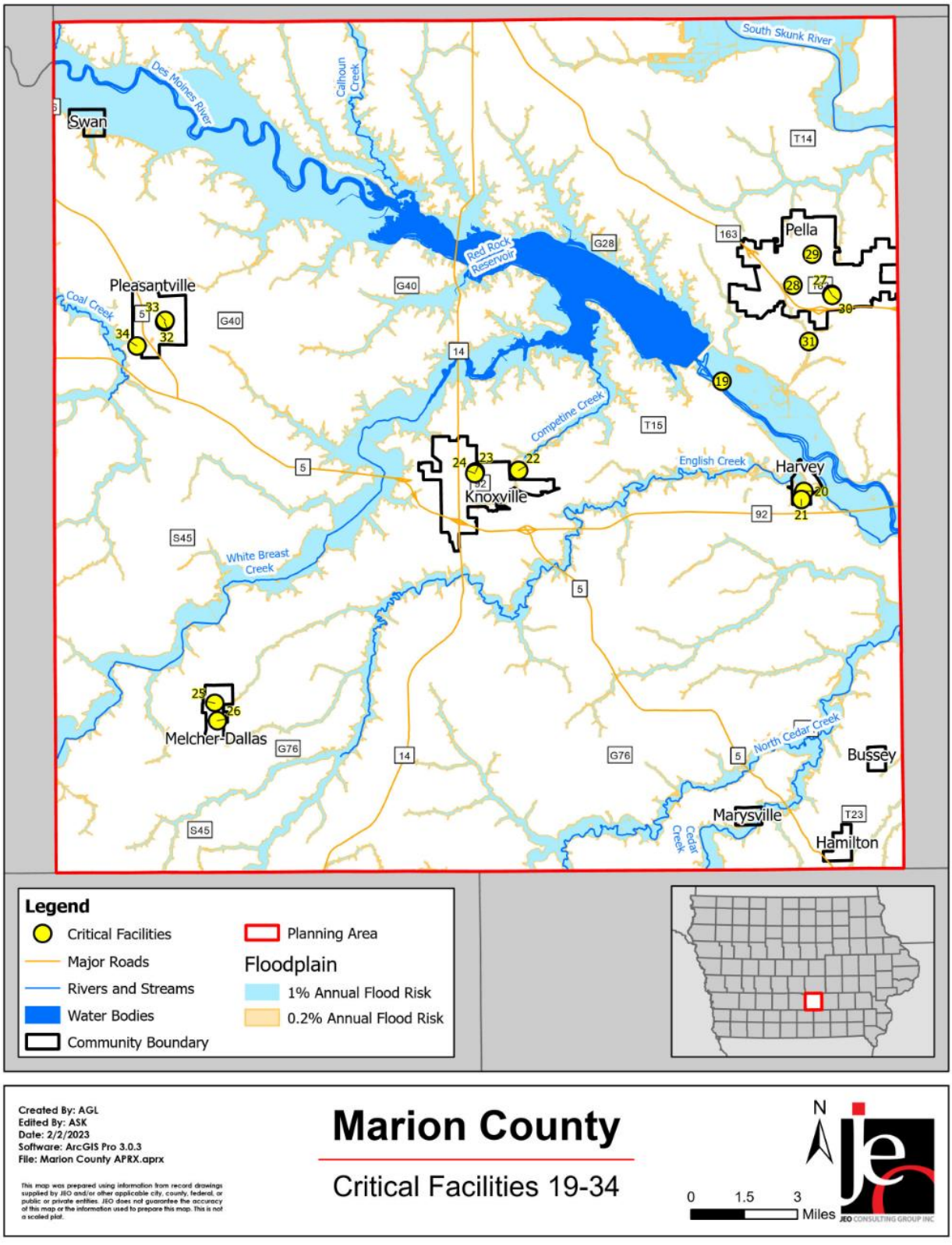


Figure 15: Critical Facilities Map of Communications and Energy Lifelines

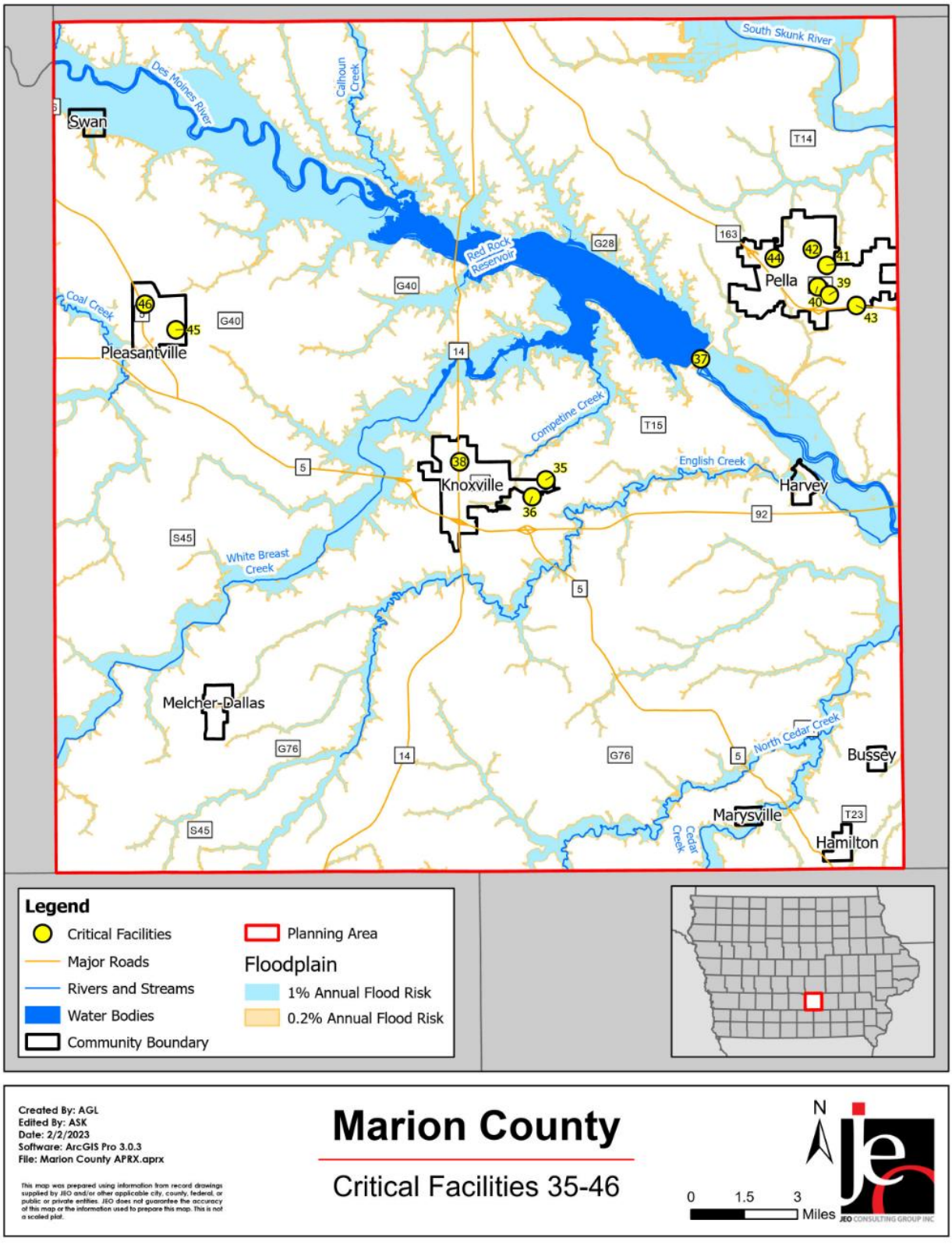


Figure 16: Critical Facility Map for Health and Medical Lifelines

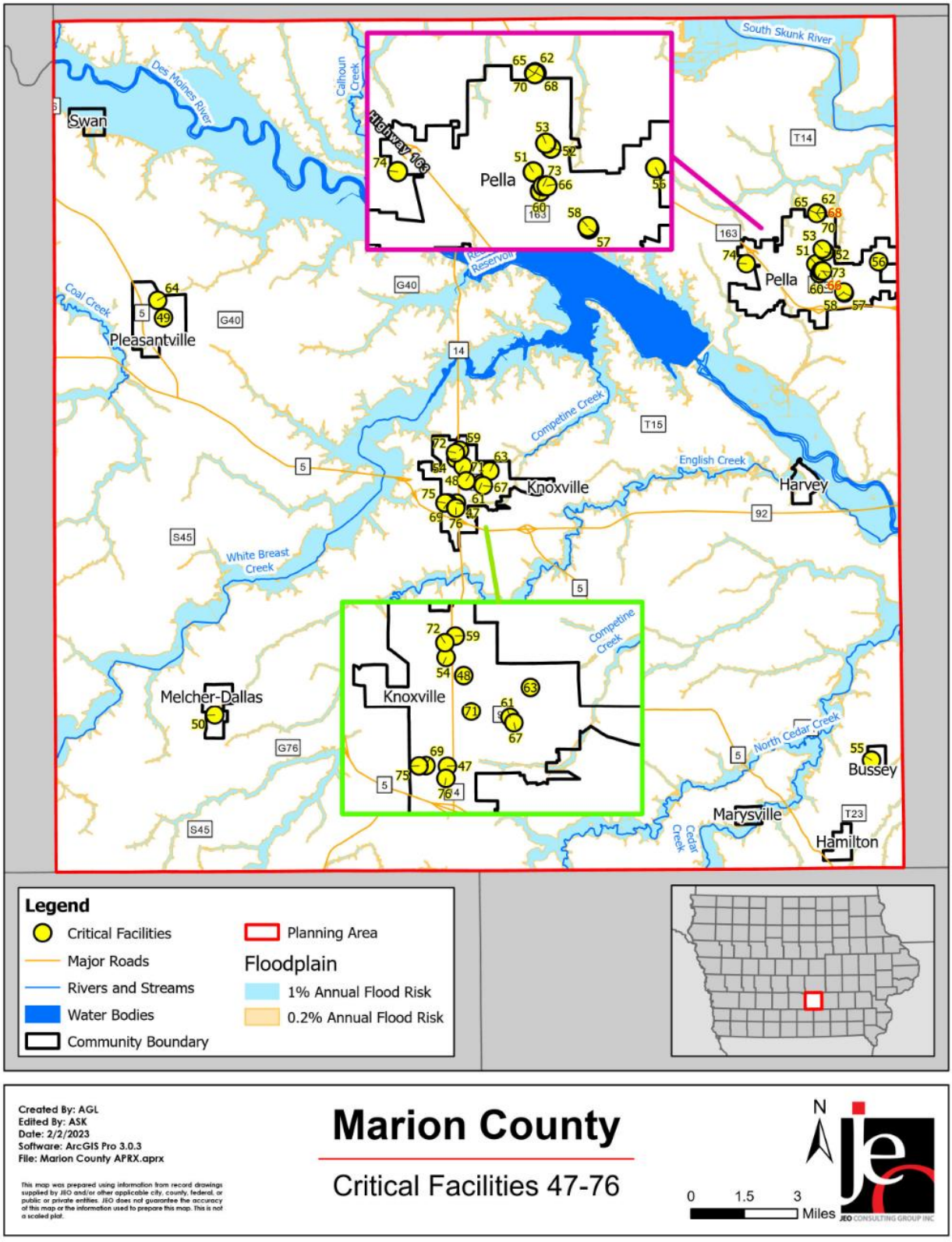


Figure 17: Critical Facilities Map of Other Lifelines: Shops and Stockpiles

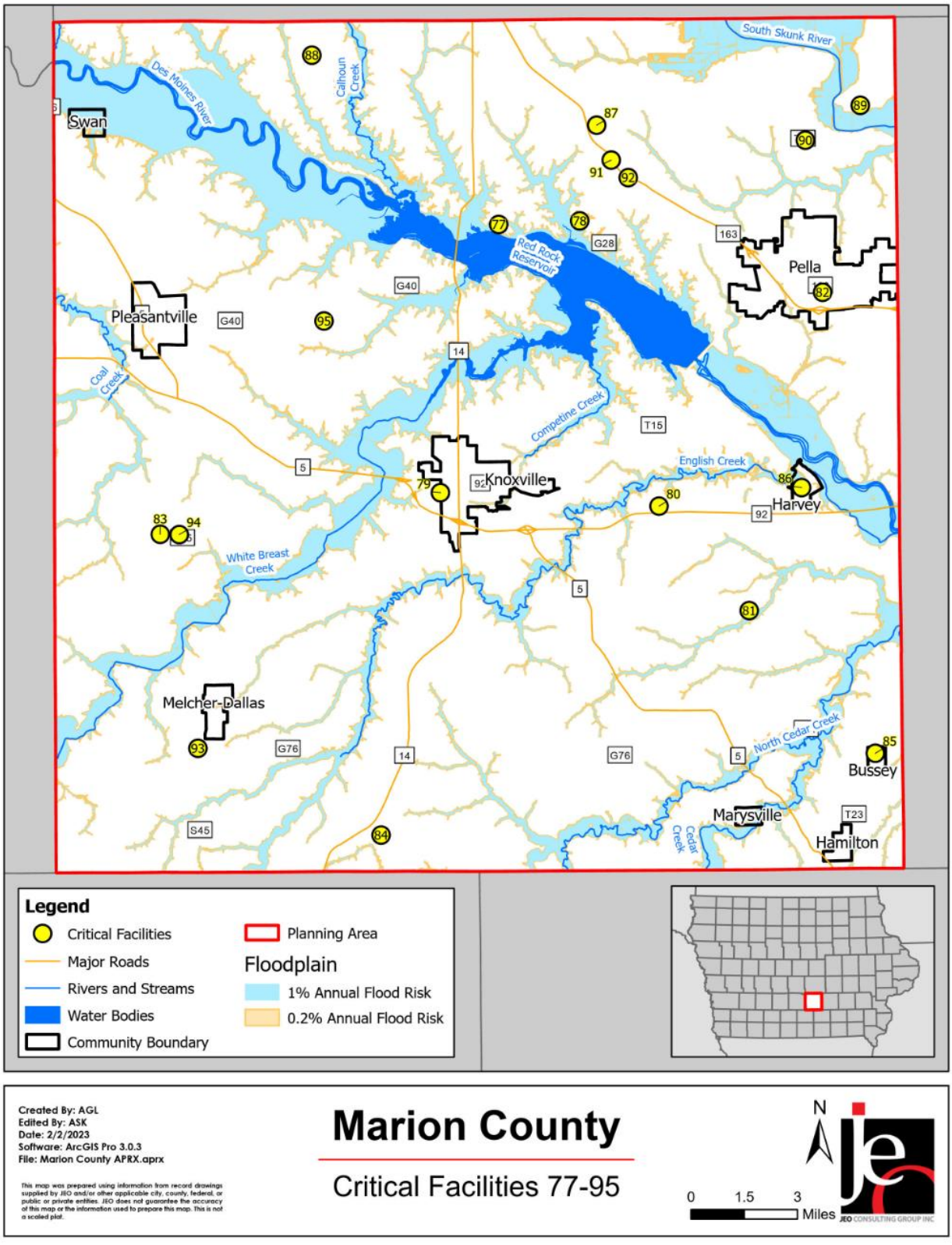
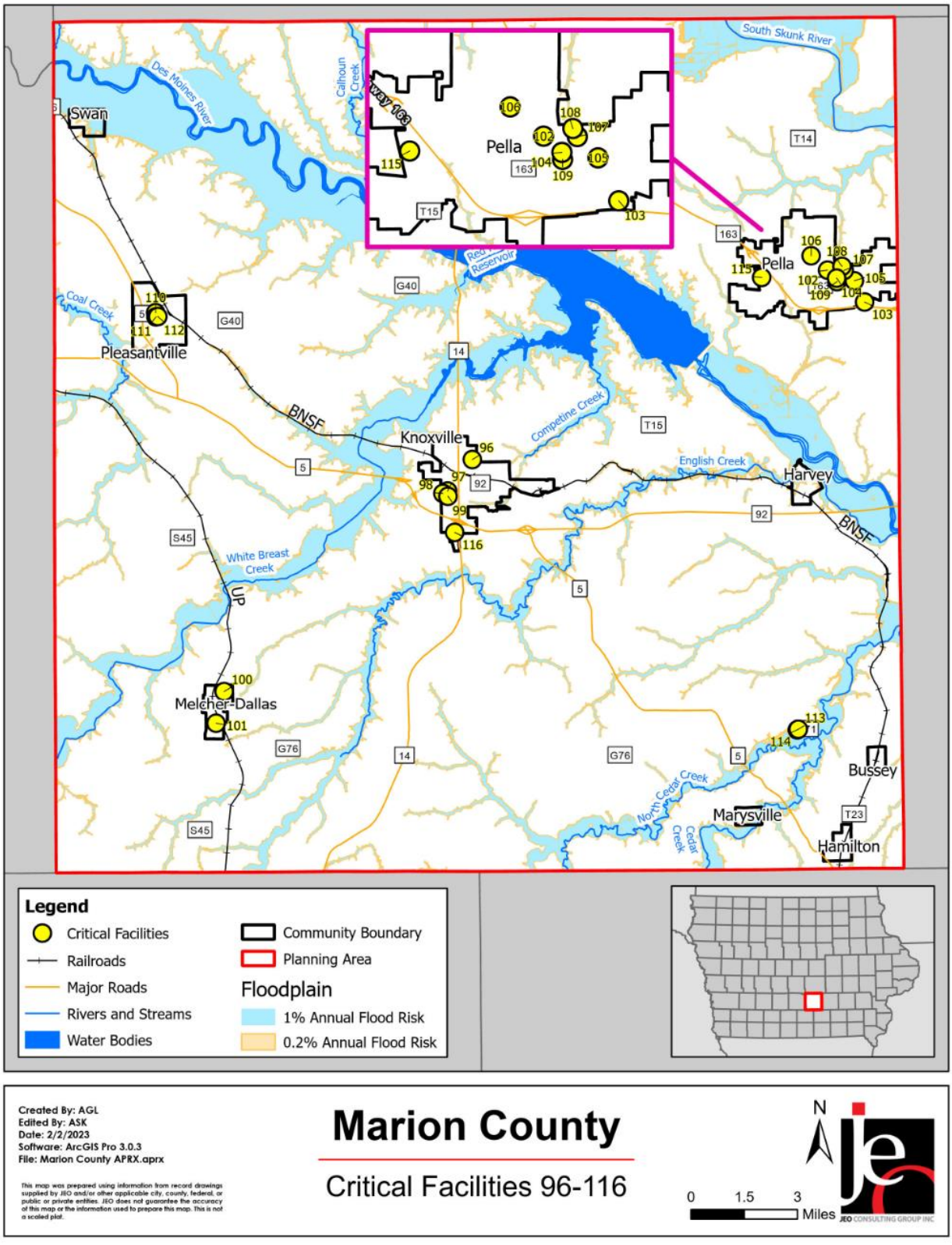


Figure 18: Critical Facilities Map of Other Lifelines: Schools and Transportation Lifelines



Transportation

Transportation information is important to hazard mitigation plans because it suggests possible evacuation corridors in the community, as well as areas more at risk of transportation incidents. Marion County's major transportation corridors include State Highway 5, which runs northwest to southeast through the county. This highway passes through Pleasantville, Knoxville, Attica, and Hamilton. This highway is the primary cooridor for traffic to and from Des Moines. State Highway 92 breifly enters Marion County, just south of Pleasantville, before merging with Highway 5. State Highway 92 primarily transports traffic to and from Indianola in the neighboring western county. State Highway 92 reemerges in the east-central portion of the county. There are also lesser traveled highways in the county. State Highway 14, which runs north to south through Columbia, Knoxville, and travels over Lake Red Rock via the Mile Long Bridge, and accompanying bridges to the north and southThe county also maintains a number of county highways.

The planning team noted that there are only three main North-South corridors in Marion County. These include Highway 14, T15, and T17. T15 travels over Red Rock Dam, for which the dam and road easement is managed and controlled by the US Army Corps of Engineers. T17 travels over the Des Moines River.

There are three non-passenger rail lines operated by three rail companies in Marion County. The largest line travels northwest to southeast and passes through the communities of Pleasantville, Knoxville, Flagler, Harvey, Tracy, Bussey, and Hamilton. This line is largely maintained by Burlington Northern Sante Fe (BNSF), however Norfolk Southern operates small portions between Knoxville and Flagler and between Tracy and Bussey. Union Pacific operates a line in the southwest quadrant of the county, which enters Marion County southwest of Pleasantville, and passed through Melcher-Dallas before proceeding into Lucas County in the South.

There are two publicly owned airports in Marion County. The Pella Municipal Airport is located one mile from Pella's central business district. The general aviation airport has been at its current site since 1967. No airline services are offered at this airport. Knoxville Municipal Airport has a 4,000 X 75 ft single runway and serves a number of Knoxville businesses, medical emergency services and recreational users. The airport has 34 T-hangar facilities. Also located on the airport grounds are a maintenance facility, two community hangars, fuel farm, and ramp space with 18 tie-down areas. An AWOSS Weather System is also located on site.

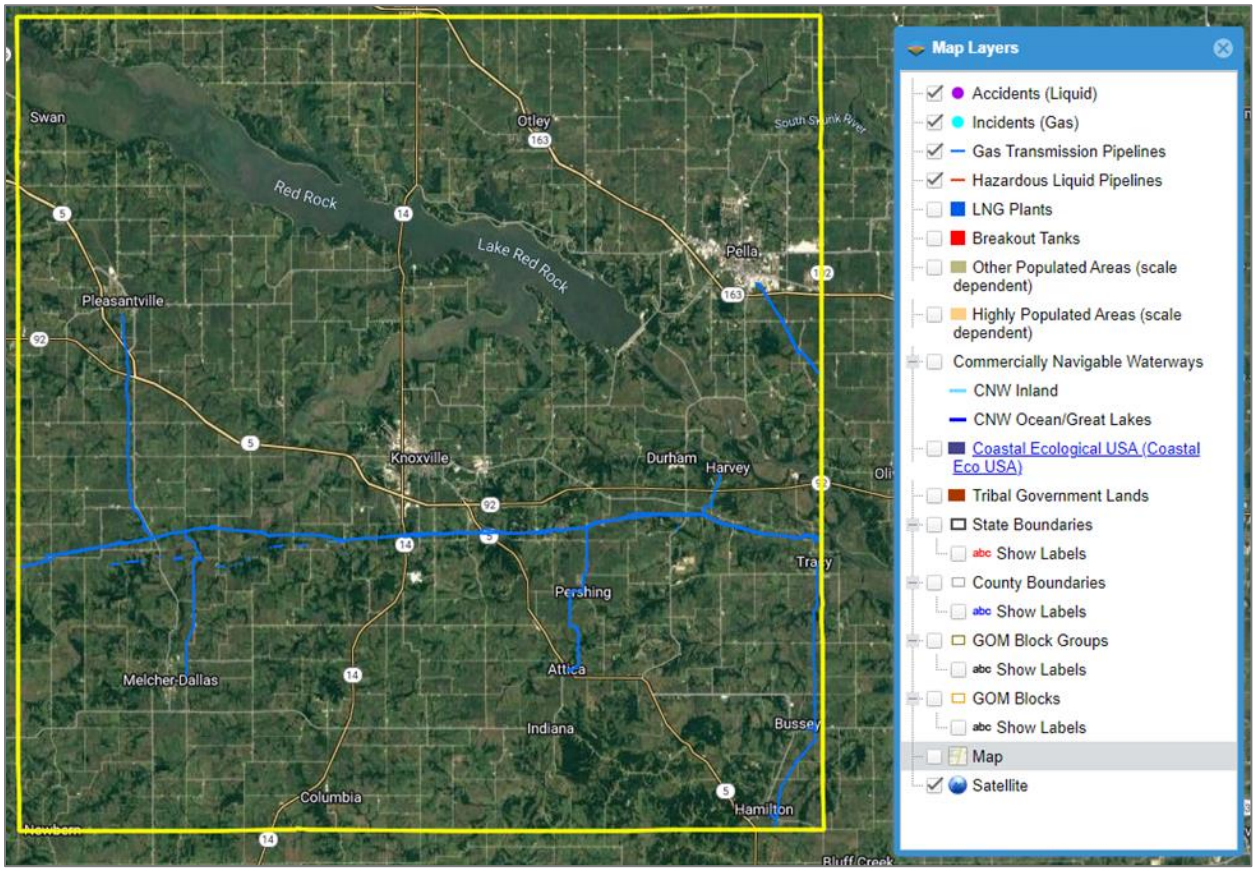
Table 37: Transportation Lifelines

Components	#	Critical Facility Name	Hazard Type Concerns and Notes
Airports	115	Pella Municipal Airport	
	116	Knoxville Municipal Airport	
Railroads	-	Union Pacific (UP)	Derailments – Hazard Material Release
	-	BNSF Railway Co. (BNSF)	Derailments – Hazard Material Release
	-	Norfolk Southern Railway Co. (NS)	Derailments – Hazard Material Release
Highways	-	IA-5	
	-	IA-14	
	-	IA-92	
	-	IA-163	

Hazardous Materials

There is an interestate pipeline which runs east-west through the central portion of the county. This pipeline transports natural gas. The line enters Marion County from the west near Perry Street and exits the county just north of the City of Tracy. The pipline has appendeges which travel from the main span to Plesantville, Melcher-Dallas, Pershing, Attica, Harvey, Tracy, Bussey, and Hamilton. The natural gas from these piplines is sold by Interstate Power and Light and MidAmerican Energy to the communities in Marion County.

Figure 19: Pipelines in Marion County



Source: National Pipeline Mapping System[39]

The Hazardous Materials Lifeline includes chemical storage facilities, pipelines, and transported chemical tanks. According to the Tier II System reports submitted to the Iowa Department of Natural Resources, there are 30 chemical storage sites within Marion County which house hazardous materials (listed below). In the event of a chemical spill, local fire departments and emergency response may be the first to respond to the incident. If a HAZMAT team is required to assist with a chemical spill, the county's HAZMAT team is based in the City of Knoxville. The county's planning team reported one significant chemical spill that has occurred within the county. A diesel fuel spill occurred West of Pleasantville on Highway 5. Impacts were minimal.

[39] National Pipeline Mapping System. 2022. "Public Viewer." Accessed December 2022. https://pvnpms.phmsa.dot.gov/PublicViewer/.

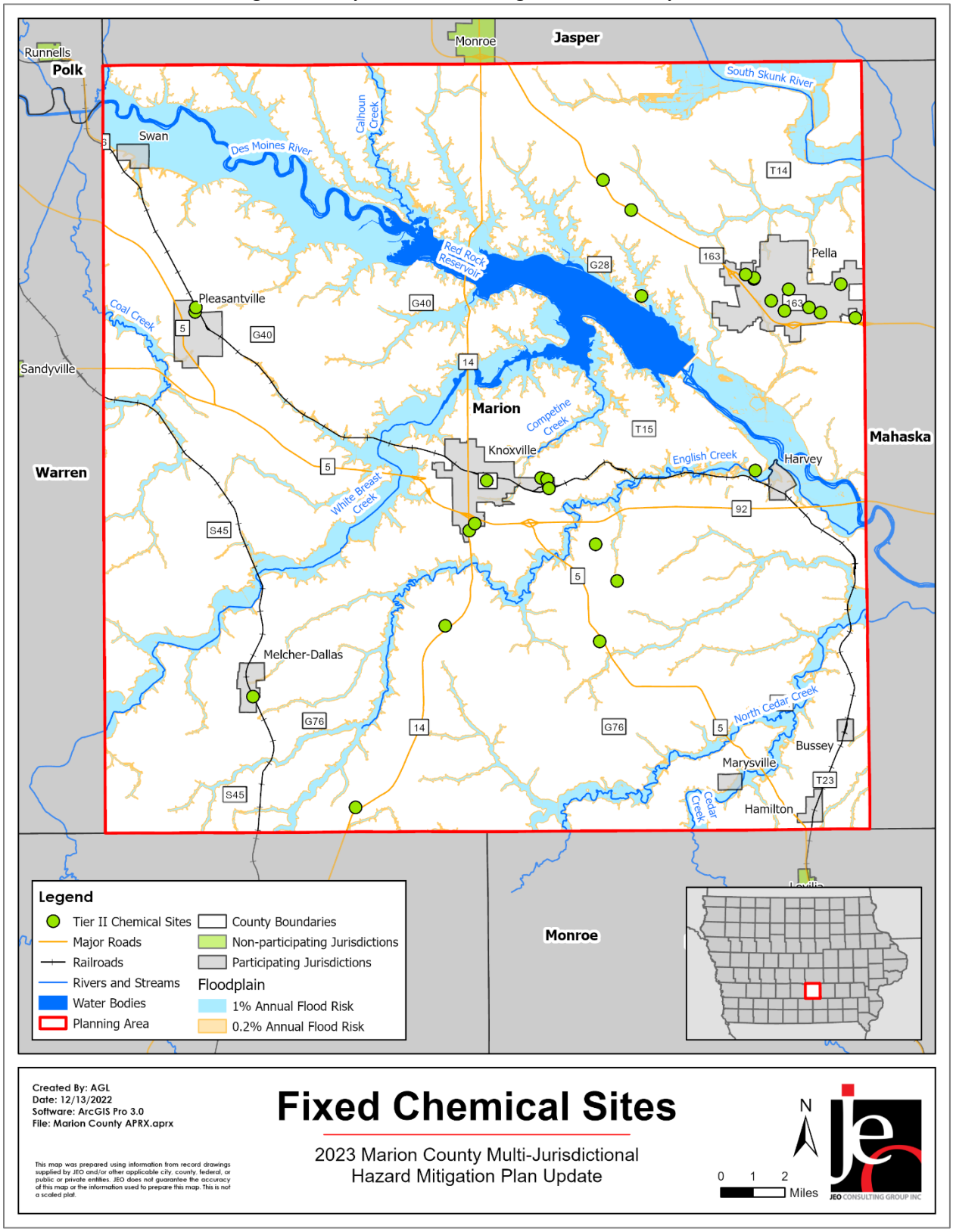
Table 38: Chemical Storage Sites

CRITICAL FACILITY NAME	COMMUNITY LOCATION
3M Co Industrial Tape Division	Knoxville, IA
AGRILAND FS, Inc. - Knoxville	Knoxville, IA
Chem-Tech, Ltd	Pleasantville, IA
City Of Pella - West Substation	Pella, IA
City of Pella Water Works	Pella, IA
Columbia-SFG	Columbia, IA
Ferrellgas	Knoxville, IA
Furnal Inc	Pleasantville, IA
Hormel Foods Corporation	Knoxville, IA
Knoxville Industrial Peaking Power Station	Knoxville, IA
Manatts Inc--Pella Ready Mix Plant	Pella, IA
Melcher-SFG	Melcher-Dallas, IA
Natural Gas Pipeline Company - Station 198	Knoxville, IA
Norris Asphalt Paving Co Plant #450	Harvey, IA
Pella Corporation - Pella Operations	Pella, IA
Pella Engraving Company	Pella, IA
Precision Pulley & Idler Inc Plt4	Pella, IA
Precision Pulley & Idler, Inc	Pella, IA
Red Rock Marina	Pella, IA
Smith Fertilizer & Grain-wagons Pleasantville	Pleasantville, IA
Smith Fertilizer and Grain - Knoxville	Knoxville, IA
Smith Fertilizer and Grain - Pleasantville	Pleasantville, IA
Two Rivers Cooperative - Otley	Otley, IA
Two Rivers Cooperative - Otley Fertilizer	Otley, IA
Two Rivers Cooperative - Otley NH3	Otley, IA
Two Rivers Cooperative - Pella	Pella, IA
Vermeer Corporation	Pella, IA
Weiler	Knoxville, IA
Windstream IOWA TELECOM - KNOXVILLE	Knoxville, IA
Windstream IOWA TELECOM - PELLA	Pella, IA

Source: Iowa Department of Natural Resources[40], Marion County EMA - Personal Correspondence

[40] Iowa Department of Natural Resources. 2022. "Emergency Response - Tier II Chemical Storage." Accessed December 2022. https://facilityexplorer.iowadnr.gov/facilityexplorer/.

Figure 20: Map of Chemical Storage Sites and Floodplain



State and Federally Owned Properties

The following table lists major state and federally owned properties within the county. Note that this list does not include federally or state-owned highway systems or specific buildings within each community.

Table 39: State and Federally Owned Facilities and Lands

Site Name	Nearest Community
Lake Red Rocks	Knoxville, Pella
Pella Wildlife Management Area	Pella

Source: Iowa Department of Natural Resources,[41] U.S National Park Service[42]

Historical Sites

According to the National Register of Historic Places for Iowa by the National Park Service, there are 28 historic sites located in the county. Structures identified as cultural or historic resources represent assets that are unique to the county and are, in many situations, irreplaceable and have local significance.

Table 40: Historical Sites

Site Name	Date Listed	Nearest Community
Chicago, Rock Island and Pacific Passenger Depot-Pella	7/22/1991	Pella
Coal Ridge Baptist Church and Cemetery	8/23/2006	Knoxville
Collegiate Neighborhood Historic District	10/26/2017	Pella
East Amsterdam School	12/1/2000	Pella
Ellis, Evan F., Farmhouse	1/3/1985	Bussey
First Christian Church	3/29/2007	Pella
Hammond Bridge	5/15/1998	Hamilton
Harvey Railroad Bridge	5/15/1998	Harvey
Hays, E. R., House	9/27/1984	Knoxville
Knoxville Veterans Administration Hospital Historic District	5/1/2012	Knoxville
Knoxville WPA Athletic Field Historic District	8/2/2007	Knoxville
Koelman, Philipus J. and Cornelia, House	12/21/2005	Pella
Marion County Courthouse	7/2/1981	Knoxville
Pella High School	10/19/2020	Pella
Pella Opera House	3/20/1992	Pella
Peoples Nationals Bank	4/21/2010	Pella
Porter-Rhynsburger House	8/28/2003	Pella
Scholte, Dominie Henry P., House	12/10/1982	Pella
St. Joseph's Roman Catholic Church and Cemetery Historic District	1/24/1995	Lacona
Ten Hagen Cottage-Stegman Store	7/16/2008	Pella
Tuttle, Thomas F. and Nancy, House	1/27/2015	Pella
Van Asch, William, House-Huibert Debooy Commercial Room	12/2/1987	Pella
Van Den Berg, Hendrik J. and Wilhelmina H., Cottage	8/28/2003	Pella
Van Loon, Dirk, House	11/17/1977	Pella
Van Maren, Henry and Johanna, House-Diamond Filling Station	7/10/2008	Pella
Van Spanckeren, B. H. and J. H. H., Row Houses	2/12/1990	Pella
Vander Wilt, Dirk and Cornelia J., Cottage	8/8/2001	Pella
Wabash Railroad Bridge	5/15/1998	Pella

Source: National Park Service[43]

41 Iowa Department of Natural Resources. 2022. "Wildlife Management Areas." https://www.iowadnr.gov/hunting/places-to-hunt-shoot/wildlife-management-areas#13254117-t---w

42 U.S. Department of the Interior National Park Service. 2022. "National Register of Historic Places." [shapefile]. https://irma.nps.gov/DataStore/Reference/Profile/2210280.

43 U.S. National Park Service. 2022. "National Register of Historic Places NPGallery Database." https://npgallery.nps.gov/nrhp.

Mitigation Strategy

The Marion County Hazard Mitigation Plan evaluates a range of natural and man-made hazards which pose a risk to the counties, communities, and other participants. The full impacts of these hazards on the county are analyzed in *Section Four: Risk Assessment.* However, during the planning process, the local planning team identified some hazards of higher concern for Marion County. These hazards include Hazardous Materials Release, Human Infectious Diseases, Tornadoes and High Winds, Flooding, and Severe Winter Storm and Extreme Cold. Throughout this planning process, the county was asked to review mitigation projects from the 2016 HMP and identify new potential mitigation and strategic actions to further reduce the effects of hazards. Below are the updated and new mitigation and strategic actions for Marion County.

Completed Mitigation and Strategic Actions

Mitigation Action	County DFIRM Maps
Description	Ask FEMA for Complete Digital FIRM maps for the county or to update them.
Hazard(s)	Flooding
Status	County DFIRM Maps were updated in February 2018.

Mitigation Action	Implement Zoning Ordinances
Description	Implement and Enforce Zoning Ordinances
Hazard(s)	Flooding
Status	The county zoning ordinances were updated in 2023, floodplain ordinances were updated in 2017, and subdivision regulations were updated in 2017.

Mitigation Action	Continuity and Succession Plans
Description	Create a jurisdictional continuity of operations and succession plan.
Hazard(s)	All Hazards
Status	Marion County contracted JEO Consulting Group to write a Continuity of Operations Plan in 2023.

Mitigation Action	Warning Sirens
Description	Install Warning Sirens
Hazard(s)	Severe Thunderstorms, Tornadoes and High Winds
Status	This mitigation action has been completed.

Mitigation Action	Emergency Operations Plan
Description	Adopt a thorough emergency operations plan (EOP) addressing hazards and mass casualties.
Hazard(s)	All Hazards
Status	This mitigation action has been completed through the ESF and COOP.

Continued Mitigation and Strategic Actions

Hazardous Materials Release

Mitigation Action	Road Closure Barricade
Description	Purchase and install road closure barricades.
Hazard(s)	Hazardous Materials Release, Severe Winter Storms and Extreme Cold, Severe Thunderstorms, Tornadoes and High Winds, Flooding, Landslide, Sinkhole, Transportation Incidents
Estimated Cost	$500/barricade
Funding	County Funds
Timeline	5+ Years
Priority	Low
Lead Agency	Roads Department, Engineering Department
Status	This mitigation action has not been started.

Mitigation Action	Emergency Communications
Description	Purchase new, modernize, and/or harden existing mobile and personal communications equipment.
Hazard(s)	Hazardous Materials Release, Severe Winter Storms and Extreme Cold, Severe Thunderstorms, Tornadoes and High Winds, Flooding, Transportation Incidents, Grass and Wildland Fire, Infrastructure Failure
Estimated Cost	$500,000
Funding	County Funds
Timeline	2-5 Year
Priority	Medium
Lead Agency	Marion County Emergency Management
Status	This mitigation action is currently in the works and is under halfway complete. Radios are being purchased.

Human Infectious Disease

Mitigation Action	Emergency Preparedness Drills
Description	Organize and host community drills and exercises throughout the county for a range of hazards that impact county operations.
Hazard(s)	Hazardous Materials Release, Tornadoes and High Winds, Severe Winter Storms, Flooding, Human Infectious Diseases, Terrorism and Civil Disorder
Estimated Cost	$1,000
Funding	Local, State, and Federal Funding
Timeline	1 Year
Priority	Low
Lead Agency	Marion County Public Health
Status	This mitigation action has not been started. An exercise should be held utilizing County COOP and ESF plans.

Tornadoes and High Winds

Mitigation Action	Abandoned Properties
Description	Demolish abandoned properties in unincorporated Marion County
Hazard(s)	Grass and Wildland Fires, Tornadoes and High Winds
Estimated Cost	$15,000
Funding	County Funds
Timeline	5+ Years
Priority	High
Lead Agency	Board of Supervisors
Status	This mitigation action has not been started.

Mitigation Action	Tree Planting Programs
Description	Implement a tree planting program on public property to break high winds and improve soil conditions
Hazard(s)	Severe Winter Storms, Tornadoes and High Winds, Drought, Agricultural Plant and Animal Disease
Estimated Cost	$5,000
Funding	County Funds
Timeline	2-5 Years
Priority	Low
Lead Agency	Conservation Department
Status	This mitigation action has not been started.

Mitigation Action	Emergency Vehicle Tracking
Description	Install computers and/or GPS units in emergency and county vehicles.
Hazard(s)	Flooding, Grass and Wildland Fire, Hazardous Material Release, Infrastructure Failure, Landslide, Severe Thunderstorms, Severe Winter Storms, Sinkhole, Terrorism and Civil Disorder, Tornado and High Winds, Transportation Incidents
Estimated Cost	$500/unit
Funding	County Funds
Timeline	2-5 Years
Priority	Medium
Lead Agency	Board of Supervisors
Status	This mitigation action has not been started.

Flooding

Mitigation Action	Hazard Signs
Description	Install hazard signs in area campgrounds, parks, and open spaces.
Hazard(s)	Flooding, Tornadoes and High Winds, Severe Thunderstorms
Estimated Cost	$1,000
Funding	County Funds
Timeline	2-5 Years
Priority	Medium
Lead Agency	Conservation Department
Status	This mitigation action has not been started.

Mitigation Action	Soil Erosion Stabilization Projects
Description	Develop Soil Erosion Stabilization Projects – conduct studies to determine specific project needs.
Hazard(s)	Flooding, Drought
Estimated Cost	$25,000
Funding	County Funds
Timeline	2-5 Years
Priority	Medium
Lead Agency	Board of Supervisors
Status	This mitigation action has not been started.

Mitigation Action	Watershed Studies
Description	Develop and implement watershed studies and plans for possible flood prone areas along and near Coon, Coal, and Cedar Creeks.
Hazard(s)	Flooding
Estimated Cost	$20,000
Funding	County Funds
Timeline	2-5 Years
Priority	Medium
Lead Agency	Engineering Department
Status	This mitigation action has not been started.

Mitigation Action	GIS Mapping
Description	Implement GIS Mapping system and digital hazard maps.
Hazard(s)	Flooding, Grass and Wildland Fire, Hazardous Materials Release, Infrastructure Failure, Terrorism and Civil Disorder, Transportation Incidents
Estimated Cost	$5,000
Funding	County Funds
Timeline	2-5 Years
Priority	Medium
Lead Agency	County GIS Department
Status	This mitigation action as not been started.

Severe Winter Storms and Extreme Cold

Mitigation Action	Backup Generators
Description	Purchase/Install Backup Fixed Power Generators
Hazard(s)	Infrastructure Failure, Severe Thunderstorms, Severe Winter Storms, Tornadoes and High Winds
Estimated Cost	$75,000
Funding	County Funds, IRUA funds, HMA Grants
Timeline	2-5 Years
Priority	Medium
Lead Agency	Board of Supervisors, Iowa Regional Utilities Association
Status	This mitigation action has not been started.
Partnership	IRUA identified a need to install backup generators to provide redundancy and protection of water infrastructure, including those providing services to Marion County. IRUA and Marion County may work collaboratively to identify locations for generators that would be mutually beneficial.

Mitigation Action	Upgrade Equipment
Description	Purchase Snowplows, Trucks, and Sanders
Hazard(s)	Severe Winter Storms
Estimated Cost	$100,000
Funding	County Funds, Roads Department
Timeline	5+ Years
Priority	Medium
Lead Agency	Board of Supervisors
Status	This mitigation action has not been started.

Removed Mitigation and Strategic Actions

Mitigation Action	Full Review of Policy, Procedure, and Codes
Description	Complete fill review of policy, procedure, and codes.
Hazard(s)	All Hazards
Reason for Removal	This action is met by regular operations. It does no qualify as a mitigation action.

Mitigation Action	Harden Buildings
Description	Harden public buildings throughout Marion County
Hazard(s)	Severe Thunderstorm, Tornadoes and High Winds
Reason for Removal	While the county will continue to encourage strong buildings that can protect citizens within, this action is unspecified and too general to be considered a mitigation action.

Mitigation Action	Increase Bridge Capacity
Description	Increase bridge capacity.
Hazard(s)	Transportation Incidents
Reason for Removal	This mitigation action does not have a clear description of how this action will be completed and does not meet the requirement to be a mitigation action.

Mitigation Action	Improve Roads
Description	Improve Roads (Resurface, pave, and widen)
Hazard(s)	Transportation Incidents
Reason for Removal	This mitigation action does not have a clear description of how this action will be completed and does not meet the requirement to be a mitigation action. County Road Department addresses road improvements as needed.

Mitigation Action	Maintain Emergency Operations Center
Description	Maintain Emergency Operations Center with 24-hour capabilities.
Hazard(s)	All Hazards
Reason for Removal	This action is met by regular operations. It does not qualify as a mitigation action.

Mitigation Action	NFIP Participation
Description	Maintain active participation in the NFIP to include: Continued enforcement of floodplain management requirements (including regulating new construction in Special Flood Hazard Areas [SFHAs])
Hazard(s)	Flooding
Reason for Removal	While the community will continue to participate in the NFIP, this is no longer considered a specific mitigation action. Enforcement of floodplain policies is required as part of ongoing codes.

Mitigation Action	Train Emergency Response Personnel
Description	Train first responders, EMTs, Firefighters, and Emergency Disaster Responders
Hazard(s)	All Hazards
Reason for Removal	This is not a specific action as first responders are continuously trained.

Plan Maintenance

Hazard Mitigation Plans should be living documents and updated regularly to reflect changes in hazard events, priorities, and mitigation actions. These updates are encouraged to occur after every major disaster event, alongside community planning documents (e.g., annual budgets and Capital Improvement Plans), during the fall before the HMA grant cycle begins, and/or prior to other funding opportunity cycles begin, including CDBG, Water Sustainability Fund, Revolving State Fund, or other identified funding mechanisms.

The local planning team is responsible for reviewing and updating this community profile as changes can occur before or after a major event. Members of the county's Hazard Mitigation Planning Team (see *Section Two*) can suggest or make revisions or additions to the plan at any time. Team members are responsible for providing all such revisions to the Marion County Emergency Management Agency's Assistant EMA Coordinator to update the final plan. The entire plan will be reviewed by EMA bi-annually or as needed. The county PIO officer and County Commissioners will notify and involve the public in the plan review and revision through social media and website updates.

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Section Four
Risk Assessment

Introduction

The ultimate purpose of this hazard mitigation plan is to minimize the loss of life and property across the county due to natural or man-made hazards. This section contains a risk assessment including descriptions of potential hazards, vulnerabilities and exposures, probability of future occurrences, and potential impacts and losses. By conducting a thorough risk assessment, participating jurisdictions can develop specific strategies to address areas of concern. The following table defines terms that will be used throughout this section of the plan.

Table 41: Term Definitions

Term	Definition
Hazard	A potential source of injury, death, or damages
Asset	People, structures, facilities, and systems that have value to the community
Risk	The potential for damages, loss, or other impacts created by the interaction of hazards and assets
Vulnerability	Susceptibility to injury, death, or damages to a specific hazard
Impact	The consequence or effect of a hazard on the community or assets
Historical Occurrence	The number of hazard events reported during a defined period of time
Extent	The strength or magnitude relative to a specific hazard
Probability	Likelihood of a hazard occurring in the future

Methodology

The risk assessment methodology utilized for this plan follows the same methodology as outlined in the FEMA Local Mitigation Planning Handbook. This process consists of four primary steps:

1. Describe the hazard
2. Identify vulnerable community assets
3. Analyze risk
4. Summarize vulnerability

When describing the hazard, this plan will examine the following items: previous occurrences of the hazard within the county; locations where the hazard has occurred in the past or is likely to occur in the future; extent of past events and likely extent for future occurrences; and probability of future occurrences. While the identification of vulnerable assets will be conducted across the entire county, *Section Seven* will discuss community-specific assets at risk for relevant hazards. Analysis for regional risk will examine historic impacts and losses and what is possible should the hazard occur in the future. Risk analysis will include both qualitative (i.e., description of historic or potential impacts) and quantitative data (i.e., assigning values and measurements for potential loss of assets).

Requirement §201.6(c)(2): Risk assessment. The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

Requirement §201.6(c)(2)(i): The risk assessment shall include a description of the type, 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.

Requirement §201.6(c)(2)(ii): The risk assessment shall include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. The plan must also address National Flood Insurance Program insured structures that have been repetitively damaged by floods.

Requirement §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 area.

Requirement §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

Average Annual Damages and Frequency

This risk assessment methodology includes an overview of assets at risk and provides historic average annual dollar losses for all hazards for which historic event data are available (FEMA *Requirement §201.6(c)(2)(ii)(B)).* Average annual losses from historical occurrences can be calculated for those hazards which there is a robust historic record and for which monetary damages are recorded. Additional loss estimates are provided separately for those hazards for which sufficient data is available. These estimates can be found within the relevant hazard profiles. There are three main pieces of data used throughout this formula.

- **Total Damages in Dollars:** This is the total dollar amount of all property damages and crop damages as recorded in federal, state, and local data sources. The limitation to these data sources is that dollar figures usually are estimates and often do not include all damages from every event, but only officially recorded damages from reported events.

- **Total Years of Record:** This is the span of years there are data available for recorded events. During this planning process, vetted and cleaned National Centers for Environmental Information (NCEI) data are available for 1996 to 2022. Although some data are available back to 1950, this plan update only utilizes the more current and more accurate data available. Other periods of record for data sets are supplied where appropriate.

- **Number of Hazard Events:** This shows how often an event occurs. The frequency of a hazard event will affect how a community responds. A thunderstorm may not cause much damage each time, but multiple storms can have an incremental effect on housing and utilities. In contrast, a rare tornado can have a widespread effect on a community.

An example of the event damage estimate is found below:

$$\textbf{Avg. Annual Damages } (\$) = \frac{Total\ Damages\ in\ Dollars\ (\$)}{Total\ Years\ \text{of}\ Record\ (\#)}$$

It should be noted that NCEI data is not all inclusive and the database provides very limited information on crop losses. To provide a better picture of the crop losses associated with the hazards, crop loss information provided by the Risk Management Agency (RMA) of the USDA between 2000 and 2022 was also utilized. Data for all the hazards are not always available, so only those with an available dataset are included in the loss estimation.

Annual probability can be calculated based on the total years of record and the total number of years in which an event occurred. An example of the annual probability estimate is found below:

$$\textbf{Annual Probability } (\%) = \frac{Total\ Years\ with\ an\ Event\ Occurring\ (\#)}{Total\ Years\ of\ Record\ (\#)}\ x\ 100$$

FEMA Standard Economic Values

As part of FEMA's Benefit-Cost Analysis Toolkit, standard economic values were developed to help better estimate the avoided loss of services when implementing a hazard mitigation project. These standard economic values can also be used to help estimate potential future economic impacts from a hazard event. Table 42 shows the economic value for traffic delays on roads and bridges, loss of electric services, loss of wastewater services, loss of potable water services, and loss of communications/IT services. The assumed damages do not consider physical damage to utility equipment and infrastructure but do consider the impact on economic activity and impact on residential customers.

Table 42: FEMA Standard Economic Values

Service Lost	Economic Value
Traffic Delays on Roads and Bridges	$35.60/Vehicle/Hour
Loss of Electric Services	$182/Person/Day
Loss of Wastewater Services	$60/Person/Day
Loss of Potable Water Services	$116/Person/Day
Loss of Communications/IT Services	$130/Person/Day

Source: FEMA, 2022[44]

Also included in FEMA's Benefit-Cost Analysis Toolkit are life safety economic values. Life safety is the value of lives saved and injuries prevented resulting from mitigation measures. Table 43 shows the six different severity levels, their economic value, and common injuries associated with each level.

Table 43: FEMA Life Safety Economic Values

Injury Severity Level	Selected Common Injuries	Economic Value
Minor	Superficial abrasion or laceration of skin; digit sprain; first degree burn; head trauma with headache or dizziness (no other neurological signs).	$35,000

44 FEMA. 2022. "Benefit-Cost Analysis Sustainment and Enhancement". https://www.fema.gov/sites/default/files/documents/fema_standard-economic-values-methodology-report_092022.pdf.

Injury Severity Level	Selected Common Injuries	Economic Value
Moderate	Major abrasion or laceration of skin; cerebral concussion (unconscious less than 15 minutes); finger or toe crush/amputation; closed pelvic fracture with or without dislocation.	$545,000
Serious	Major nerve laceration; multiple rib fracture (but without flail chest); abdominal organ contusion; hand, foot, or arm crush/amputation.	$1,218,000
Severe	Spleen rupture; leg crush; chest-wall perforation; cerebral concussion with other neurological signs (unconscious less than 24 hours).	$6,879,000
Un-Survivable	Spinal cord injury (with cord transection); extensive second- or third- degree burns; cerebral concussion with severe neurological signs (unconscious more than 24 hours).	$11,600,000

Source: FEMA, 2022

FEMA's standard economic values and life safety economic values will not be used to determine average annual damages and average damage per event estimates for each hazard profile. Past hazard events do not list the total number of people or vehicles impacted, and thus it is impossible to retroactively calculate the total economic impact using these values. While injuries and fatalities may be given it is not known the severity of those injured during the event. The values are provided in this plan so that participants can better estimate potential losses and determine the benefits of potential future mitigation actions.

Hazard Identification

The identification of relevant hazards for the county began with a review of the 2018 State of Iowa Hazard Mitigation Plan. Marion County representatives and key contacts reviewed, discussed, and determined the list of hazards to be profiled in this HMP update at the Kick-off Meeting. The hazards for which a risk assessment was completed are included in the following table.

Table 44: Hazards Addressed in the Plan

Hazards Addressed in the Plan		
Agricultural Plant and Animal Disease	Flooding (both ravine and flash flooding)	Severe Thunderstorms
Dam Failure	Grass and Wildland Fire	Severe Winter Storms and Extreme Cold
Drought	Hazardous Materials Release	Sinkhole
Earthquakes	Human Infectious Diseases	Terrorism and Civil Disorder
Expansive Soils	Infrastructure Failure	Tornado and High Winds
Extreme Heat	Landslides	Transportation Incident

Hazard Profile Changes

All hazards from the State HMP were considered for Hazard Mitigation Plan. Given the location and history of the planning area one hazard was not included while some were combined due to their similarity of risks, impacts, and mitigation strategies. Levee failure was removed from the list of hazards due to no levees being located within the county. Other changes to hazard profiles are listed below.

- **Flooding:** This hazard includes both Flash and Riverine Flooding.
- **Hazardous Materials Release:** This includes both Hazardous Materials and Radiological incidents.

Hazard Assessment Summary Tables

The following table provides an overview of the data contained in the hazard profiles. Hazards listed in this table and throughout the section are in alphabetical order. This table is intended to be a quick reference for people using the plan and does not contain source information. Source information and full discussion of individual hazards are included later in this section. Annual probability is based off the number of years that had at least one event.

Table 45: Regional Risk Assessment

Hazard	Previous Occurrences	Approximate Annual Probability*	Likely Extent
Agricultural Plant and Animal Disease	Animal Disease: Unavailable	Unknown	Unknown
	Plant Disease: 18	Plant Disease 9/22 = 41%	Crop damage or loss
Dam Failure	0	Less than 1%	Varies by structure Inundation of floodplain downstream from dam

Hazard	Previous Occurrences	Approximate Annual Probability*	Likely Extent
Drought	489/1,532 months	28%	Mild Drought (D1)
Earthquakes	0	Less than 1%	Less than 5.0 on the Richter Scale
Expansive Soils	Unknown	Unknown	Varies by event
Extreme Heat	Heat: Avg 2 day/year	29/84 = 35%	Max Temp ≥100°F
Flooding	133	21/27 =78%	Some inundation of structures and road closures. Some evacuations of people may be necessary.
Grass and Wildland Fire	39	5/15 = 33%	Avg 6 acres
Hazardous Materials Release	Fixed Site Spill: 25	17/33 = 52%	Avg Liquid Spill: 125 gallons Avg Gas Spill: 3,057 lbs.
	Transportation Spill: 6	5/52 = 10%	Avg Spill: 3,358 lbs of product
Human Infectious Diseases	2 major outbreaks	Unknown	Unknown
Infrastructure Failure	Unknown	Likely to occur annually	Varies by event
Landslide	Unknown	Less than 1%	Varies by event
Severe Thunderstorms	428	27/27= 100%	>1" rainfall Avg 75 mph winds Avg. hail 1.2"
Severe Winter Storms & Extreme Cold	Storms: 72	24/27 = 89%	1-8" snow 25-35 mph winds
	Cold: Avg 4 days/year	68/84 = 81%	Max Temp ≤ 10°F
Sinkhole	Unknown	Less than 1%	Varies by location/event
Terrorism and Civil Disorder	0	Less than 1%	Varies by event
Tornado and High Winds	Tornadoes: 25	13/27 = 48%	Mode: EF1 Range: EF0-EF3
	High Winds: 31	19/27 = 70%	Avg: 56 mph Range 40-73 mph
Transportation Incident	Auto: 5,640	11/11 = 100%	Damages incurred to vehicles involved and traffic delays; substantial damages to aircrafts involved with some aircrafts destroyed
	Aviation: 22	16/61 = 26%	
	Rail: 46	18/48 = 38%	

** Annual Probability = Total Years with an Event Occurrence / Total Years of Record*

Table 46: Hazard Loss Estimates for the Planning Area

Hazard Type		Count	Property ($)	Crop ($)[2]
Agricultural Plant and Animal Disease	Animal Disease	Unknown	N/A	N/A
	Agricultural Plant Disease[1]	18	N/A	$705,024
Dam Failure[3,11]		0	-	N/A
Drought[4,7]		489/1,532 months	$12,650,000	$22,863,238
Earthquake[5]		0	-	$0
Expansive Soils		Unknown	N/A	N/A
Extreme Heat[6]	Heat (≥100°F)	Avg 2 day /year	$135,000	$190,811
Flooding[7]	Flash Flood	34	$2,117,000	$4,759,233
	Flood	99	$5,037,070	
Grass and Wildland Fire[8] 1 injury		39	209 Acres	-
Hazardous Materials Release	Fixed Site[9] 3 injuries	25	$200,000	N/A
	Transportation[10]	6	$885,874	N/A
Human Infectious Diseases[16]		8,784 COVID cases; 133 fatalities	N/A	N/A
Infrastructure Failure		Unknown	N/A	N/A
Landslide		Unknown	N/A	N/A
Severe Thunderstorms[7]	Hail	144	$755,000	$22,844,644
	Heavy Rain	93	$0	
	Lightning	6	$117,000	
	Thunderstorm Wind 1 injury	185	$3,503,000	
Severe Winter Storms and Extreme Cold[7]	Blizzard	11	$335,000	$971,532
	Extreme Cold/ Wind Chill (≤10°F) [6]	310 days	N/A	
	Heavy Snow	24	$861,560	
	Ice Storm	11	$323,330	
	Winter Storm	25	$564,900	
	Winter Weather	1	$0	
Sinkhole		Unknown	N/A	N/A
Terrorism and Civil Disorder[12]		0	-	N/A

Hazard Type		Count	Property ($)	Crop ($)[2]
Tornado and High Winds[7]	Tornadoes: Average: EF1 Range: EF0-EF3 24 injuries	25	$121,535,000	$537,598
	High Winds: Average: 56 mph Range: 40-73 mph	31	$879,110	$144,633
Transportation Incident	Auto[13] 1,649 injuries, 38 deaths	5,640	$34,979,475	N/A
	Aviation[14] 4 injuries, 4 deaths	22	N/A	N/A
	Rail[15] 18 injuries, 1 death	46	$65,850	N/A
Total		**13,068***	**$369,683,338**	**$106,043,108**

**does not include counts for Animal Disease, Drought, Expansive Soils, Extreme Heat, Human Infectious Diseases, Infrastructure Failure, Landslide, or Sinkholes*

N/A: Data not available
1 USDA RMA, 2000 - 2021
2 U.S. Department of Agriculture - Risk Management Agency. 2022.
3 IDNR Communication, 2022
4 NOAA, 1895 - August 2022
5 USGS, 1900 - April 2022
6 NOAA Regional Climate Center, 1939 - 2022
7 NCEI, 1996 - 2022
8 IDNR, 2019 - 2021
9 NRC, 1990 - 2022
10 PHMSA 1971 - October 2022
11 USACE NLD, 1900 - October 2022
12 University of Maryland, 1970 - 2018
13 IDOT, 2012 - October 2022
14 NTSB, 1962 - December 2022
15 FRA, 1975 - 2021
16 IDPH, as of 6/15/22

Historical Disaster Declarations

The following tables show past disaster declarations that have been granted within the county.

Small Business Administration Disasters

The U.S. Small Business Administration (SBA) was created in 1953 as an independent agency of the federal government to aid, counsel, assist, and protect the interests of small business concerns, to preserve free competitive enterprise, and maintain and strengthen the overall economy of our nation. A program of the SBA includes disaster assistance for those affected by major natural disasters. The following table summarizes the SBA and Secretary of Agriculture Disasters involving the planning area since 2007.

Table 47: SBA and SA Declarations

Declaration Date	Disaster Number	Title	Primary County	Contiguous County
2/23/2007 to 3/02/2007	IA-00006*	Severe Winter Storms		
12/10/2007 to 12/11/2007	IA-00013*	Severe Winter Storm		
5/25/2008	IA-00015*	Severe Storms, Tornadoes, and Flooding		
6/01/2010	IA-00024*	Severe Storms, Flooding, and Tornadoes		
4/17/2013 to 4/30/2013	IA-00052*	Severe Storms, Straight-Line Winds, and Flooding		
6/20/2015 to 6/25/2015	IA-00064*	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding		
12/11/2018	IA-00077*	Severe Storms, Tornadoes, Straight-line Winds, and Flooding		X
8/10/2018	IA-00082**	Drought		X
9/12/2018	IA-00084*	Severe Storm and Tornadoes	X	
8/20/2020	IA-00092*	Severe Storms		X
9/08/2020	IA-00096**	Drought		X
9/03/2020	IA-00097**	Derecho		X
9/19/2022	IA-00116**	Drought		X
10/3/2022	IA-00118**	Drought	X	

**: Presidential and SBA Agency Declared Disasters*
***: Secretary of Agriculture Declared Disasters*
Source: Small Business Administration, 2007-2022[45]

Presidential Disaster Declarations

The presidential disaster declarations involving the county from 1962 to December 2022 are summarized in the following table. Declarations prior to 1962 are not designated by county and are not included.

45 Small Business Administration. 2022. "Current Declared Disasters". https://disasterloanassistance.sba.gov/ela/s/search-declarations.

Table 48: Presidential Disaster Declarations

Disaster Declaration Number	Declaration Date	Title
193	04/22/65	Flooding
259	04/25/69	Flooding
269	8/14/69	Heavy Rains and Flooding
386	5/23/73	Severe Storms & Flooding
443	6/24/74	Severe Storms & Flooding
868	05/26/90	Severe Storms & Flooding
996	07/09/93	Severe Storms & Flooding
1191	11/20/97	Severe Snowstorms
1230	07/02/98	Severe Storms, Tornadoes And Flooding
3239	09/10/05	Hurricane Katrina Evacuation
1688	3/14/07	Severe Winter Storms
1737	1/04/08	Severe Winter Storms
1763	05/27/08	Severe Storms, Tornadoes, And Flooding
1930	07/29/10	Severe Storms, Flooding, And Tornadoes
4119	5/31/13	Severe Storms, Straight-Line Winds, and Flooding
4234	07/31/15	Severe Storms, Tornadoes, Straight-Line Winds, And Flooding
4392	09/12/18	Severe Storm, Tornadoes
3480	03/13/20	COVID-19
4483	03/23/20	COVID-19 Pandemic

Source: Federal Emergency Management Agency, 1953 – 2022[46]

Climate Adaptation

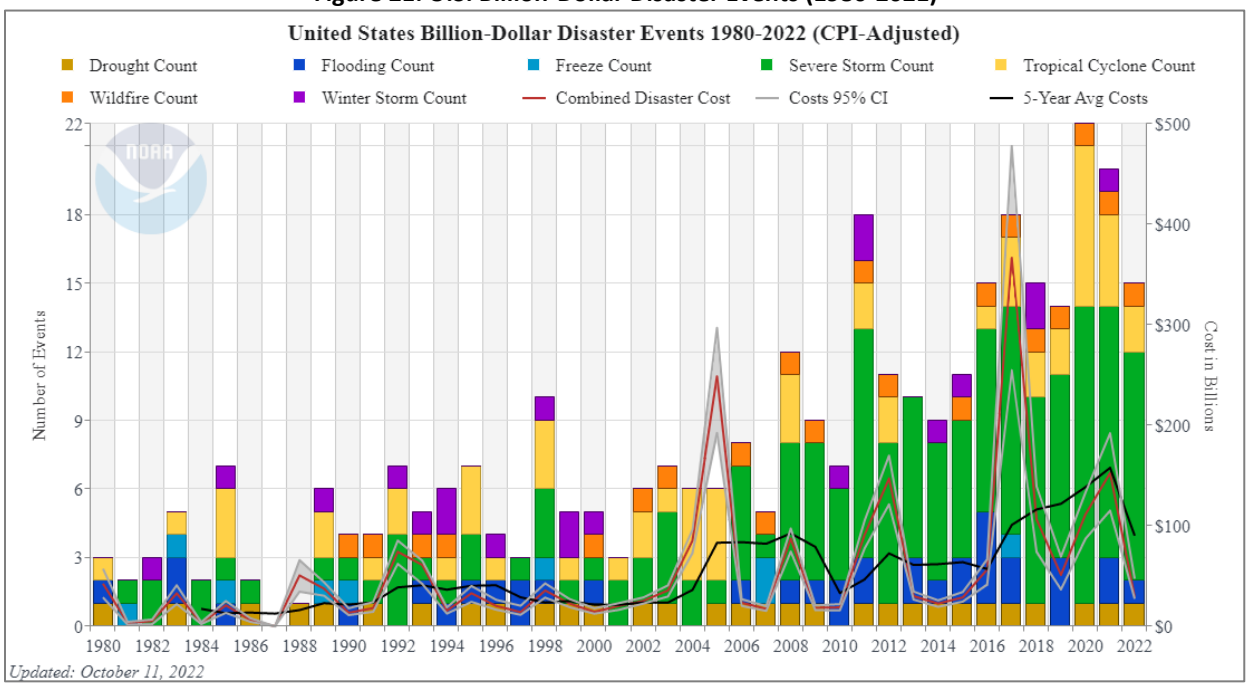
Long-term climate trends have shifted throughout the 21st century and have created significant changes in precipitation and temperature which have altered the severity and subsequent impacts from weather events. Changes in the regional climate is a top concern impacting communities, residents, local economies, and infrastructure throughout the planning area. Challenges that are expected to affect communities, environments, and residents as a result of climate change include:

- Developing and maintaining sustainable agricultural systems.
- Resolving increasing competition among land, water, and energy resources.
- Conserving vibrant and diverse ecological systems.
- Enhancing the resilience of the region's people to the impacts of climatic extremes.

As seen in the figure below, the United States is experiencing an increase in the number of billion-dollar natural disasters due to increases in development and climate change.

[46] Federal Emergency Management Agency. 2022. "Disaster Declarations". Accessed December 2022. https://www.fema.gov/disasters.

Figure 21: U.S. Billion-Dollar Disaster Events (1980-2021)



Source: NOAA, 2021[47]

The planning area is located in the Midwest region of the United States, which includes Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The area is well known for agricultural production. The Midwest has many federal, state, and private forests that provide considerable economic and ecological benefits. The Fourth National Climate Assessment has provided an overview of potential impacts within the planning area.[48]

- **Agriculture:** The Midwest is a major producer of a wide range of food and animal feed for national consumption and international trade. Increases in warm-season absolute humidity and precipitation have eroded soils, created favorable conditions for pests and pathogens, and degraded the quality of stored grain. Projected changes in precipitation, coupled with rising extreme temperatures before mid-century, will reduce Midwest agricultural productivity to levels of the 1980s without major technological advances.

- **Forestry:** Midwest forests provide numerous economic and ecological benefits, yet threats from a changing climate are interacting with existing stressors such as invasive species and pests to increase tree mortality and reduce forest productivity. Without adaptive actions, these interactions will result in the loss of economically and culturally important tree species such as paper birch and black ash and are expected to lead to the conversion of some forests to other forest types or even to non-forested ecosystems by the end of the century. Land managers are beginning to manage risk in forests by increasing diversity and selecting for tree species adapted to a range of projected conditions.

[47] NOAA National Centers for Environmental Information. 2022. "U.S. Billion-Dollar Weather and Climate Disasters". https://www.ncdc.noaa.gov/billions/

[48] U.S. Global Change Research Program. 2018. "Fourth National Climate Assessment". https://nca2018.globalchange.gov/.

- **Biodiversity and Ecosystems:** The ecosystems of the Midwest support a diverse array of native species and provide people with essential services such as water purification, flood control, resource provision, crop pollination, and recreational opportunities. Species and ecosystems, including the important freshwater resources of the Great Lakes, are typically most at risk when climate stressors, like temperature increases, interact with land-use change, habitat loss, pollution, nutrient inputs, and nonnative invasive species. Restoration of natural systems increases in the use of green infrastructure, and targeted conservation efforts, especially of wetland systems, can help protect people and nature from climate change impacts.

- **Human Health:** Climate change is expected to worsen existing health conditions and introduce new health threats by increasing the frequency and intensity of poor air quality days, extreme high temperature events, and heavy rainfalls; extending pollen seasons; and modifying the distribution of disease-carrying pests and insects. By mid-century, the region is projected to experience substantial, yet avoidable, loss of life, worsened health conditions, and economic impacts estimated in the billions of dollars as a result of these changes. Improved basic health services and increased public health measures—including surveillance and monitoring—can prevent or reduce these impacts.

- **Transportation and Infrastructure:** Storm water management systems, transportation networks, and other critical infrastructure are already experiencing impacts from changing precipitation patterns and elevated flood risks. Green infrastructure is reducing some of the negative impacts by using plants and open space to absorb storm water. The annual cost of adapting urban storm water systems to more frequent and severe storms is projected to exceed $500 million for the Midwest by the end of the century.

- **Community Vulnerability and Adaptation:** At-risk communities in the Midwest are becoming more vulnerable to climate change impacts such as flooding, drought, and increases in urban heat islands. Integrating climate adaptation into planning processes offers an opportunity to better manage climate risks now. Developing knowledge for decision-making in cooperation with vulnerable communities will help to build adaptive capacity and increase resilience.

Certain groups of people may face greater difficulty when dealing with the impacts of a changing climate. Older adults, immigrant communities, and those living in poverty are particularly susceptible. Additionally, specific industries and professions tied to weather and climate, like outdoor tourism, commerce, and agriculture, are especially vulnerable.[49]

Iowa's Changing Climate

According to the Iowa Climate Change Impacts Committee's Report to the Governor and Iowa General Assembly, the following changes can be expected for Iowa's future climate:[50]

Increased Precipitation

- Increased frequency of precipitation extremes that lead to flooding.
- Increase of 8 percent more precipitation from 1873 to 2008.

[49] U.S. Environmental Protection Agency. "Climate Impacts on Society." Accessed December 2022. https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-society_.html.

[50] Iowa Climate Change Impacts Committee. 2010. "Climate Change Impacts on Iowa". https://www.iowadnr.gov/portals/idnr/uploads/air/environment/climatechange/complete_report.pdf?amp;tabid=1077

- A larger increase in precipitation in eastern Iowa than in western Iowa.

Higher Temperatures

- Long-term winter temperatures have increased six times more than summer temperatures.
- Nighttime temperatures have increased more than daytime temperatures since 1970.
- Iowa's humidity has risen substantially, especially in summer, which now has 13 percent more atmospheric moisture than 35 years ago as indicated by a three to five degree (Fahrenheit) rise in dew-point temperature. This fuels convective thunderstorms that provide more summer precipitation.

Agricultural Challenges

- Climate extremes, not averages, have the greater impact on crop and livestock productivity.
- Increased soil erosion and water runoff.
- Increased challenges associated with manure applications.
- Favorable conditions for survival and spread of many unwanted pests and pathogens.

Habitat Changes

- Plants are leafing out and flowering sooner.
- Birds are arriving earlier in the spring.
- Some animals are now being sighted farther north than in the past.

Public Health Effects

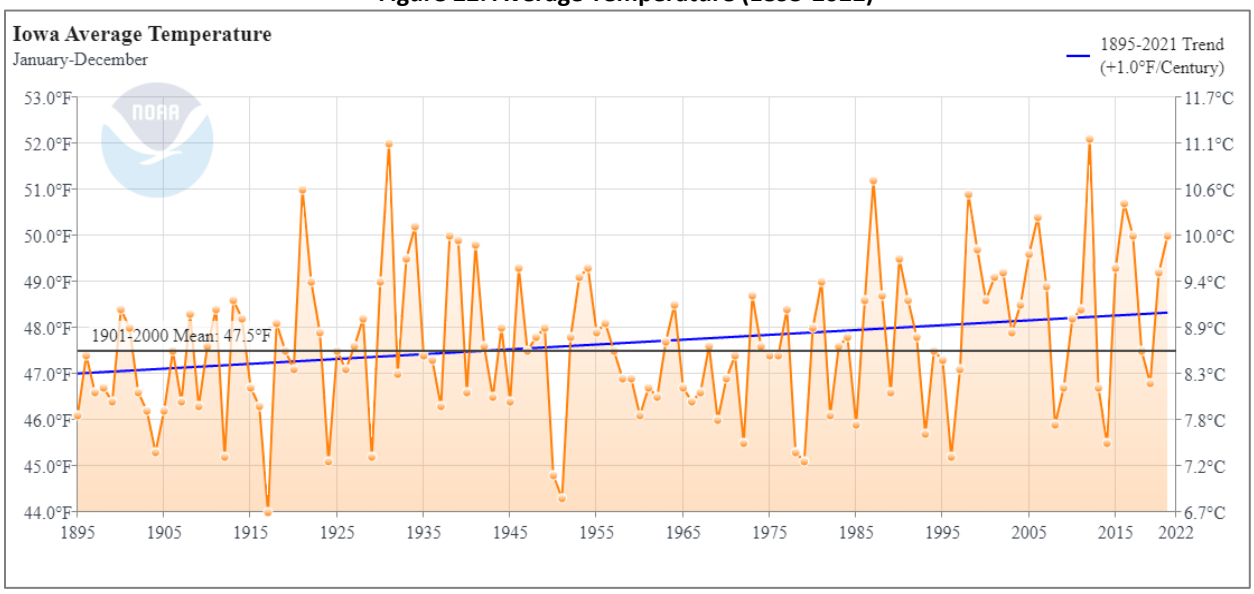
- Increases in heart and lung programs from increasing air pollutants of ozone and fine particles enhanced by higher temperatures.
- Increases in infectious diseases transmitted by insects that require a warmer, wetter climate.
- An increased prevalence of asthma and allergies.

Changes in Temperature

Since 1895 Iowa's overall average temperature has increased by 1° (Figure 22). Climate modeling suggests warmer temperature conditions will continue in the coming decades and rise steadily into mid-century. Warming has increased the most in winter and spring months with winter minimum temperatures rising 2-4°F. Summer has not warmed substantially with a below average number of very hot days. In addition, there is greater warming for nighttime lows than for daytime highs. Since 2000, temperatures in Iowa have been higher than any other historical period, apart from the 1930s dustbowl era. Historically unprecedented warming is projected to continue during this century.[51]

[51] NOAA. "State Climate Summaries 2022 - Iowa". Accessed December 2022. https://statesummaries.ncics.org/chapter/ia/#:~:text=Precipitation%20varies%20widely%20across%20Iowa,central%20part%20of%20the%20state.

Figure 22: Average Temperature (1895-2022)



Source: NOAA, 2022[52]

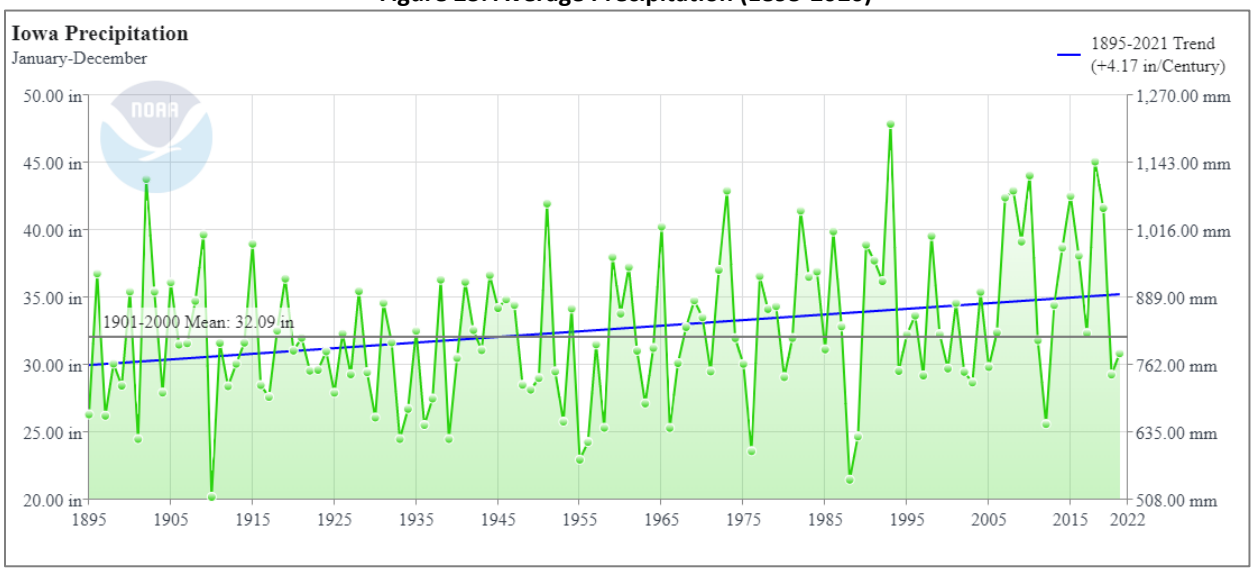
Changes in Precipitation

Changing extremes in precipitation are anticipated in the coming decades, with more significant rain and snowfall events and more intense drought periods. Climatological patterns of precipitation for Iowa consist of an east-west gradient, with drier conditions to the west and wetter to the east, The southeastern portion of the state receives around 38 inches annually compared to only 26 inches in the northwest. Much of Iowa's precipitation falls in summer, with an average of 14 inches in the central part of the state. Spring precipitation has been above average since 1990. Since 1895, yearly annual precipitation for Iowa has increased (Figure 23). This trend is expected to continue as the impacts of climate change continue to be felt.[53]

[52] NOAA. 2022. "Climate at a Glance: Statewide Time Series.". Accessed December 2022. https://www.ncdc.noaa.gov/cag/statewide/time-series/13/tavg/12/12/1895-2020?base_prd=true&begbaseyear=1901&endbaseyear=2000&trend=true&trend_base=100&begtrendyear=1895&endtrendyear=2020

[53] NOAA. 2022. "State Climate Summaries 2022 - Iowa". Accessed December 2022. https://statesummaries.ncics.org/chapter/ia/#:~:text=Precipitation%20varies%20widely%20across%20Iowa,central%20part%20of%20the%20state.

Figure 23: Average Precipitation (1895-2020)



Source: NOAA, 2022[54]

Future Adaptation and Mitigation

The county will have to adapt to a changing climate and its impacts or experience an increase in economic losses, property damages, agricultural damages, and loss of life. Past events have typically informed HMPs to be more resilient to future events. A priority in this HMP update was to evaluate specific climate change impacts per hazard to the planning area. All mitigation strategies should be implemented with the consideration of future climate impacts. Participating jurisdictions should consider past and future climate changes and impacts when incorporating mitigation actions into local planning processes.

[54] NOAA. 2022. "Climate at a Glance: Statewide Time Series.". Accessed December 2022. https://www.ncdc.noaa.gov/cag/statewide/time-series/13/pcp/12/12/1895-2020?base_prd=true&begbaseyear=1901&endbaseyear=2000&trend=true&trend_base=100&begtrendyear=1895&endtrendyear=2020.

Hazard Profiles

Information from participating jurisdictions was collected and reviewed alongside hazard occurrence, magnitude, and event narratives as provided by local, state, and federal databases. Based on this information, profiled hazards were determined to either have a historical record of occurrence or the potential for occurrence in the future. The following profiles will broadly examine the identified hazards across the region. Hazards of local concern or events which have deviated from the norm are discussed in greater detail in each respective community profile (see *Section Seven* of this plan). The following table identifies the prioritization of hazards by participating jurisdictions (i.e., hazards of top concern). Local jurisdictional planning teams selected these hazards from the regional hazard list as the prioritized hazards for the community based on historical hazard occurrences, potential impacts, and the jurisdictions' capabilities. However, it is important to note that while a jurisdiction may not have selected a specific hazard to be profiled, hazard events can impact any community at any time and their selection is not a full indication of risk.

Table 49: Top Hazards of Concern

Jurisdiction	Ag Plant and Animal Disease	Dam Failure	Drought	Earthquake	Expansive Soils	Extreme Heat	Flooding	Grass/Wildland Fire	Hazardous Materials Release	Human Infectious Diseases	Infrastructure Failure	Landslide	Severe Thunderstorms	Severe Winter Storms and Extreme Cold	Sinkhole	Terrorism and Civil Unrest	Tornado and High Winds	Transportation Incidents
Marion County							X		X	X				X			X	
Bussey														X			X	
Harvey							X						X	X				
Knoxville									X				X					
Melcher-Dallas									X		X			X			X	
Pella													X			X	X	
Pleasantville							X		X		X		X				X	X
Knoxville School District														X			X	X
Melcher-Dallas Schools District									X					X		X		
Pella Christian Schools													X					
Pella School District													X				X	
Twin Cedars School District													X	X			X	

Agricultural Plant and Animal Disease

Agriculture disease is any biological disease or infection that can reduce the quality or quantity of either livestock or vegetative crops. These incidents are naturally occurring infection of livestock with insects, vermin, or diseases that render the livestock unfit for consumption or use. This section looks at both animal disease and plant disease, as both make up a significant portion of Marion County's economy. Because of the substantial agricultural industry and related facilities and locations, the potential for infestation of crops or livestock poses a significant risk to the local economy. According to the Iowa Department of Agriculture & Land Stewardship (IDALS) in 2017, the market value of agricultural products sold was estimated at nearly $28 billion; this total is split between crops (estimated $13.8 billion) and livestock (estimated $15.1 billion). For the planning area, the market value of sold agricultural products totaled over $110 million.[55]

Iowa cropland is vulnerable to disease and some level of agricultural infestation is normal, but the introduction of a high-consequence disease could significantly limit or eliminate the ability of producers to move, harvest, and export products. The concern is when the level of an infestation escalates suddenly, or a new infestation appears, overwhelming normal control efforts. The levels and types of agricultural infestation appear to vary by many factors, including cycles of heavy rains and drought. An outbreak of a major infection, disease, or pest infestation may have widespread economic and societal implications for the planning area. Response to an outbreak is a lengthy process and many producers may be put out of business if the economic impacts are large enough. Impact of disease outbreaks to the agricultural market is exhibited by a 2003 incident in Kansas when a rumor of a foot-and-mouth disease outbreak caused the livestock market to plummet. Additionally, the 2009 swine flue outbreak caused market loss in Iowa's pork market. When infestation hits a crop field, the pest may become endemic causing the infestation to occur each subsequent growing season.

Animal Diseases and Infections

In 2007, the State of Iowa ranked number one in the U.S. for livestock inventory of poultry egg layers with 53,793,712, for hog and pig inventory with 19,295,092, and for replacement pullets for laying flocks with an inventory of 11,404,869. With the state having such a substantial agricultural industry, the potential for infestation of livestock poses a significant risk to the Iowa economy. Table 50 shows the population of livestock within Marion County. This count does not include wild populations that are also at risk from animal diseases.

Table 50: Livestock Inventory

Market Value of 2017 Livestock Sales	Cattle and Calves	Hogs and Pigs	Sheep and Lambs	Poultry Egg Layers
$26,437,000	27,157	29,260	3,022	2,418

Source: U.S. Census of Agriculture, 2017

Crop Pests/Plant Diseases

A plant disease outbreak or a pest infestation could negatively impact crop production and agriculturally dependent businesses. An extreme outbreak or infestation could potentially result in billions of dollars in

[55] US Department of Agriculture, National Agricultural Statistics Server. 2022. "2017 Census of Agriculture – County Data." Accessed December 2022. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Iowa/.

production losses. The cascading net negative economic effects could result in wide-spread business failures and reduction of tax revenues. Many factors influence disease development in plants, including hybrid/variety genetics, plant growth stage at the time of infection, weather (e.g., temperature, rain, wind, hail, etc.), single versus mixed infections, and genetics of the pathogen populations.

The following tables provide the value and acres of land in farms for the county. Corn is the most prevalent crop type in the region, followed by soybeans.

Table 51: Land and Crop Values in Marion County

Number of Farms	Land in Farms (acres)	Market Value of 2017 Crop Sales	Corn		Soybeans	
			Acres Planted	Value (2017)	Acres Planted	Value (2017)
1,030	255,013	$84,162,000	72,180	$41,036,000	75,453	$36,406,000

Source: U.S. Census of Agriculture, 2017

Location

Given the strong agricultural presence in the county, animal and plant disease have the potential to occur across the county. If a major outbreak were to occur, the economy in the entire region would be affected, including urban areas. According to the 2017 U.S. Census of Agriculture, there are 1,030 farms in the county that cover 255,013 acres of land, accounting for roughly 70 percent of the county's land area.

The primary land uses where animal and plant disease will be observed include agricultural lands, range or pasture lands, and forests. It is possible that animal or plant disease will occur in domestic animals or crops in urban areas but in a much smaller and easier to contain fashion. Rodeos and fairs also pose a risk of disease transmission for livestock.

Historical Occurrences

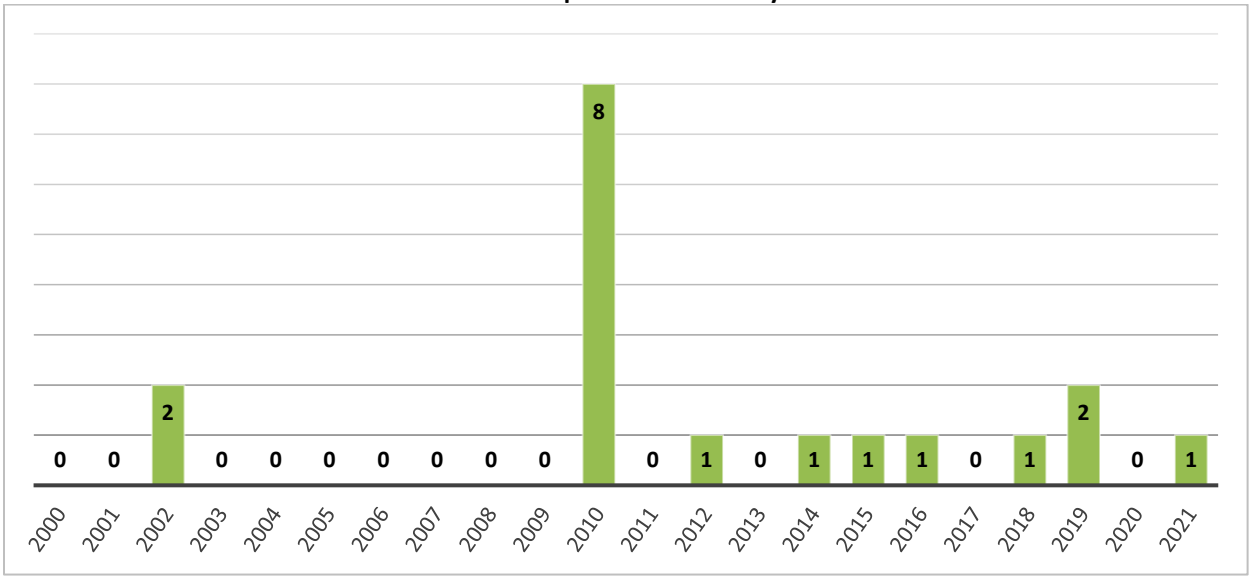
Animal Disease

According to the 2018 Iowa State Plan, in 2015 Iowa experienced impacts to avian populations when 18 counties and 77 sites across the state were affected by highly pathogenic avian influenza. While Marion County was not directly impacted, more than 33 million birds had to be euthanized and disposed of with the cost of replacement estimated at $83.6 million. The replacement cost does not include economic impacts from unemployment and costs to euthanize and dispose of carcasses.

Plant Disease

The RMA provides data on plant disease events and plant losses in the county. The RMA reported 19 instances of plant disease in Marion County between 2000 and 2021. These outbreaks caused $705,024 in crop losses with $36,296 attributed to plant disease and $668,728 attributed specifically to mycotoxin aflatoxin hitting corn and soybean crops.

Table 52: Crop Disease Events by Year



Source: USDA RMA (2000-2021)

Average Annual Losses

Average annual losses for agricultural animal disease cannot be calculated as there is no source in the state for documented historical events. According to the USDA RMA (2000-2021) there were 18 plant disease events in the planning area. While the RMA does not track losses for livestock, annual crop losses from plant disease can be estimated.

Table 53: Agricultural Plant Disease Losses

Hazard Type	Number of Events	Events per Year	Total Crop Loss	Average Annual Crop Loss
Plant Disease	18	0.81	$705,024	$32,047

Source: RMA, 2000-2021

Emerald Ash Borer

The spread and presence of the Emerald Ash Borer (EAB) has become a rising concern for many Iowan communities in recent years as the beetle spreads through transport of infected ash trees, lumber, and firewood. EAB has impacted millions of trees across North America, killing young trees one to two years after infestation and mature trees three to four years after infestation.[56] All species of North American ash trees are vulnerable to infestation. In Marion County, EAB was confirmed in the City of Maryville in 2014 and in Marion County Park in 2017.[57] Figure 24 shows the locations of Iowa's confirmed EAB cases as of December 2022. Many communities across the state are prioritizing the removal of ash trees to help curb potential infestations and tree mortality.

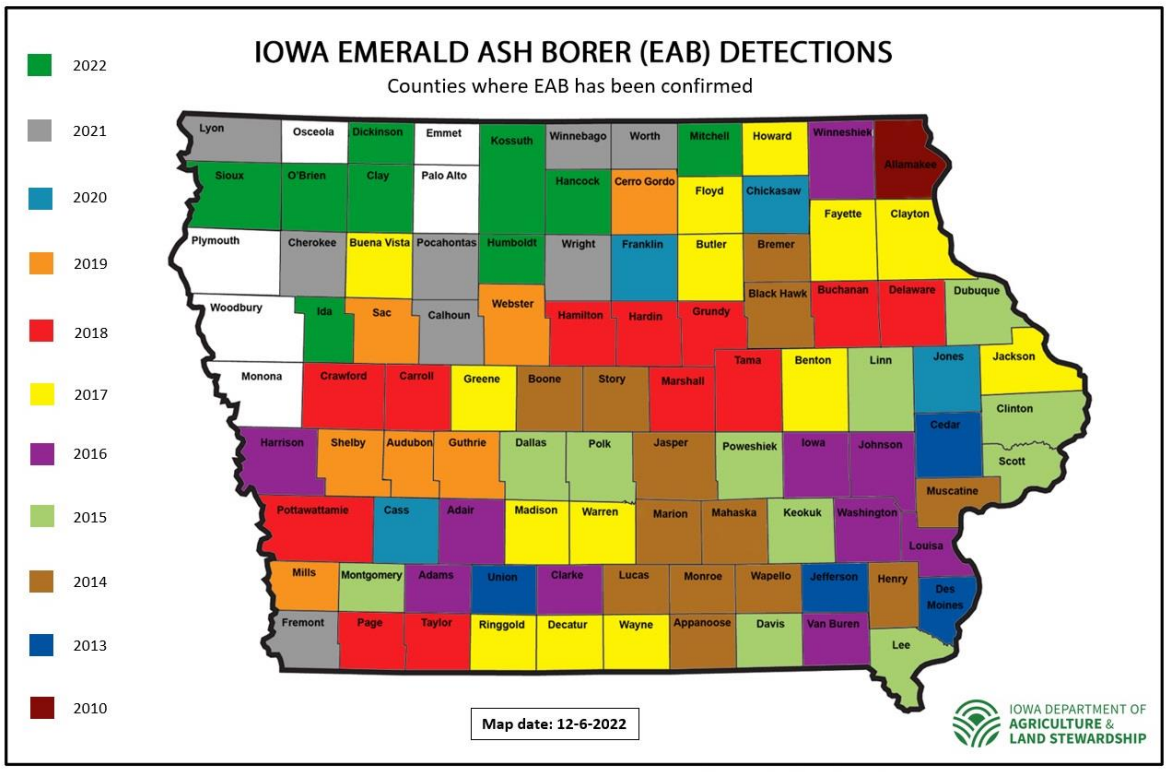
While adult beetles cause little damage, larvae damage trees by feeding on the inner bark of mature and growing trees, causing tunnels. Effects of EAB infestation include extensive damage to trees by birds, canopy dieback, bark splitting, and water sprout growth at the tree base, and eventual tree mortality.

[56] Arbor Day Foundation. 2015. "Emerald Ash Borer." https://www.arborday.org/trees/health/pests/emerald-ash-borer.cfm.

[57] Iowa Department of Agriculture & Land Stewardship. 2022. "Iowa EAB Locations (Confirmed)." http://iowatreepests.com/documents/Iowa_EAB_Locations_2_17_2022.pdf.

Iowa has an estimated 3.1 million urban ash trees. Estimated costs to Iowa communities for ash tree removal is $1.6 billion and $468 million to replant.[58] Dead or dying trees affected by EAB are also more likely to cause damage during high winds, severe thunderstorms, or severe winter storms from weakened or hazardous limbs and can contribute a significant fuel load to grass/wildfire events.

Figure 24: EAB Infestation Status in Iowa



Source: Iowa Department of Agriculture & Land Stewardship, 2022[59]

Extent

There is no standard for measuring the magnitude of agricultural disease. The State of Iowa does not report livestock disease numbers, so the extent is not known. The county is heavily dependent on the agricultural economy. Any severe plant or animal disease outbreak which may impact this sector would negatively impact the entire county's economy.

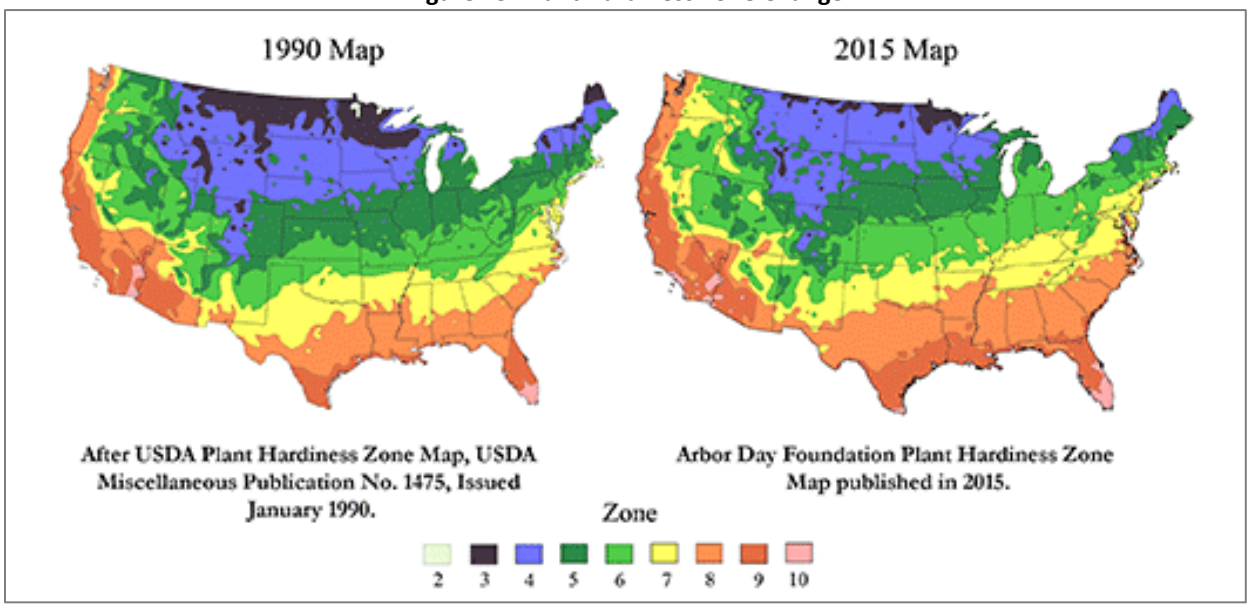
[58] Iowa Department of Natural Resources. 2016. "Emerald Ash Borer." https://www.iowadnr.gov/Portals/idnr/uploads/forestry/Forest%20Health/emerald%20ash%20borer%202016.pdf?ver=2016-12-21-151336-840.

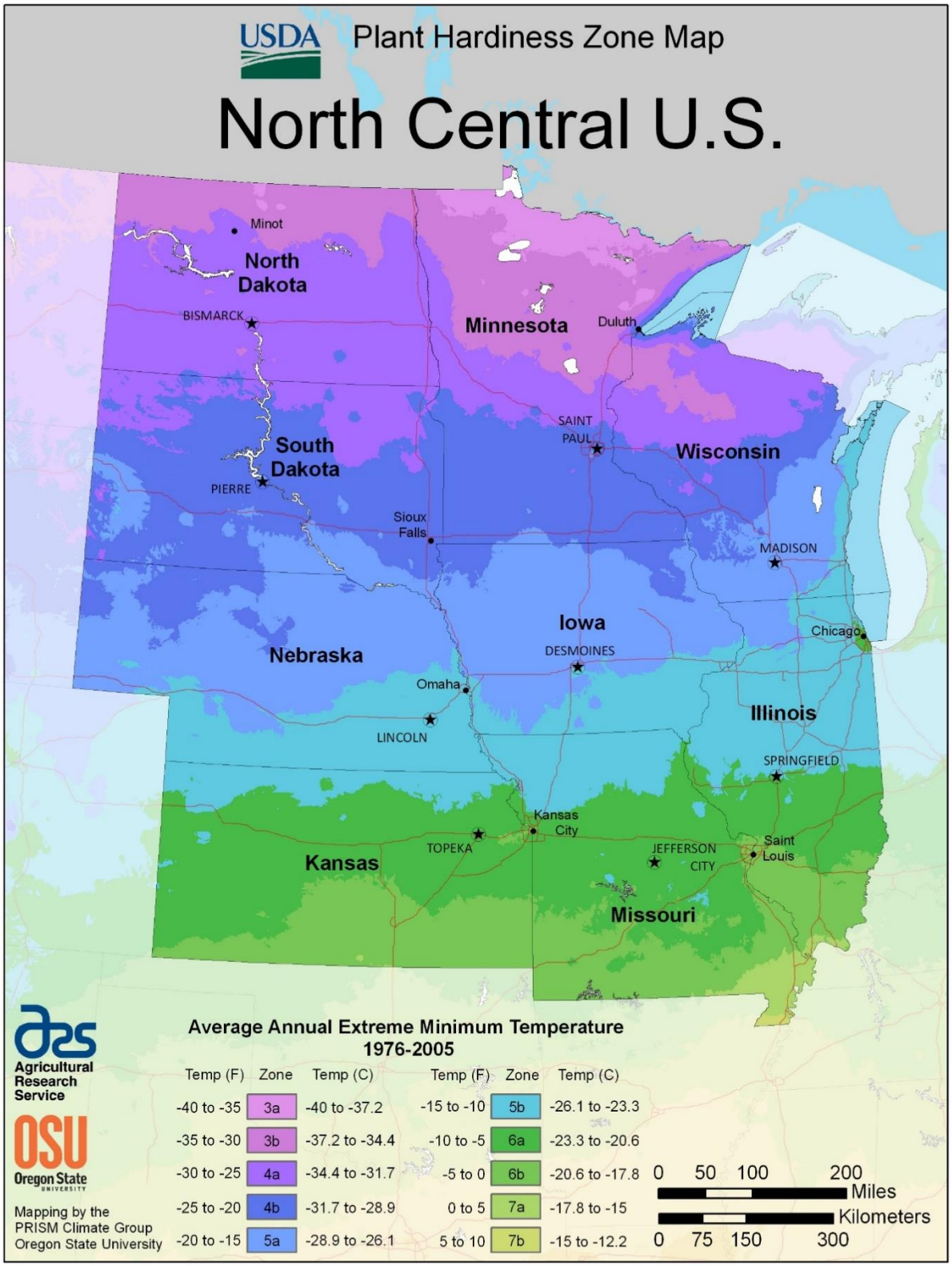
[59] Iowa Department of Agriculture & Land Stewardship. 2022. "Iowa Emerald Ash Borer (EAB) Infestation Status." http://www.iowatreepests.com/eab_home.html.

Climate Change

Iowa is vulnerable to changes in growing season duration and growing season conditions as a heavily agriculturally dependent state. The agricultural sector will experience an increase in droughts, an increase in grass and wildfire events, changes in the growth cycle as winters warm, an influx of new and damaging agricultural diseases or pests, and changes in the timing and magnitude of rainfall. As described in the Plant Hardiness Zone map available for the United States these changes have shifted the annual growing season and expected agricultural production conditions. These added stressors on agriculture could have devastating economic effects if new agricultural and livestock management practices are not adopted.

Figure 25: Plant Hardiness Zone Change





Source: Arbor Day Foundation, 2018[60]

[60] Arbor Day Foundation. 2018. "Hardiness Zones." https://www.arborday.org/media/map_change.cfm.

The distribution and severity of animal and plant disease outbreaks will likely increase alongside climate change impacts. Shifting climatic conditions will stress existing agricultural populations and plant species, creating vulnerability for new diseases to take hold. The trend toward higher average temperatures and increased periods of drought[61] increases the stress levels on animal populations, increasing the risk of disease taking hold. Changes in temperature and precipitation can also alter the geographic range of disease-carrying insects and pests. Mosquitoes that transmit viruses such as Zika, West Nile and dengue may become more prevalent in Iowa. These diseases may initially spread faster as the local population is not aware of the proper steps to reduce their risk. Additionally, uncommon diseases may return at higher amounts as changes in the environment cause the release of previously contained diseases or promotes the mutation of diseases.

As noted by the Fourth National Climate Assessment: "*rural communities, where economies are more tightly interconnected with agriculture than with other sectors, are particularly vulnerable to the agricultural volatility related to climate… Crop and livestock production in certain regions will be adversely impacted both by direct effects of climate change (such as increasing trends in daytime and nighttime temperatures; changes in rainfall patterns; and more frequent climate extremes, flooding, and drought) and consequent secondary effects (such as increased weed, pest, and disease pressures; reduced crop and forage production and quality; and damage to infrastructure). While climate change impacts on future agricultural production in specific regions of the United States remain uncertain, the ability of producers to adapt to climate change through planting decisions, farming practices, and use of technology can reduce its negative impact on production*."[62]

As average temperatures increase, water temperatures also rise and put water bodies at risk for eutrophication and excess algal growth that reduce water quality. In agricultural landscapes this can be exacerbated from major storm events that cause sediment and nutrients such as phosphorous and nitrogen to runoff into nearby water sources. The runoff can contribute to the buildup of nutrients in the water, increasing plant and algae growth that can deplete oxygen and kill aquatic life. Nutrient enrichment can lead to toxic cyanobacterial harmful algae blooms (cyanoHABs), which can be harmful to animal and human health. CyanoHABs can cause economic damage such as decreasing property values, reducing recreational revenue, and increasing the costs for treating drinking water.[63]

Changes to crop growth cycles due to warming winters and alterations in the timing and magnitude of rainfall events have already been observed. As these trends continue, they will require new agriculture and livestock management practices.

Economic Impacts

The agricultural sector would see the largest economic impacts from an animal or plant disease outbreak. Infrastructure and transportation will largely be unaffected with only minor localized impacts possible. Marion County had a market value of sold agricultural projects totaled over $110 million in 2017. A large disease outbreak could potentially result in millions of dollars in losses. The agricultural impacts would likely have trickle down effects to local businesses and economies that rely on the agricultural sector.

[61] University of Nebraska-Lincoln. 2014. "Understanding and Assessing Climate Change: Implications for Nebraska". http://snr.unl.edu/download/research/projects/climateimpacts/2014ClimateChange.pdf.

[62] Fourth National Climate Assessment. 2018. "Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II". https://nca2018.globalchange.gov/.

[63] USGS. "Nutrients and Eutrophication". Accessed December 2022. https://www.usgs.gov/mission-areas/water-resources/science/nutrients-and-eutrophication?qt-science_center_objects=0#qt-science_center_objects.

While this hazard could occur across the county, smaller rural communities would likely see the largest impacts.

Future Development

The likelihood of agricultural disease outbreaks is likely to remain consistent or increase as future development occurs; particularly if agricultural production remains a driving economic sector in the county. Increases in acreage planted with crops would increase the exposure to drought-related agricultural losses. Increases in population would add additional strain on water supply systems to meet growing demand for potable water.

Probability

Given the historic record of occurrence for agricultural plant disease events (nine out of 22 years with a reported event), for the purposes of this plan, the annual probability of agricultural plant disease occurrence is 41%.

Community Top Hazard Status

No jurisdictions identified Agricultural Plant and Animal Disease as a top hazard of concern.

Regional Vulnerabilities

The following table provides information related to regional vulnerabilities; for jurisdictional-specific vulnerabilities, refer to *Section Seven*.

Table 54: Regional Agricultural Disease Vulnerabilities

SECTOR	VULNERABILITY
People	-Those in direct contact with infected livestock -Potential food shortage during prolonged events -Residents in poverty if food prices increase
Economic	-Regional economy is reliant on the agricultural industry -Large scale or prolonged events may impact tax revenues and local capabilities -Land value may largely drive population changes within the county
Built Environment	None
Infrastructure	-Transportation routes can be closed during quarantine
Critical Facilities	None
Climate	-Exacerbate outbreaks, impacts, and/or recovery period -Changes in seasonal normals can promote spread of invasive species and agricultural disease

Dam Failure

A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Dams are typically constructed of earth, rock, concrete, or mine tailings. Dam failure is the uncontrolled release of impounded water due to a structural failure resulting in downstream flooding, affecting both life and property. Dam failure can be caused by any of the following: flooding; earthquakes; flow blockages; landslides; lack of maintenance; improper operation; poor construction; vandalism; terrorism, erosion, piping, saturation, or under seepage.

The effective height of a dam is defined as the difference in elevation in feet between the natural bed of the stream or watercourse measured at the downstream toe (or from the lowest elevation of the outside limit of the barrier if it is not across stream) to the auxiliary spillway crest. A dam's effective storage is defined as the total storage volume in acre-feet in the reservoir below the elevation of the crest of the auxiliary spillway. If the dam does not have an auxiliary spillway, the effective height and effective storage should be measured at the top of dam elevation.

The thresholds for state-regulated dams are outlined in Iowa Administrative Code 567-73.3. They are listed below.

- A dam with a height of at least 25 feet and a storage of 15 acre-feet or more at the top of the dam elevation.
- A dam with a storage of 50 acre-feet or more at the top of the dam elevation and a height of at least 6 feet.
- A dam that is assigned a hazard potential of high hazard.

Exceptions include:

- Road embankments or driveways with culverts are exempt unless such structure serves, either primarily or secondarily, a purpose commonly associated with dams, such as the temporary storage of water for flood control.

Iowa Administrative Code 567-71.3 outlines the state administrative thresholds indicating required approval from the Department of Natural Resources for any construction, operation, or maintenance of a dam. The thresholds are primarily based on both dam height and water storage volumes. Approval by the department shall be required in the following instances:

- In rural areas:
  a) Any dam designed to provide a sum of permanent and temporary storage exceeding 50 acre-feet at the top of dam elevation, or 25 acre-feet if the dam does not have an emergency spillway, and which has a height of 5 feet or more.
  b) Any dam designed to provide permanent storage in excess of 18 acre-feet and which has a height of 5 feet or more.
  c) Any dam across a stream draining more than 10 square miles.
  d) Any dam located within 1 mile of an incorporated municipality, if the dam has a height of 10 feet or more, stores 10 acre-feet or more at the top of dam elevation, and is situated such that the discharge from the dam will flow through the incorporated area.

- In urban areas: Any dam which exceeds the thresholds in rural areas "a", "b", or "d".

- Low head dams: Any low head dam on a stream draining 2 or more square miles in an urban area, or 10 or more square miles in a rural area.

The State of Iowa classifies dams as one of three categories according to the downstream damage that could occur in the event of failure. The dam hazard potential classifications do not reflect the current condition of a dam, only the potential for death and/or destruction due to the size of the dam, the size of impoundment, and the characteristics of the area downstream of the dam. The classification can change over time due to changes in development downstream from the dam. In addition, older dams may not have been built to the standards of their updated classification when this occurs. High hazard dams must meet the State's highest level of criteria and are inspected by the Iowa Department of Natural Resources on a two-year cycle.

Table 55: Dam Hazard Classification Definitions

Hazard Type	Definition
Low	A dam is classified as high hazard if located in an area where failure may create a serious threat of loss of human life or result in serious damage to residential, industrial, or commercial areas, important public utilities, public buildings, or major transportation facilities.
Moderate (Significant)	A dam is classified as moderate hazard when failure may damage isolated homes or cabins, industrial or commercial buildings, moderately traveled roads or railroads, or interrupt major utility services. A moderate hazard dam does not present a substantial risk of loss of human life. In addition, a dam is classified as moderate hazard when the dam and its impoundment are of themselves of public importance, such as dams associated with public water supply systems, industrial water supply or public recreation, or which are an integral feature of a private development complex.
High	A dam is classified as low hazard if damages from a failure would be limited to loss of the dam, loss of livestock, damages to farm outbuildings, agricultural lands, and lesser used roads, and where loss of human live is considered unlikely.

Source: Iowa Department of Natural Resources

Location and Extent

Areas directly downstream of dams (e.g., agricultural land, out buildings, county roads, and communities) are at greatest risk in the case of dam failure. The extent of dam failure is indicated by its hazard classification and location. Note that hazard classification does not indicate the likelihood of a dam failure event to occur, but rather the extent of potential damages that may occur in case of a failure. The National Inventory of Dams database lists 46 dams in Marion County; 40 of the 46 dams are low hazard dams, five are significant hazard dams, and one high hazard dam. The high hazard dam is the Red Rock Dam, built in 1969, which holds the largest lake in the State of Iowa, Lake Red Rock. Figure 26 maps the location of these dams in the county.

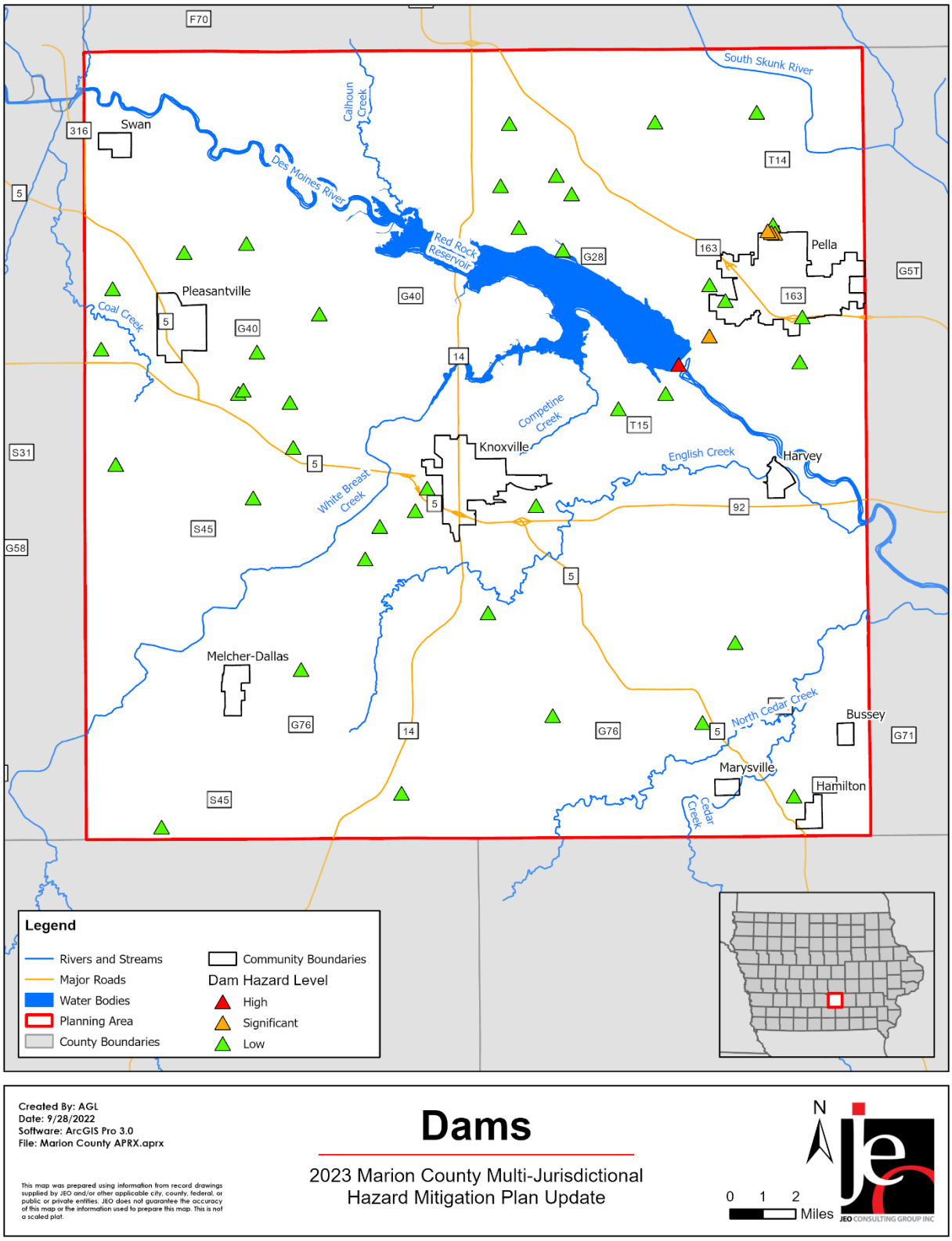
Table 56: Dams in the County

Low Hazard	Moderate Hazard	High Hazard
40	5	1

Source: USACE, 2022[64]

[64] USACE. December 2022. "National Inventory of Dams." https://nid.usace.army.mil/#/

Figure 26: Dams in the Planning Area



Dams classified with high hazard potential require the creation of an Emergency Action Plan (EAP). The EAP defines responsibilities and provides procedures designed to identify unusual and unlikely conditions which may endanger the structural integrity of the dam within sufficient time to take mitigating actions and to notify the appropriate emergency management officials of possible, impending, or actual failure of the dam. The EAP may also be used to provide notification when flood releases will create major flooding. An emergency situation can occur at any time; however, emergencies are more likely to happen when extreme conditions are present. There is one high hazard dams located within the county. At this time dam inundation maps are not included in the HMP for safety and security purposes. Marion County officials and Emergency Management have access to dam inundation maps which are reviewed during hazard events or project scoping.

Table 57: High Hazard Dams in the Planning Area

Dam Name	NID ID	Dam Height (Feet)	Dam Length (Feet)	Condition	Inspection Date
Red Rocks Dam	IA00013	142	6,260	N/A	12/02/2021

Source: USACE, 2022

Upstream Dams Outside the Planning Area

There are approximately 33 high hazard dams upstream of Marion County, which may affect the county adversely. Most of these dams are unlikely to significantly impact the planning area, excluding the Saylorville Dam, which holds such a significant volume of water, a dam failure would likely result in flooding within Marion County.

Historical Occurrences

According to the Association of State Dam Safety Dam Incident Database, there are no reported dam failures within the planning area.[65] No additional historical occurrences or records of damages from dam failure were discovered after discussion with Marion County officials, the Hazard Mitigation Planning Team, or public meeting participants.

Average Annual Losses

There are no recorded instances of dam failure in the planning area; therefore, the average annual losses are $0.

Climate Change

While climate change does not directly affect dam failure events, changes in precipitation and temperature swings and extremes can affect dam failure. Increased rainfall events, either in frequency or in magnitude[66], will lead to exacerbated stress on infrastructure systems including dams. Additionally, historical streamflow records are typically used to design or determine dam construction requirements and maintenance requirements.

Climate change may impact dam systems in the following ways.

- Drought: land subsidence, erosion, embankment settling, or foundation cracking.
- Flooding: increased embankment erosion, sloughing, overtopping risk, or damage from ice jams.

[65] Association of State Dam Safety Officials. "Dam Incident Database Search". Accessed December 2022. https://damsafety.org/incidents

[66] University of Nebraska-Lincoln. 2014. "Understanding and Assessing Climate Change: Implications for Nebraska". http://snr.unl.edu/download/research/projects/climateimpacts/2014ClimateChange.pdf.

Economic Impacts

Economic impacts of dam failure would primarily be limited to the identified dam inundation areas. Without the dam inundation maps, it is difficult to determine the full possible impacts. However, any buildings, roadways, and bridges in the inundation area could be damaged. This would cause roadways to be closed for an extended period of time while repairs are made. Most roadway damages would likely be limited to small areas and not cause any significant delays. However, a failure of the Red Rock Dam could cause larger transportation impacts in the county. The dam inundation area for the Red Rock Dam crosses Highway 92 on the east-central edge of the county. If Highway 92 was damaged it could cause it to be closed for a significant period of time. FEMA standard values for traffic delays can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*. The U.S. Army Corps of Engineers estimates that if the dam were to fail it would have a potential economic cost of up to $1,790,751,240. However, not all of those costs would occur in Marion County.

Future Development

Future development located downstream from dams in floodplains or inundation zones would increase vulnerability to this hazard. It is recommended that citizens in inundation areas be made aware of the unique protection they enjoy below a dam. As communities and the county develop, considerations should be made to a variety of local vulnerabilities.

Probability

There is no data available that would provide a basis for estimating dam failure in Marion County, and standard inspection and maintenance practices support a low probability of dam failures in Marion County. Additionally, probability of failure can be reduced further with increased attention to sound design, and quality construction of dams within the county. For the purpose of this plan, the probability of dam failure will be stated at less than one percent annually as no dams have failed in the planning area.

Community Top Hazard Status

No jurisdictions identified Dam Failure as a top hazard of concern.

Regional Vulnerability

Dam failure is typically an additional or secondary impact of another disaster such as flooding or earthquake. While the probability of a future dam failure is low, the residents and farm land below the Red Rock Dam is vulnerable to a dam breach. The Red Rock Reservoir contains 114,400 cubic feet of water, which would inundate downstream areas, should the dam fail. The result of failure of the Red Rock Dam is outlined in the Iowa State 2018 HMP and lists the would be impact area as some 140 miles along the rest of the Des Moines River until its confluence with the Mississippi. Failure of the Red Rock Dam could even have consequences for downstream areas as far as Saint Charles, Missouri. The Iowa State 2018 HMP states that if the Red Rock Dam were to fail when the dam's water level is at the top of active storage, then the population at risk was up to 22,100 and direct property damage was estimated to be $1.308 billion. If the dam were to fail at maximum high pool level, up to 27,500 people could be in danger and direct property damage could be upwards of $1.791 billion. Additionally, a flood event would inundate acres of farm land, causing damages to a crops which would likely be lost.

Regional vulnerabilities to dam failure vary based on surrounding development and other flood control measures. The following table provides information related to county vulnerabilities; for jurisdictional-specific vulnerabilities, refer to *Section Seven*.

Table 58: Regional Dam Failure Vulnerabilities

SECTOR	VULNERABILITY
People	-Those living downstream of high hazard dams -Those at recreational sites situated near high hazard dams -Evacuation needs likely with high hazard dam failure events -Hospitals, nursing homes, and the elderly at greater risk due to low mobility
Economic	-Loss of downstream agricultural land -Businesses or recreation sites located in inundation areas would be impacted and closed for an extended period of time -Employees of closed businesses may be out of work for an extended period of time
Built Environment	-Damage to facilities, recreation areas, and roads
Infrastructure	-Transportation routes could be closed for extended period of time
Critical Facilities	-Any critical facilities in inundation areas are vulnerable to damages
Climate	-Increased annual precipitation contributes to sustained stress on systems -Changes in water availability and supply can constrain energy production and reservoir stores

Drought

Drought is defined as a period of prolonged abnormally low precipitation producing severe dry conditions. Although many erroneously consider it a rare and random event, drought is a normal, recurrent feature of climate. Drought can be spotty or widespread and occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. A drought often coexists with periods of extreme heat, though they can and do occur during cooler months. Drought combined with extreme heat can cause significant social stress, economic losses, and environmental degradation. The length of a drought can vary from a few weeks to a period of years with a prolonged drought having serious impacts on a community's water supply and economy. The planning area is largely rural, which presents an added vulnerability to drought events; drought conditions can significantly and negatively impact the agricultural economic base. If agricultural production is damaged or destroyed by a loss of crops or livestock, food shortages may occur.

Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another.
~National Drought Mitigation Center

Drought is a slow-onset, creeping phenomenon that can affect a wide range of people, livestock, and industries. While many impacts of these hazards are non-structural, there is the potential that during prolonged drought events structural impacts can occur. Drought normally affects more people than other natural hazards, and its impacts are spread over a larger geographical area. As a result, the detection and early warning signs of drought conditions and assessment of impacts are more difficult to identify than that of quick-onset natural hazards (e.g., flood) that results in more visible impacts. According to the National Drought Mitigation Center (NDMC), droughts are classified into four major types:

- ***Meteorological Drought*** is defined based on the degree of dryness and the duration of the dry period. Meteorological drought is often the first type of drought to be identified and should be defined regionally as precipitation rates and frequencies (norms) vary.

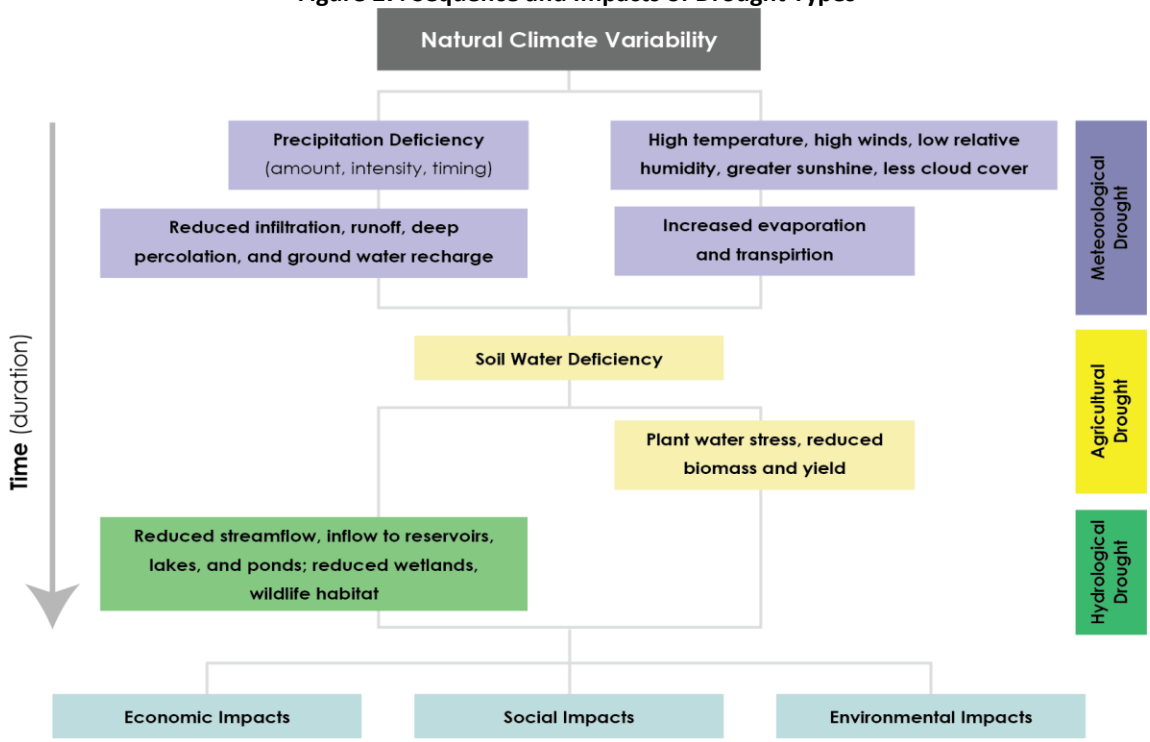
- ***Agricultural Drought*** occurs when a deficiency in moisture hinders planting germination, leading to low plant population per hectare and a reduction of final yield. Agricultural drought is closely linked with meteorological and hydrological drought, as agricultural water supplies are contingent upon the two sectors.

- ***Hydrologic Drought*** occurs when water available in aquifers, lakes, and reservoirs falls below the statistical average. This situation can arise even when the area of interest receives average precipitation. This is due to the reserves diminishing from increased water usage, usually from agricultural use or high levels of evapotranspiration, resulting from prolonged high temperatures. Hydrological drought often is identified later than meteorological and agricultural drought. Impacts from hydrological drought may manifest themselves in decreased hydropower production and loss of water-based recreation.

- ***Socioeconomic Drought*** occurs when the demand for an economic good exceeds supply due to a weather-related shortfall in water supply. The supply of many economic goods includes, but are not limited to, water, forage, food grains, fish, and hydroelectric power.[67]

The following figure indicates different types of droughts, their temporal sequence, and the various types of effects they can have on a community.

Figure 27: Sequence and Impacts of Drought Types



Source: National Drought Mitigation Center, University of Nebraska-Lincoln, 2017[68]

The four different definitions all have significance in Iowa. A meteorological drought is the easiest to determine based on rainfall data and is an easier drought to monitor from rain gauges and reports. A hydrological drought means that stream and river levels are low, which also has an impact for surface water and ground water irrigators. In addition, in-stream discharges that fall below a pre-required level also place the state in regulatory difficulty with U.S. Fish and Wildlife and with neighboring states over cross-border flowage rights. An agricultural drought represents difficulty for Iowa's agricultural-based economy and is also relatively easy to monitor based on crop viabilities for different regions.

Location

All of Marion County is at risk of drought. The area has an average of 37.45 inches of rainfall per year. Successive years or extended periods of time with below average amounts of rain or snow result in drought. According to the Palmer Drought Severity Index (PDSI), in the period of record (1/1895-11/2022) Marion County has experienced 194 months of mild droughts, 133 months of moderate droughts, 90 months of severe drought, and 72 months of extreme droughts.

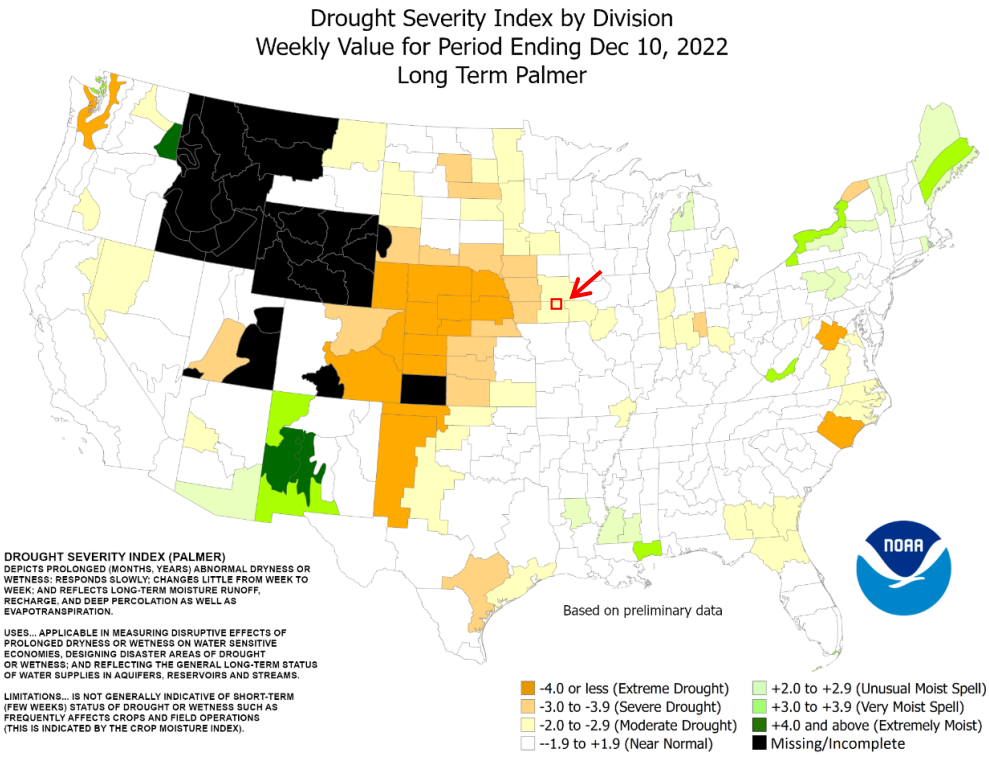
[67] National Drought Mitigation Center. 2017. "Drought Basics." https://drought.unl.edu/.

[68] National Drought Mitigation Center. 2017. "Types of Drought." https://drought.unl.edu/Education/DroughtIn-depth/TypesofDrought.aspx.

Historical Occurrences

The PDSI is utilized by climatologists to standardize global long-term drought analysis. It uses temperature and precipitation data to calculate water supply and demand, incorporates soil moisture, and is considered most effective for unirrigated cropland. It primarily reflects long-term drought and has been used extensively to initiate drought relief. The PDSI for the period ending on December 10, 2022, is provided below. The index indicates moderate drought levels in the planning area (shown approximately by the red box).

Figure 28: Palmer Drought Severity Index for Dec 10, 2016



The data for Marion County was collected for Climate Division 8, which includes the county. This station's period of record started in 1895.

Table 59 shows the details of the Palmer classifications and Figure 29 shows drought data from this time period. The planning area has experienced several extreme droughts since 1902 and moderate, severe, and extreme droughts are likely in the future.

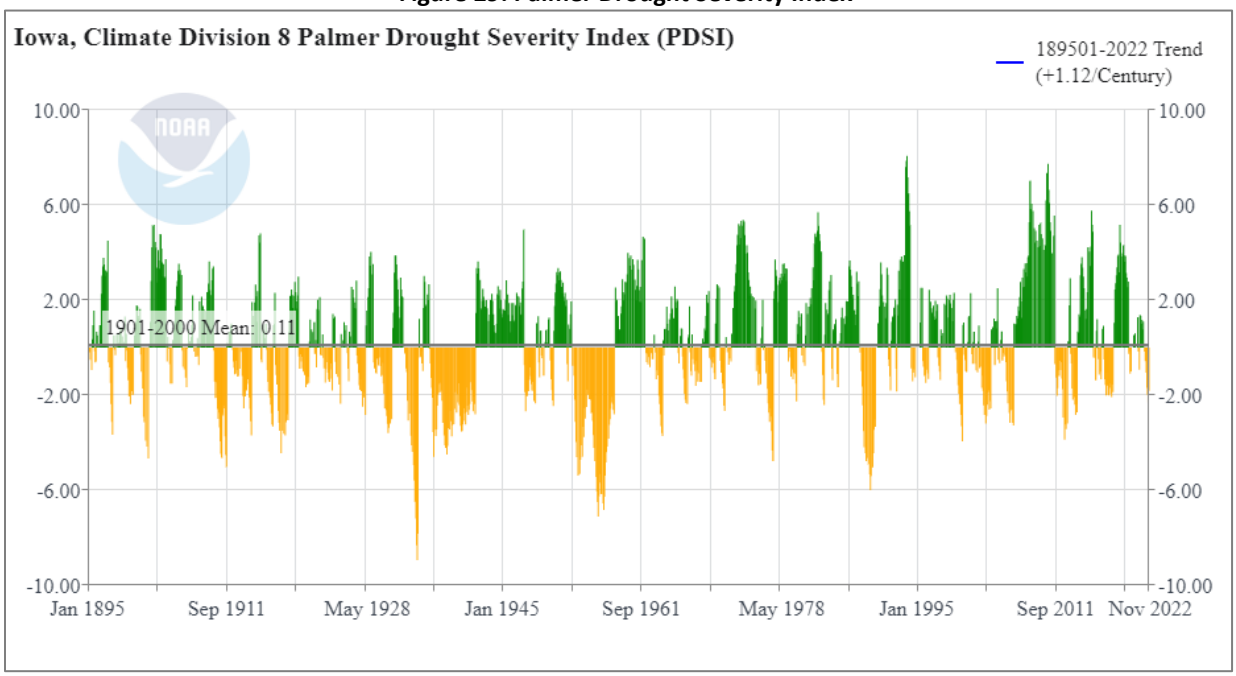
Table 59: Palmer Drought Severity Index Classification

Numerical Value	Description	Numerical Value	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		

Source: Climate Prediction Center[69]

[69] National Weather Service. 2017. "Climate Prediction Center." https://www.cpc.ncep.noaa.gov/.

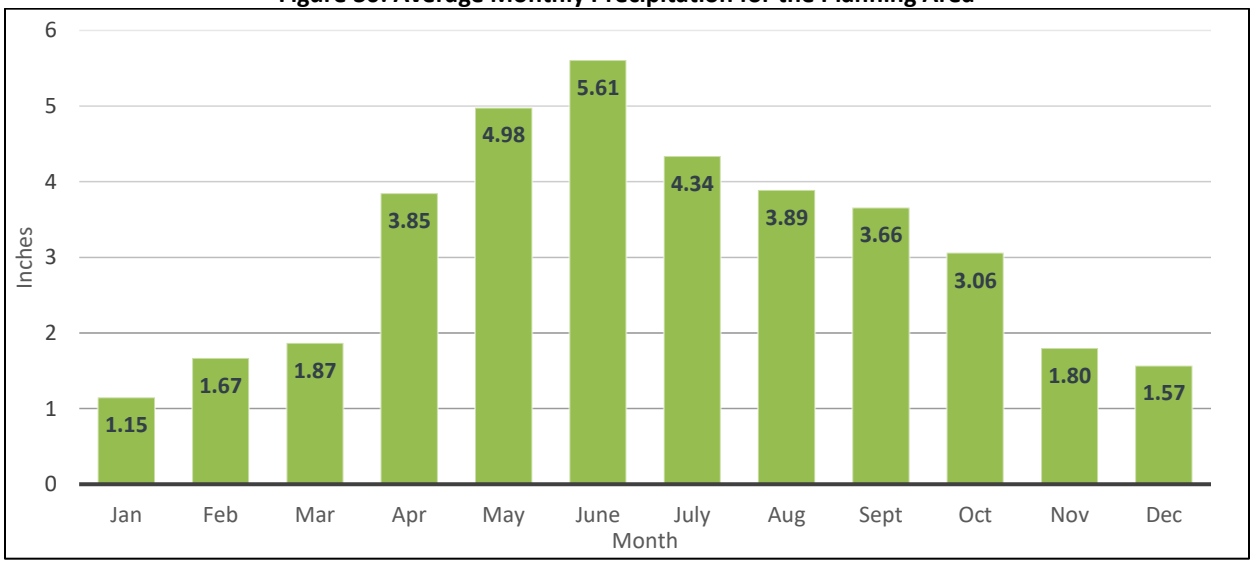
Figure 29: Palmer Drought Severity Index



Source: NCEI, 1895-December 2022[70]

Figure 30 shows the normal average monthly precipitation for the planning area, which is helpful in determining whether any given month is above, below, or near normal in precipitation. Prolonged deviation from the norm showcases drought conditions and influences growing conditions for farmers.

Figure 30: Average Monthly Precipitation for the Planning Area



Source: NCEI, 1991-2022[71]

[70] National Centers for Environmental Information. 1895-2022. "Climate at a Glance: Divisional Time Series". Accessed December 2022. https://www.ncdc.noaa.gov/cag/divisional/time-series.

[71] NOAA National Centers for Environmental Information. December 2022. "Data Tools: 1991-2020 Normals." [datafile]. https://www.ncdc.noaa.gov/cdo-web/datatools/normals.

Average Annual Losses

The annual property estimate was determined based upon NCEI Storm Events Database since 1996. The annual crop loss was determined based upon the RMA Cause of Loss Historical Database since 2000. A summary of loss estimate is shown in
Table 60 with detailed summary of insured crop losses as a result of drought provided in Table 61. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. The direct and indirect effects of drought are difficult to quantify. Potential losses such as power outages could affect businesses, homes, and critical facilities. High demand and intense use of air conditioning or water pumps can overload the electrical systems and damage infrastructure. The severe drought of 2012 significantly affected the county with the USDA RMA reporting a total of $11,399,304 in corn, soybean, forage seeding, and oat crop losses alone.

Table 60: Loss Estimate for Drought

Hazard Type	Total Property Loss[1]	Average Annual Property Loss[1]	Total Crop Loss[2]	Average Annual Crop Loss[2]
Drought	$12,650,000	$468,518	$22,863,237	$1,039,238

Source: 1 Indicates data is from NCEI (1996-2022); 2 Indicates data is from USDA RMA (2000-2021)

Table 61: Annual Losses for Insured Crops Due to Drought in Marion County

Year	Total Crop Loss	Year	Total Crop Loss
2000	$60,443.00	**2011**	$432,630.44
2001	$45,416.00	**2012**	$11,399,304.06
2002	$39,871.00	**2013**	$6,148,824.33
2003	$1,621,032.00	**2014**	$24,068.50
2004	$0.00	**2015**	$0.00
2005	$63,725.00	**2016**	$4,144.00
2006	$226,269.00	**2017**	$1,058,621.29
2007	$141,918.00	**2018**	$1,071,118.85
2008	$69,658.00	**2019**	$0.00
2009	$0.00	**2020**	$398,262.00
2010	$0.00	**2021**	$57,931.50

Source: USDA RMA, 2000-2021

Extent

Although drought is not predictable, long-range outlooks may indicate an increased chance of drought, which can serve as a warning. A drought period can last for months, years, or even decades. It is rarely a direct cause of death, though the associated heat, dust, and stress can all contribute to increased mortality. Table 64 indicates it is reasonable to expect Extreme drought to occur 4.7% of the time for the planning area (72 extreme drought months in 1,532 months). Severe drought occurred in 90 months of the 1,532 months of record (5.9% of months). Moderate drought occurred in 133 months of the 1,532 months of record (8.7% of months), and mild drought occurred in 194 of the 1,532 months of record (12.7% of months). Non-drought conditions occurred in 1,046 months, or 68% percent of months. These statistics show that the drought conditions of the planning area are highly variable. The average annual planning area precipitation is approximately 37.45 inches according to the NCEI.[72]

[72] NOAA National Centers for Environmental Information. December 2022. "Data Tools: 1991-2022 Normals." [datafile]. https://www.ncdc.noaa.gov/cdo-web/datatools/normals.

Climate Change

In Iowa, future droughts are projected to increase in intensity even with an increase in precipitation. An increase in average temperatures will contribute to the rise in the frequency and intensity of hazardous events like extreme heat and drought, which will cause significant economic, social, and environmental impacts on Iowans. [73] Although drought is a natural part of the climate system, increasing temperatures will increase evaporation rates, decrease soil moisture, and lead to more intense droughts in the future, having negative impacts on farming and community water systems. Increasing temperatures and drought may reduce the potential for aquifers to recharge, which has long-term implications for the viability of agriculture in Iowa. The increase in droughts will also lead to an increased risk of wildfire events as vegetation becomes drier. The table below shows the likelihood of a year-plus drought and year-plus extreme drought in the county with different warming scenarios.

Table 62: Likelihood of Drought with Different Warming Scenarios

	Warming Scenarios			
Likelihood of:	0.5° C	1° C	2° C	3° C
Year-Plus Drought	11-33%	11-33%	11-50%	34-50%
Year-Plus Extreme Drought	0-10%	0-10%	0-20%	21-33%

Source: Probable Futures[74]

NOAA has created the Climate Mapping for Resilience and Adaptation tool that looks at how different emission scenarios affect climatological hazards. The table below shows that the annual number of dry days is projected to increase as time goes on in both the lower emissions and higher emissions scenario.

Table 63: Annual Number of Dry Days – Marion County

Emission Scenario	Historical (1976-2005)	Early Century (2015-2044)	Mid Century (2035-2064)	Late Century (2070-2099)
Lower Emissions (RCP 4.5)	159 Days	161.5 Days	162 Days	162.3 Days
Higher Emissions (RCP 8.5)	159 Days	162.6 Days	164.1 Days	167.4 Days

Source: NOAA[75]

Economic Impacts

The agricultural sector would see the largest economic impacts from a drought event. Marion County had a market value of sold agricultural projects totaling $110 million in 2017. A prolonged drought event during the growing season could potentially result in millions of dollars in losses. The agricultural impacts would likely have trickle down effects to local businesses and economies that rely on the agricultural sector. While this hazard could occur across the county, smaller rural communities would likely see the largest impacts. Infrastructure and transportation will largely be unaffected by drought. Some roadways and water lines may see damage from shrinking soils, but impacts will likely be minor and localized. If drought is significant enough, community water systems may be impacted. Communities may need to implement voluntary or mandatory water restrictions to help reduce water usage and protect the water supply. FEMA standard values for potable water can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

[73] University of Nebraska-Lincoln. 2014. "Understanding and Assessing Climate Change: Implications for Nebraska". http://snr.unl.edu/download/research/projects/climateimpacts/2014ClimateChange.pdf.

[74] Probable Futures. "Maps of Dryness". Accessed December 2022. https://probablefutures.org/ .

[75] NOAA. August 2022. "Climate Mapping for Resilience and Adaptation". https://livingatlas.arcgis.com/assessment-tool/explore/details .

Future Development

Any future developments are likely to increase water demand, increase travel on local transportation routes, and influence continued growth on economic sectors at risk from the impacts of drought. Growing communities will need to adapt and account for increased potable water demands for residential, commercial, and industrial development.

Probability

Drought conditions are likely to occur regularly within the county. The following table summarizes the magnitude of drought and monthly probability of occurrence.

Table 64: Period of Record in Droughts

PDSI Value	Magnitude	Occurrences by Month	Monthly Probability
4 or more to -0.99	No Drought	1,046/1,532	68.3%
-1.0 to -1.99	Mild Drought	194/1,532	12.7%
-2.0 to -2.99	Moderate Drought	133/1,532	8.7%
-3.0 to -3.99	Severe Drought	90/1,532	5.9%
-4.0 or less	Extreme Drought	72/1,532	4.7%

Source: NCEI, 1895- 2022[76]

Community Top Hazard Status

No jurisdictions identified Drought as a top hazard of concern.

Regional Vulnerabilities

The impacts of drought can be categorized as primarily economic, environmental, or social. Many economic impacts occur in agriculture and related sectors, including forestry and fisheries, because of the reliance of these sectors on surface and subsurface water supplies. In addition to obvious losses in yields in both crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. The incidence of forest and range fires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk. Environmental losses are the result of damages to plant and animal species, wildlife habitat, and air and water quality, forest and range fires, degradation of landscape quality, loss of biodiversity, and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent.

With Marion County's 1,030 farms covering 255,013 acres of land which equates to 70 percent of the land used for agriculture, the planning area has a high exposure to this hazard. Aside from agricultural impacts, other losses related to drought include costs of fire suppression and damage to roads and structural foundations due to the shrink of dynamic expansive soils during excessively dry conditions. Areas associated with agricultural use are vulnerable to drought conditions which could result in a decrease in crop production or a decrease in available grazing area for livestock.

The Drought Impact Reporter is a database of drought impacts throughout the United States, with data going back to 2000. The Drought Impact Reporter has recorded a total of eight drought-related impacts

[76] National Centers for Environmental Information. 1895-November 2022. Accessed December 2022. https://www.ncdc.noaa.gov/cag/divisional/time-series

in the county. Notable drought impacts are summarized in the following table. This is not a comprehensive list of droughts that may have impacted the planning area.

Table 65: Notable Drought Impacts in Planning Area

CATEGORY	DATE	TITLE
Agriculture	8/25/2022	Drought hurting corn, soybean yields in Iowa
Agriculture	8/17/2018	Yellow corn with brown husks in Marion County, Iowa
Agriculture, Water Supply and Quality	7/08/2016	Corn yield potential down in Iowa
Agriculture, Relief, Response & Restrictions	9/11/2013	Muscatine County and 35 other Iowa counties received authorization from the Farm Service Agency for emergency haying and grazing.
Agriculture, Relief, Response & Restrictions	5/17/2013	Drought-related USDA disaster declarations in 2013
Agriculture, Relief, Response & Restrictions	9/21/2012	USDA Designates 6 Counties in Iowa as Primary Natural Disaster Areas with Assistance to Producers in Surrounding States
Plants & Wildlife, Water Supply & Quality	8/06/2012	Roughly 40,000 shovelnose sturgeon died in the Des Moines River in Iowa
Relief, Response & Restrictions	9/07/2006	Relief, Response & Restrictions impact from Media submitted on 9/7/2006

Source: NDMC, 2000-December 2022[77]

The following table provide information related to regional vulnerabilities and FEMA's National Risk Index values for Drought. For jurisdictional specific vulnerabilities, refer to *Section Seven*.

Table 66: Regional Drought Vulnerabilities

SECTOR	VULNERABILITY
People	-Insufficient water supply -Loss of jobs in agricultural sector -Residents in poverty if food prices increase
Economic	-Closure of water intensive businesses (carwashes, pools, etc.) -Short-term interruption of business -Loss of tourism dollars -Decrease in cattle prices -Decrease of land prices jeopardizes educational funds
Built Environment	-Cracking foundations (residential and commercial structures) -Damages to landscapes
Infrastructure	-Damages to waterlines below ground -Damages to roadways (prolonged extreme events)
Critical Facilities	-Loss of power and impact on infrastructure
Climate	-Increased risk of wildfire events, damaging buildings and agricultural land
National Risk Index Values	Risk Index – Relatively Low Expected Annual Loss – Relatively Moderate

Source: FEMA National Risk Index, 2022

[77] National Drought Mitigation Center. 2022. "U.S. Drought Impact Reporter." Accessed December 2022. http://droughtreporter.unl.edu/map/.

Earthquake

An earthquake is the result of a sudden release of energy in the Earth's tectonic plates that creates seismic waves. According to the United States Geological Survey (USGS), an earthquake is a term used to describe both sudden slip on a fault, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth. The seismic activity of an area refers to the frequency, type, and size of earthquakes experienced over a period of time. Earthquakes occur primarily along fault zones, tears in the Earth's crust, along which stresses build until one side of the fault slips, generating compressive and shear energy that produces the damage. Although rather uncommon, earthquakes do occur in Iowa and are usually small, generally not felt, and cause little to no damage. Heavy damage generally occurs nearest the epicenter which is that point on the Earth's surface directly above the fault movement.

The composition of geologic materials between these points is a major factor in transmitting energy to buildings and other structures on the Earth's surface. Earthquakes are measured by magnitude and intensity. Magnitude is measured by the Richter Scale, a base-10 logarithmic scale, which uses seismographs around the world to measure the amount of energy released by an earthquake. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because the scale is logarithmic based, each whole number increase represents a tenfold increase in measured amplitude. Each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Table 67: Richter Scale

Richter Magnitudes	Earthquake Effects
Less Than 3.5	Generally not felt but recorded.
3.5 – 5.4	Often felt, but rarely causes damage.
Under 6.0	At most, slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 – 6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0 – 7.9	Major earthquake. Can cause serious damage over larger areas.
8 Or Greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Source: FEMA, 2016[78]

Intensity is measured by the Modified Mercalli Intensity Scale, which determines the intensity of an earthquake by comparing actual damage against damage patterns of earthquakes with known intensities. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and finally - complete destruction. The Modified Mercalli Intensity Scale is composed of 12 increasing levels of intensity, designated in Roman Numerals, that range from imperceptible shaking to catastrophic destruction. It does not have a mathematical basis but is an arbitrary ranking based on observed effects. Structural engineers usually contribute information for assigning intensity values of VIII or above.

[78] Federal Emergency Management Agency. 2016. "Earthquake." https://www.fema.gov/earthquake.

Table 68: Modified Mercalli Intensity Scale

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	
II	Feeble	Some people feel it	< 4.2
III	Slight	Felt by people resting, like a truck rumbling by	
IV	Moderate	Felt by people walking	
V	Slightly Strong	Sleepers awake; church bells ring	< 4.8
VI	Strong	Trees sway, suspended objects swing, objects fall off shelves	< 5.4
VII	Very Strong	Mild Alarm; walls crack; plaster falls	< 6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	< 6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	< 7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards	< 8.1
XII	Catastrophic	Total destruction, trees fall, ground rises and falls in waves	> 8.1

Source: FEMA, 2016

Location

According to the Iowa Department of Natural Resources, there are no major fault lines in Iowa. The two regions of active seismicity in the Midwest are the Nemaha Ridge and the New Madrid Fault Zone. The Nemaha Ridge in Kansas and Nebraska, associated with the Humboldt Fault, is characterized by numerous small earthquakes that release stresses before they build to dangerous levels, but is not considered a threat to Iowa. The New Madrid Fault Zone has greater destructive potential, and is located along the valley of the Mississippi River, from its confluence with the Ohio River southward, and includes portions of Illinois, Kentucky, Tennessee, Missouri, Arkansas, and Mississippi. Iowa counties are located in low-risk zones as a whole.

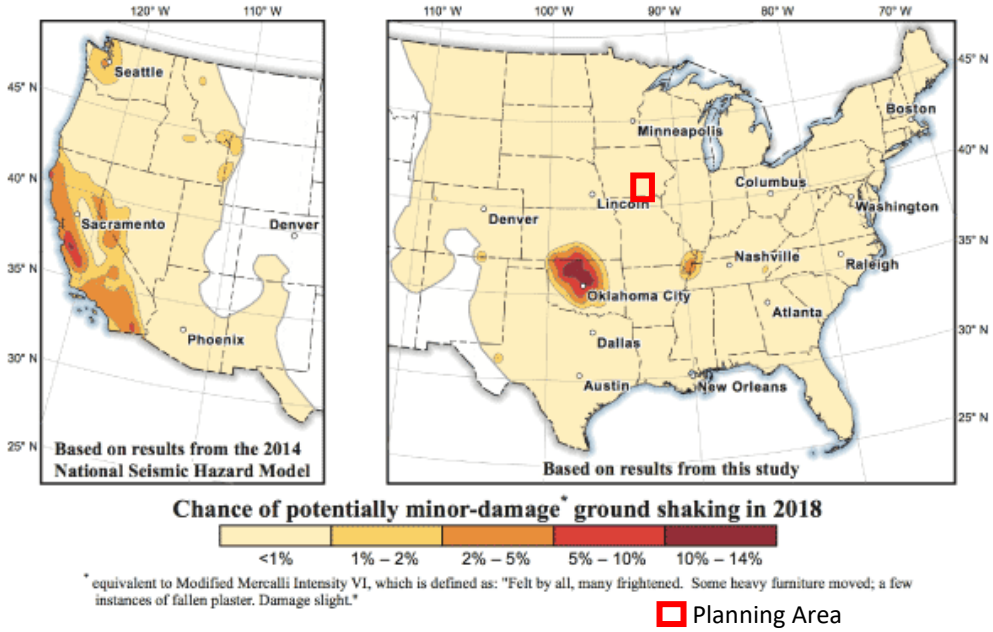
Historical Occurrences

According to the United States Geological Survey (USGS), there have been zero earthquakes that have occurred in the planning area since 1900.

Average Annual Losses

Due to zero historical earthquakes and low earthquake risk for the area, it is not feasible to utilize the 'event damage estimate formula' to estimate potential losses for the planning area. Figure 31 shows the probability of damage from earthquakes according to the USGS. The figure shows that the planning area has a less than one percent chance of damages from earthquakes.

Figure 31: 2018 Probability of Damage from Earthquakes



Source: USGS, 2018[79]

Extent

If an earthquake were to occur in the planning area, it would likely measure 5.0 or less on the Richter Scale. Very little to no damage is anticipated from events of these magnitudes.

Climate Change

At this time, there is no scientific consensus on the correlation between climate change and frequency or magnitude of earthquakes. According to the U.S. Geological Survey, statistically, there is approximately an equal distribution of earthquakes in cold weather, hot weather, rainy weather, etc. Very large low-pressure changes associated with major storm systems (typhoons, hurricanes, etc.) are known to trigger episodes of fault slip (slow earthquakes) in the Earth's crust and may also play a role in triggering some damaging earthquakes. However, the numbers are small and are not statistically significant.[80]

Economic Impacts

Earthquakes have the potential to cause damages to underground pipes, buildings, and roadways. However, with no past earthquakes and no major fault lines in the county or Iowa very little damage is anticipated. The Modified Mercalli Intensity Scale does not show major infrastructure or building damage until categories VII or IX. There is a very low probability of more than a category V earthquake occurring in the county. Any damages to pipes or roadways would likely be very localized. FEMA standard values for potable water, traffic delays, and wastewater can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

[79] United States Geological Survey. 2018. "Short-term Induced Seismicity Models: 2018 One-Year Model." https://www.usgs.gov/natural-hazards/earthquake-hazards/science/short-term-induced-seismicity-models?qt-science_center_objects=0#qt-science_center_objects.

[80] USGS. N.d. "Is there earthquake weather?" Accessed November 2022. https://www.usgs.gov/faqs/there-earthquake-weather?qt-news_science_products=0#qt-news_science_products.

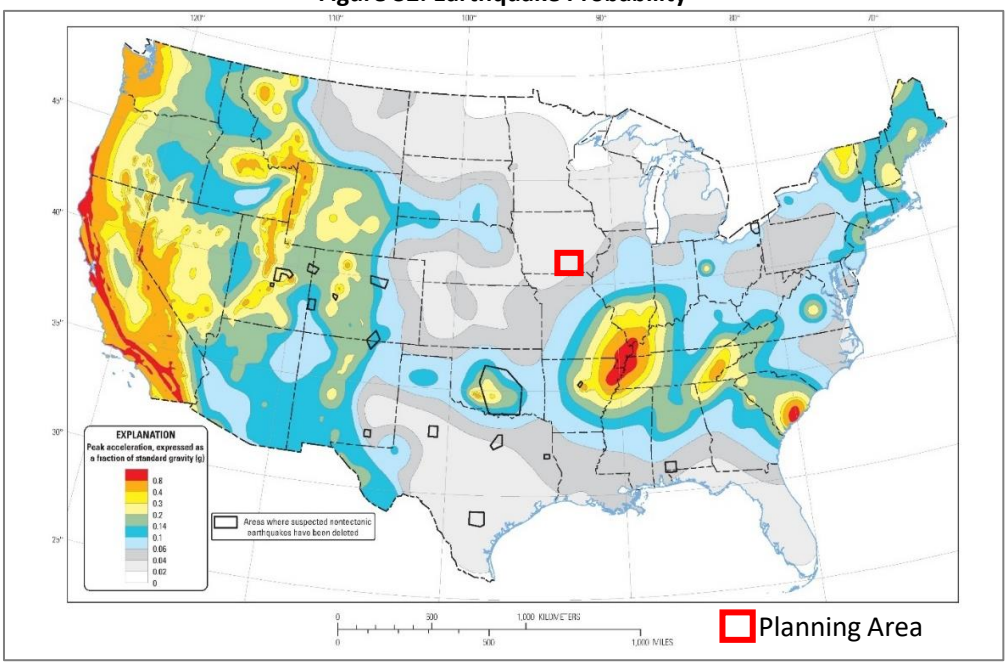
Future Development

Future development and growth would likely increase the intensity of earthquake impacts across the planning area including increased damage near dams, in urban areas, and to new structures built without reinforcements.

Probability

The following figure visualizes the probability of a 5.0 or greater earthquake occurring in the planning area within 50 years. Based on zero occurrences of earthquakes over a 123-year period, the probability of an earthquake in the county in any given year is less than one percent.

Figure 32: Earthquake Probability



**Map shows the two-percent probability of exceedance in 50 years of peak ground acceleration.*
Source: USGS 2009 PSHA Model

Community Top Hazard Status

No jurisdictions identified Earthquake as a top hazard of concern.

Regional Vulnerabilities

Particularly vulnerable populations for earthquake include, but are not limited to:

- *Low-income individuals*
  - Often, low-income individuals and families live in lower cost homes (older homes, mobile homes) that are less able to withstand disaster.
- *Older homes and mobile homes*
  - These may not have been constructed using the most advanced building codes or have received updates and retrofits that would have increased their stability and ability to withstand seismic events. Damages resulting from the 1994 Northridge earthquake in California were disproportionately focused on low- and moderate- income rental housing units that were older and thus more vulnerable to seismic damages.

- *Elderly citizens*
    - Senior citizens living on a fixed income may lack the disposable income necessary to upgrade their homes to withstand seismic events. In addition, senior citizens may lack the mobility required to implement low-cost mitigation measures. A 2006 Census Bureau report found that 20-percent of the US Population age 65 and older report some level of disability.

Although a damaging event is unlikely, and most structures in the County are not built to earthquake standards, any damage to existing and future development would likely be minor in nature. The following table provide information related to regional vulnerabilities and FEMA's National Risk Index values for Earthquakes. For jurisdictional specific vulnerabilities, refer to *Section Seven*.

Table 69: Regional Earthquakes Vulnerabilities

SECTOR	VULNERABILITY
People	-Risk of injury or death from falling objects and structures
Economic	-Short term interruption of business
Built Environment	-Damage to buildings, homes, or other structures from foundation cracking, falling objects, shattered windows, etc.
Infrastructure	-Damage to subterranean infrastructure (i.e. waterlines, gas lines, etc.) -Damage to roadways
Critical Facilities	-Same as all other structures
Climate	None
National Risk Index Values	Risk Index – Very Low Expected Annual Loss – Very Low

Source: FEMA National Risk Index, 2022

Expansive Soils

A relatively widespread geologic hazard for Iowa is the presence of expansive soils or clay soils, which behave differently than other soils due to their tendency to swell and shrink due to changes in moisture content. Fluctuations in the groundwater table, changes in humidity, and prolonged drought followed by precipitation events can accelerate the swelling and shrinking of expansive soils.

Other factors influencing the behavior of expansive soils are plumbing leaks, site drainage, and irrigation practices that cause differences in moisture volume in the soil. Expansive soils can cause the following problems in structures:

- Structural damage to lightweight structures such as sidewalks and driveways
- Lifting of buildings, damage to basements, and building settlement
- Heaving of roads and highway structures
- Cracks in walls and ceilings
- Damage to pipelines and other public utilities[81]

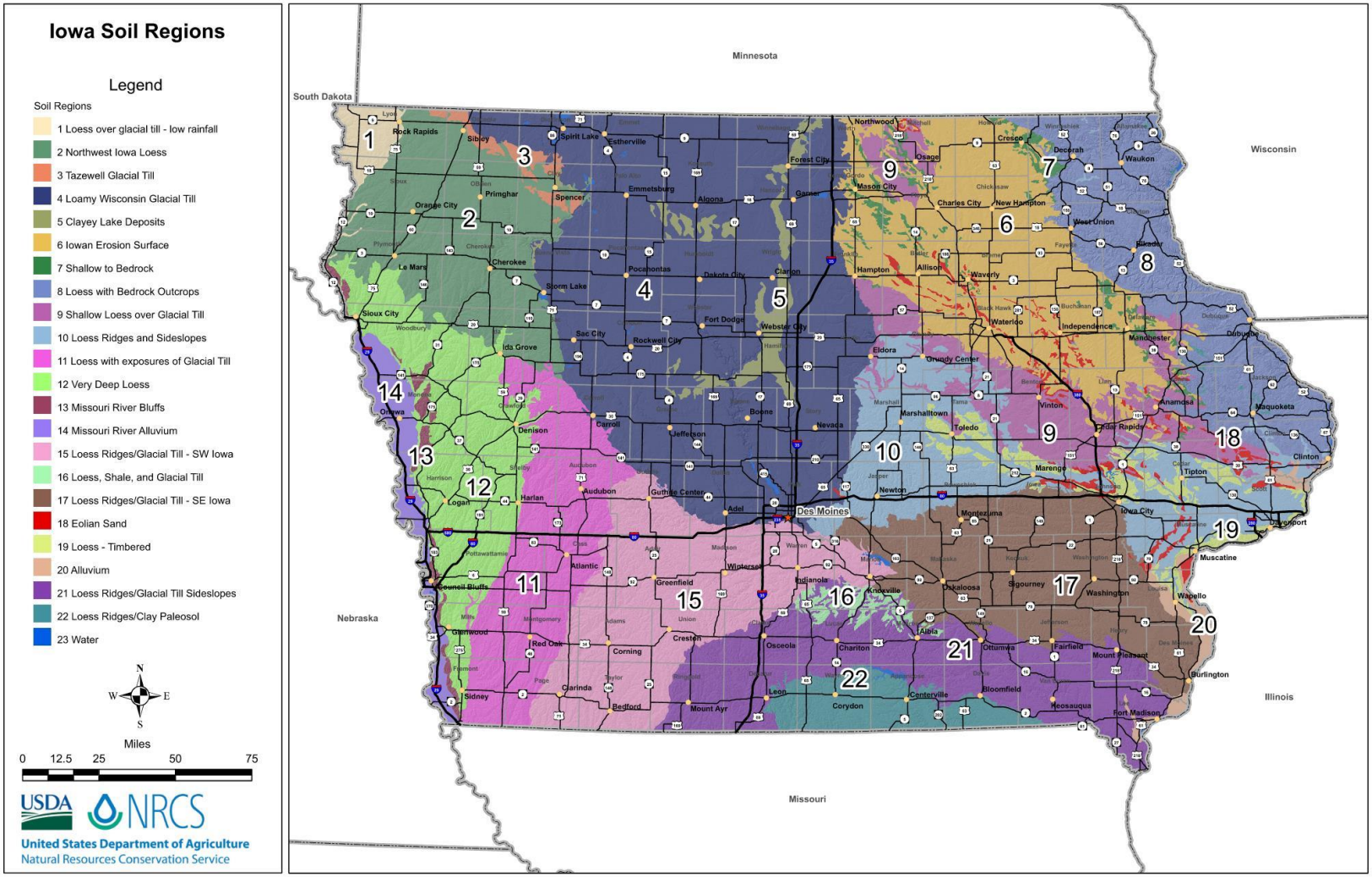
For Iowa, the vulnerability to this hazard most frequently is associated with soils shrinking during periods of drought.

Location

The following figure shows a map of the soil types in Iowa. Marion County is mainly located in Loess Ridges/Glacial Till SW and SE soil regions with portions of Loess, Shale, and Glacial Till, and Loess ridges/Glacial Till /Sideslopes soil regions. Glacial Till is a high-clay content soil that is prone to expansion. Loess is a compressive soil comprised mainly of silt.

81 Colorado Geological Survey. Accessed December 2022. "Expansive Soil and Rock". https://coloradogeologicalsurvey.org/hazards/expansive-soil-rock/#:~:text=Expansive%20soils%20are%20one%20of,the%20range%20of%20%242%20billion.

Figure 33: Iowa Soil Regions



Source: NRCS[82]

[82] Iowa Natural Resources Conservation Service. Accessed December 2022. "Iowa Soil Regions Map." https://www.nrcs.usda.gov/sites/default/files/2022-09/IowaSoilRegionsMap.pdf

Historical Occurrences

There is no official data pertaining to damages from expansive soils; however, the frequency of damage from expansive soils can be associated with the cycles of drought and heavy rainfall which reflect changes in moisture content. Streets and parking lots throughout the County are damaged every year by expansive soils. Similarly, building foundations, patios and underground utilities are damaged as the soil expands and contracts to varying degrees and depths depending on hydrological conditions.

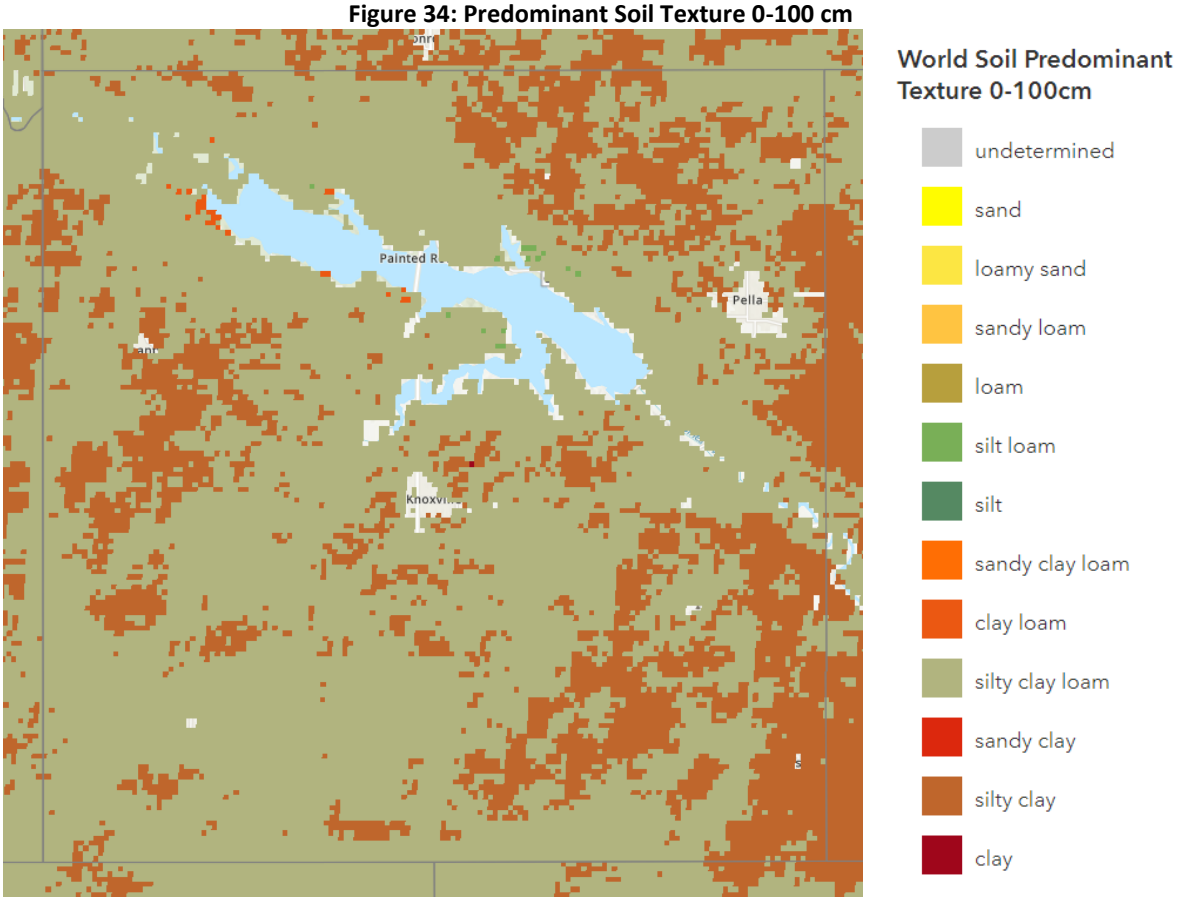
Average Annual Losses

There is no data available to determine damage estimates for this hazard. In most cases, individual property owners, local governments, and businesses pay for repairs for damages caused by this hazard.

Extent

The types of soil texture in Marion County are shown in Figure 34. Soil texture is identified by predominant USDA texture class derived from predicted percent sand, silt, and clay. The figure displays a 100cm depth, which matches many of the world's crop rooting depths. Marion County primarily consists of silty clay loam and silty clay soil textures.

Figure 34: Predominant Soil Texture 0-100 cm



Source: Esri Environment, 2022[83]

[83] Esri Environment. December 2022. "SoilGrids: World Soil Predominant texture 0-100cm". https://www.arcgis.com/home/item.html?id=3988bece11ac44b4a2fc0ecb88c8e081

Climate Change
Changes in humidity and increasingly prolonged droughts may make expansive soils subjected to accelerated swelling during precipitation events. The impacts from climate change to Drought and Flooding will likely have a subsequent impact on Expansive Soils.

Economic Impacts
Similar to earthquakes, expansive soils have the potential to cause damages to underground pipes, buildings, and roadways as the soil shrinks and swells. All the soil in Marion County is comprised partially of clay which is prone to expansion. The Hazard Mitigation Planning Team indicated that expansive soils damage streets, parking lots, and buildings throughout the county every year. However, these damages typically do not all happen at the same time, so delays and outages are minimized. The biggest potential economic impact would be damage to one of the Highways that travel through the county. While a highway closure is unlikely, delays may occur when lanes are closed to fix damages. FEMA standard values for potable water, traffic delays, and wastewater can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development
Existing and future development will continue to be vulnerable to expansive soils. As communities continue to develop and pave more land, it is expected that damages will increase as development occurs on top of expansive soil areas.

Probability
Due to a lack of data surrounding expansive soil occurrences in the planning area, the probability for this hazard occurring annually cannot be calculated. However, it is likely there will continue to be some damage to paved areas and foundations in Marion County due to swelling soils. Certain building and construction practices can alleviate these impacts.

Community Top Hazard Status
No jurisdictions identified Expansive Soils as a top hazard of concern.

Regional Vulnerabilities
The following table provides information related to regional vulnerabilities. For jurisdictional-specific vulnerabilities, refer to *Section Seven*.

Table 70: Regional Expansive Soils Vulnerabilities

SECTOR	VULNERABILITY
People	-Risk of injury from falling structures.
Economic	-Damages to buildings and property can cause significant losses to business owners and divert tax revenue from social and economic improvement programs.
Built Environment	-Basements and subterranean infrastructure can incur damage
Infrastructure	-Roadways, sidewalks, driveways, and bridges can be damaged
Critical Facilities	-Same as all other structures
Climate	-None

Extreme Heat

Extreme heat is often associated with periods of drought but can also be characterized by long periods of high temperatures in combination with high humidity. Conditions for extreme heat are defined by temperatures substantially hotter and/or more humid than average for a location at that time of year. This includes temperatures (including heat index) in excess of 100 degrees Fahrenheit or at least three successive days of 90-plus degrees Fahrenheit. During these conditions, the human body has difficulty cooling through the normal method of the evaporation of perspiration. Health risks including heatstroke, sunstroke, cramps, exhaustion, and fatigue may arise when a person is overexposed to heat. Extreme heat can also cause people to overuse air conditioners, which can lead to power failures. Power outages for prolonged periods increase the risk of heat stroke and subsequent fatalities due to loss of cooling and proper ventilation. The planning area is largely rural, which presents an added vulnerability to extreme heat events; those suffering from an extreme heat event may be farther away from medical resources as compared to those living in an urban setting.

Those at greatest risk for heat-related illness include infants and children up to four years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. However, even young and healthy individuals are susceptible if they participate in strenuous physical activities during hot weather. In agricultural areas, the exposure of farm workers, as well as livestock, to extreme temperatures is a major concern.

Along with humans, animals also can be affected by high temperatures and humidity. Cattle and other farm animals respond to heat by reducing feed intake, increasing their respiration rate, and increasing their body temperature. These responses assist the animal in cooling itself, but this is usually not sufficient. When animals overheat, they will begin to shut down body processes not vital to survival, such as milk production, reproduction, or muscle building.

Other secondary concerns connected to extreme heat hazards include water shortages brought on by drought-like conditions and high demand. Government authorities report that civil disturbances and riots are more likely to occur during heat waves. In cities, pollution becomes a problem because the heat traps pollutants in densely populated urban areas. Adding pollution to the stresses associated with the heat magnifies the health threat to the urban population. Extreme heat can also result in distortion and failure of structures and surfaces such as roadways and railroad tracks.

The National Weather Service (NWS) is responsible for issuing excessive heat outlooks, heat advisories, excessive heat watches, and excessive heat warnings. Temperatures used for each warning may vary from state to state, Iowa's NWS watches, warnings, and advisories are as follows[84]:

- ***Excessive heat outlooks*** are issued when the potential exists for an excessive heat event in the next three to seven days. Excessive heat outlooks can be utilized by public utility staffs, emergency managers, and public health officials to plan for extreme heat events.

- ***Heat advisories*** are issued when temperatures of at least 100°F or Heat Index values of at least 105°F are expected generally within the next 24 hours.

[84] National Weather Service. 2022. "Heat Information Page". Accessed December 2022. https://www.weather.gov/dmx/dssheat

- ***Excessive heat watches*** are issued when the Heat Index values are expected to reach or exceed 110°F and not fall below 75°F for at least a 48-hour period, beginning in the next 12 to 48 hours.

- ***Excessive heat warnings*** are issued when Heat Index values are expected to reach or exceed 110°F and not fall below 75°F for at least a 48-hour period, beginning in the next 24 hours.

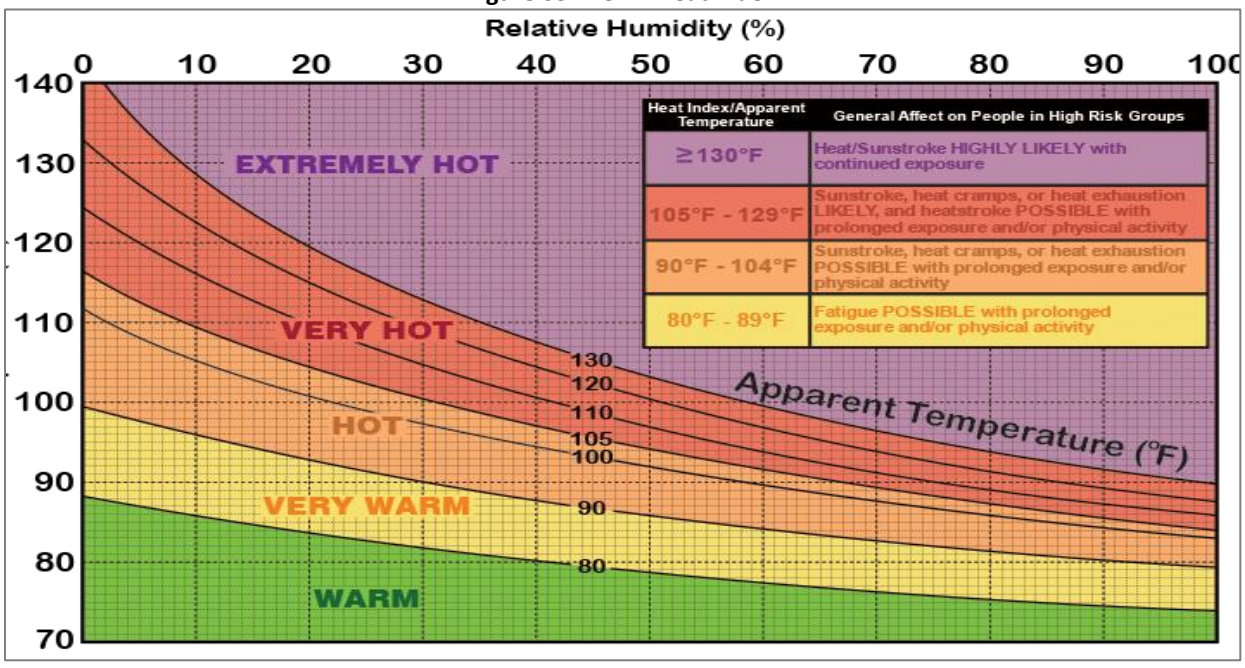
Location and Extent

The entire planning area is subject to extreme heat and all participating jurisdictions are affected. A key factor to consider regarding extreme heat situations is the humidity level relative to the temperature. As is indicated in the following figure from NOAA, as the relative humidity increases, the temperature needed to cause a dangerous situation decreases. For example, for 100% relative humidity, dangerous levels of heat begin at 86°F whereas a relative humidity of 50% requires 94°F. The heat index is a number in degrees Fahrenheit that tells how hot it really feels when relative humidity is factored into actual air temperature. The combination of relative humidity and temperature result in a heat index as demonstrated below:

$$100\%\ Relative\ Humidity + 86°\text{F} = 112°\text{F}\ Heat\ Index$$

Figure 35 is designed for shady and light wind conditions. Exposure to full sunshine or strong winds can increase hazardous conditions and raise heat index values by up to 15°F. For the purposes of this plan, extreme heat is defined as temperatures of 100°F or greater. In the planning area, the months with the highest temperatures are June, July, and August.

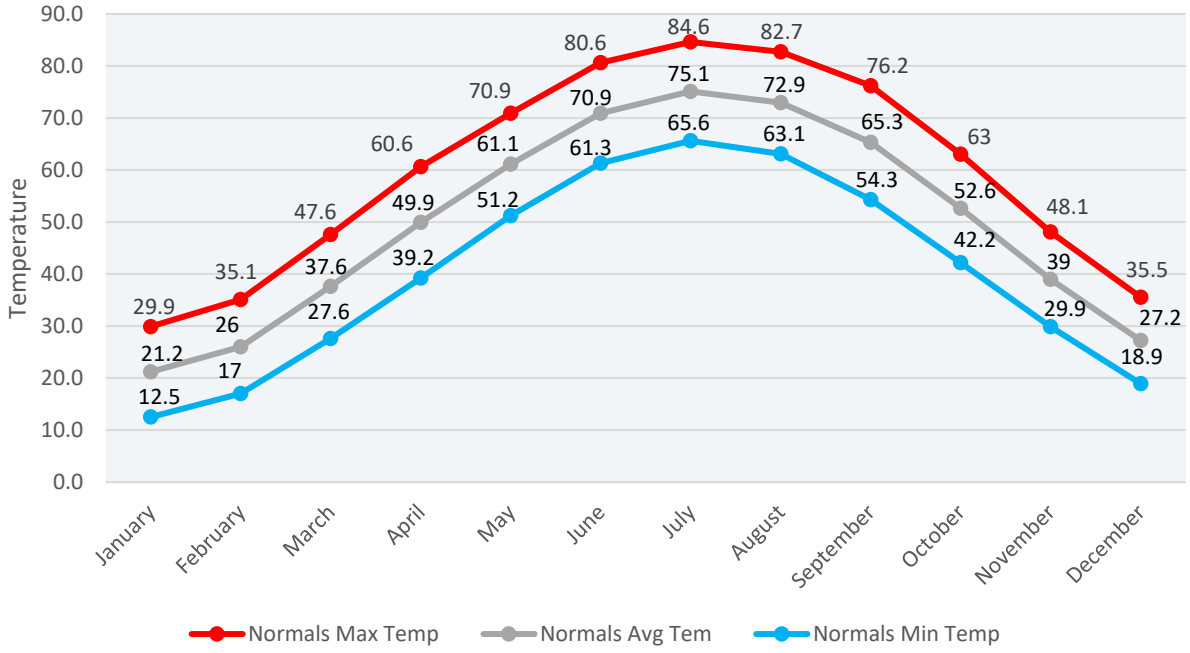
Figure 35: NOAA Heat Index



Source: NOAA, 2022[85]

[85] National Oceanic and Atmospheric Administration, National Weather Service. 2022. "Heat Index." https://www.noaa.gov/jetstream/global/heat-index.

Figure 36: Monthly Climate Normals Temperature (1991-2020)

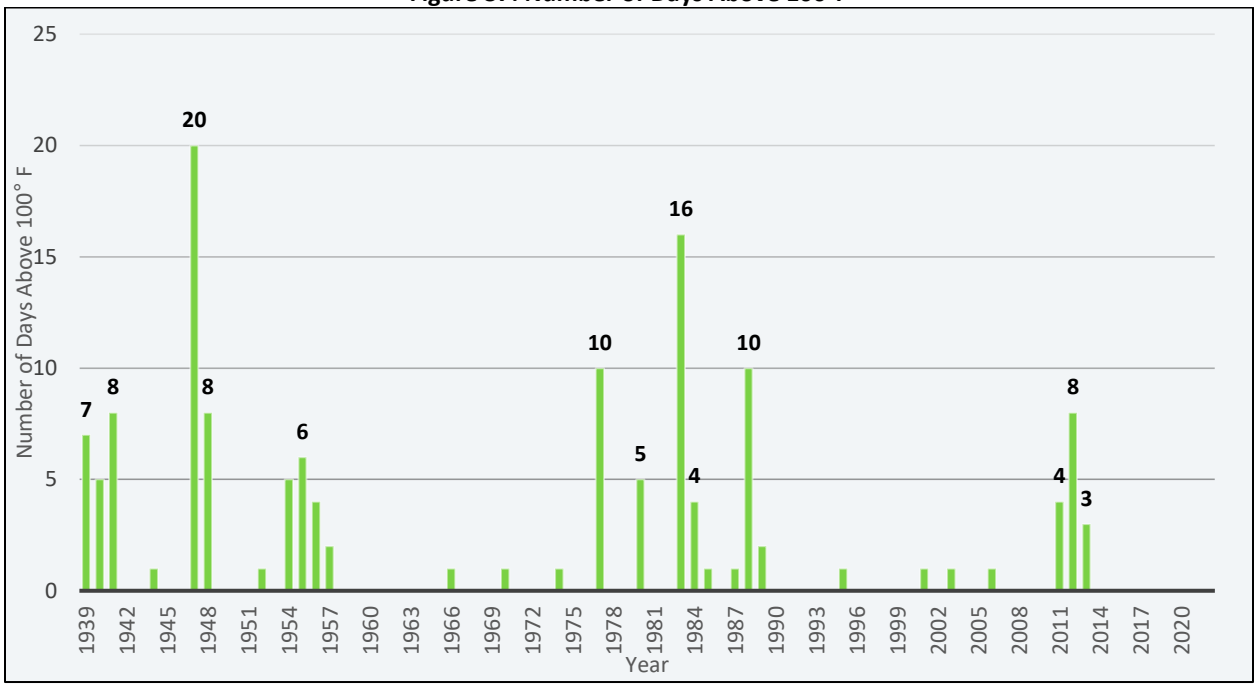


Source: NCEI, 2022

Historical Occurrences

According to the High Plains Regional Climate Center (HPRCC), on average, the county experiences two days above 100°F per year. The county experienced the most days on record above 100°F in 1947 with 20 days followed by 1983 with 16 days (Figure 37).

Figure 37: Number of Days Above 100°F



Source: HPRCC, 1939-2022

Average Annual Losses

The annual property estimate was determined based upon NCEI Storm Events Database since 1996. The annual crop loss was determined based upon the RMA Cause of Loss Historical Database since 2000. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. The direct and indirect effects of extreme temperatures are difficult to quantify. Potential losses such as power outages could affect businesses, homes, and critical facilities. High demand and intense use of HVAC systems or water pumps can overload the electrical systems and damage infrastructure.

The NCEI storm events database reports extreme heat events as excessive heat events. According to the NCEI there have been three excessive heat events within the county in July 2011, July 2016, and July 2019. In 2011, according to the Iowa Cattlemen's Association, approximately 4,000 cattle died statewide due to extreme heat. Some of these deaths likely occurred in the county. During the 22-year period from 2000-2021, 13 instances of crop insurance claims paid for losses related to extreme heat totaled $190,811.

Table 71: Loss Estimate for Extreme Heat

Hazard Type	Avg. Days Above 100°F[1]	Total Property Loss[2]	Average Annual Property Loss[2]	Total Crop Loss[3]	Average Annual Crop Loss[3]
Extreme Heat	2 days	$135,000	%5,821	$190,811	$8,673

Source: 1 HPRCC (1939-2022); 2 Indicates data is from NCEI (1996 to 2022); 3 Indicates data is from USDA RMA (2000 to 2021)

According to the FEMA Benefit Cost Analysis Reference Guide, if an extreme heat event occurred within the planning area, the following table assumes the event could potentially cause a loss of electricity for 10% of the population at a cost of $182 per person per day.[86] In rural areas, the percent of the population affected, and duration may increase during extreme events. The assumed damages do not take into account physical damages to utility equipment and infrastructure.

Table 72: Loss of Electricity - Assumed Damage

Jurisdiction	2020 Population	Population Affected (Assumed)	Electric Loss of Use Assumed Damage Per Day
Marion County	33,414	3,341	$608,062.00

Climate Change

The Union for Concerned Scientists released a report in July 2019 titled *Killer Heat in the United States: Climate Choices and the Future of Dangerously Hot Days*[87] which included predictions for extreme heat events in the future dependent on future climate actions. The table below summarizes those findings for the planning area.

Table 73: Extreme Heat Predictions for Days over 100°F

Jurisdiction	Midcentury Prediction 2036-2065 (Days per Year)	Late Century Prediction 2070-2099 (Days per Year)
Marion County	37	63

Source: Union of Concerned Scientists[88]

[86] Federal Emergency Management Agency. June 2009. "BCA Reference Guide."

[87] Union of Concerned Scientists. 2019. "Killer Heat in the United States: Climate Choices and the Future of Dangerously Hot Days." https://www.ucsusa.org/sites/default/files/attach/2019/07/killer-heat-analysis-full-report.pdf.

[88] Union of Concerned Scientists. 2022. "Extreme Heat and Climate Change: Interactive Tool". https://www.ucsusa.org/global-warming/global-warming-impacts/extreme-heat-interactive-tool?location=Marion-county--ia

Impacts from climate change will significantly affect the prevalence and extent of extreme heat conditions. As the number of 100°F days increases, along with warming nights, the stress placed on the energy grid will likely increase and possibly lead to more power outages. The Fourth National Climate Assessment noted numerous impacts including increasing health risks from extreme heat conditions or increased severe wildfire events with hot dry conditions.[89] Jurisdictions across the planning area may also experience more than one climate related impact simultaneously such as drought and extreme heat.

Economic Impacts

Extreme Heat is most likely going to affect people who are outside or lack air conditioning. It can also stress electrical systems, water systems, and even roadways during prolonged extreme events. Roadways will likely see localized impacts which will only cause minor delays unless damages occur to highways. During extreme heat events more water is used for lawn watering and irrigation of crops, which could impact water systems. When tied with drought, communities may need to implement voluntary or mandatory water restrictions to help reduce water usage and protect the water supply. Larger communities like Knoxville, Melcher-Dallas, and Pella may see large spikes in energy consumption due to the increased running of air conditioners. This could cause stress to the electrical system and short-term blackouts. FEMA standard values for injuries, potable water, electric power, and traffic delays can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development

The construction of infrastructure to support any future development should take extreme heat, and the large range of temperatures experienced in the county, into account. Facilities such as nursing homes and day cares should be designed with access to back-up power generation. Public cooling centers should be established, especially during special summer events like sprint car races at the Knoxville Raceway.

Probability

Extreme temperatures are a regular part of the climate for the planning area. Extreme heat event of over 100°F occur on average twice annually and at least one day over 100°F has occurred in 29 out of 84 years. Thus the probability that extreme heat will occur in any given year in the planning area is 34.5 percent.

Community Top Hazard Status

No jurisdictions identified Extreme Heat as a top hazard of concern.

Regional Vulnerabilities

Those at greatest risk for heat-related illness include infants and children up to four years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. Area elder care facilities, senior housing facilities, and childcare facilities are vulnerable to extreme temperatures. Most notably, power failure during an extreme heat event could shut down these facilities' HVAC systems if back-up power capabilities were not available. Additionally, infrastructure damage such as road damage can occur as a result of extreme heat. When asphalt is exposed to prolonged extreme heat, it can cause buckling of asphalt-paved roads, driveways, and parking lots.

[89] U.S. Global Change Research Program. 2018. "Fourth National Climate Assessment". https://nca2018.globalchange.gov/.

The nonprofit First Street Foundation has developed a Risk Factor tool to help understand risks from a changing climate at the county or community level. Risk Factor provides an overview for heat risk at the county level. The following table outlines key risk factors from heat risk.

Table 74: Marion County Heat Risk

MARION COUNTY	
Overall Heat Factor Risk	Moderate Heat Factor
Total Properties at Risk	25,822
Likelihood of 3+ day heat wave (>101F)	50% likelihood this year (2021); 73% likelihood in 30 years
Health Caution Days	49 days this year (2021); 67 days in 30 years
Dangerous Days	14 days this year (2021); 27 days in 30 years
Hot Days	7 days this year (2021); 19 days in 30 years
Number of cooling days (requiring AC)	169 days this year (2021); 179 days in 30 years

Source: Risk Factor, 2022[90]

Note: Health caution days = days where "feels like" temperature exceeds 90F; Dangerous days = days where "feels like" temperature exceeds 100F; Hot days = days where "feels like" temperature exceeds 101F.

The following tables provide information related to regional vulnerabilities and FEMA's National Risk Index values for Extreme Heat/Heat Wave. For jurisdictional specific vulnerabilities, refer to *Section Seven.*

Table 75: Regional Extreme Heat Vulnerabilities

SECTOR	VULNERABILITY
People	-Human Health impacts including: Heat exhaustion, Heat stroke, Hypothermia, Heart Disease, Asthma Vulnerable populations include: -People working outdoors -People without air conditioning or heat -Young children outdoors or without air conditioning or heat -Elderly outdoors or without air conditioning or heat
Economic	-Short-term interruption of business -Loss of power -Agricultural losses
Built Environment	-Damage to HVAC systems if overworked
Infrastructure	-Damages to roadways (prolonged extreme events) -Stressing electrical systems (brownouts during peak usage) -Stressing water systems
Critical Facilities	-Loss of power
Climate	-Increased risk of wildfire events -Increases in extreme heat conditions are likely, adding stress on livestock, crops, people, and infrastructure -Increases in extreme cold conditions are likely, adding stress on electrical systems, people, and infrastructure

[90] First Street Foundation. "Risk Factor: Heat Factor." Accessed November 2022. https://riskfactor.com/.

SECTOR	VULNERABILITY
National Risk Index Values	Risk Index – Relatively Low Expected Annual Loss – Relatively Low

Source: FEMA National Risk Index, 2022

Flooding

Flooding can occur on a local level, sometimes affecting only a few streets, but can also extend throughout an entire district, affecting whole drainage basins and impacting people and property in multiple states. Heavy accumulations of ice or snow can also cause flooding during the melting stage. These events are complicated by the freeze/thaw cycles characterized by moisture thawing during the day and freezing at night. There are four main types of flooding: riverine flooding, flash flooding, stormwater flooding, and ice jam flooding.

Riverine Flooding

Riverine flooding, typically slow developing with a moderate to long warning time, is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt or ice melt resulting in temporary partial or complete inundation of normally dry land. Floodwaters can be extremely dangerous; the force of 6 inches of swiftly moving water can knock people off their feet and 2 feet of water can float a car. Floods can be slow or fast-rising but generally develop over a period of days. The areas adjacent to rivers and stream banks that carry excess floodwater are called floodplains. A floodplain or flood risk area 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 in the floodplain that is subject to a one percent or greater chance of flooding in any given year. Floodplains are part of a larger entity called a basin or watershed, which is defined as all the land draining to a river and its tributaries.

Flash Flooding

Flash floods, typically rapidly developing with little to no warning time, result from intense precipitation over a brief period, usually due to slow moving thunderstorms or sudden releases due to a failure of an upstream impoundment created behind a dam, landslide, or levee. Additionally, flash floods may be combined with rapid snowmelt, ice jam release, frozen ground, saturated soil, or impermeable surfaces. Flash floods are distinguished from regular floods by a timescale of fewer than six hours. They are 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. Waters move at very fast speeds and can move boulders, tear out trees, scour channels, destroy buildings, and obliterate bridges. Flash floods cause the most flood-related deaths, both human and animal, because of this shorter timescale. Flooding from excessive rainfall events in Iowa usually occurs between late spring and early fall.

Stormwater Flooding

In some cases, flooding may not be directly attributable to a river, stream, or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage capacity. With no place to go, the water will find the lowest elevations – areas that are often not in a floodplain. This type of flooding, often referred to as stormwater flooding, is becoming increasingly prevalent as development exceeds the capacity of drainage infrastructure, therefore limiting its ability to convey stormwater. Flooding also occurs due to combined storm and sanitary sewers being overwhelmed by the high flows that often accompany storm events. Typical impacts range from dangerously flooded roads to water backing up into homes or basements, which damages mechanical systems and can create serious public health and safety concerns.

Ice Jam Flooding

Ice jams occur when ice breaks up in moving waterways, and then stacks on itself where channels narrow, or human-made obstructions constrict the channel. This creates an ice dam, often causing flooding within

minutes of the dam formation. Ice formation in streams occurs during periods of cold weather when finely divided colloidal particles called "frazil ice" form. These particles combine to form what is commonly known as “sheet ice.” This type of ice covers the entire river. The thickness of this ice sheet depends upon the degree and duration of cold weather in the area. This ice sheet can freeze to the bottom of the channel in places. During spring thaw or winter freezing, rivers frequently become clogged with this winter accumulation of ice. Because of relatively low stream banks and channels blocked with ice, rivers overtop existing banks and flow overland. This type of flooding tends to more frequently occur on wide, shallow rivers, although other rivers can be impacted.

Location

The county resides in the South Skunk, Lake Red Rock, and Lower Des Moines watersheds. The main waterway in the area is the Des Moines River, additionally the South Skunk River passing through the northeast corner of the county and White Breast River to the southwest. These rivers and their tributaries are potential locations for flooding to occur.

Table 76 shows current statuses of FIRM panels. For additional details on localized flood risk such as flood zone types, please refer to the official FIRM available from FEMA’s Flood Map Service Center. Figure 38 shows the modeled floodplain for the county. For jurisdictional-specific maps as well as an inventory of structures in the floodplain, please refer to *Section Seven.*

Table 76: FEMA FIRM Panel Status

Jurisdiction	Participating in NFIP? (Y/N)	Panel Numbers	Effective Date
Marion County	Y	19125CIND0B, 19125C0025D, 19125C0050D, 19125C0075D, 19125C0100D, 19125C0125D, 19125C0127D, 19125C0129D, 19125C0133D, 19125C0135D, 19125C0140D, 19125C0143D, 19125C0144D, 19125C0145D, 19125C0175D, 19125C0200D, 19125C0205D, 19125C0210D, 19125C0212D, 19125C0210D, 19125C0212D, 19125C0214D, 19125C0215D, 19125C0216D, 19125C0217D, 19125C0218D, 19125C0236D, 19125C0250D, 19125C0256D, 19125C0257D, 19125C0275D, 19125C0300D, 19125C0303D, 19125C0304D, 19125C0305D, 19125C0308D, 19125C0310D, 19125C0311D, 19125C0312D, 19125C0315D, 19125C0320D, 19125C0333D, 19125C0341D, 19125C0350D, 19125C0375D, 19125C0382D, 19125C0400D, 19125C0401D, 19125C0403D, 19125C0425D, 19125C0450D, 19125C0455D, 19125C0459D, 19125C0460D, 19125C0461D, 19125C0462D, 19125C0466D, 19125C0467D, 19125C0500D	2/16/2018
Bussey	Y	19125CIND0B, 19125C0459D	2/16/2018
Hamilton	N – due to very limited existing floodrisk	19125CIND0B, 19125C0466D, 19125C0467D	2/16/2018

Jurisdiction	Participating in NFIP? (Y/N)	Panel Numbers	Effective Date
Harvey	Y	19125CIND0B, 19125C0333D, 19125C0341D	2/16/2018
Knoxville	Y	19125CIND0B, 19125C0300D, 19125C0303D, 19125C0304D, 19125C0308D, 19125C0311D, 19125C0312D	2/16/2018
Marysville	Y	19125CIND0B, 19125C0462D	2/16/2018
Melcher-Dallas	Y	19125CIND0B, 19125C0382D, 19125C0401D, 19125C0403D	2/16/2018
Pella	Y	19125CIND0B, 19125C0212D, 19125C0214D, 19125C0216D, 19125C0217D, 19125C0218D, 19125C0236D, 19125C0250D	2/16/2018
Pleasantville	Y	19125CIND0B, 19125C0143D, 19125C0144D, 19125C0256D, 19125C0257D	2/16/2018
Swan	Y	19125CIND0B, 19125C0129D, 19125C0133D	2/16/2018

Source: FEMA, 2022[91] [92]

Risk Map Products

Risk Mapping, Assessment, and Planning (Risk MAP) is a FEMA program that provides communities with flood information and additional flood risk data (e.g., flood depth grids, percent chance grids, areas of mitigation interest, etc.) that can be used to enhance their mitigation plans and take action to better protect their citizens. According to the FEMA Flood Map Service Center, are currently no Risk MAP products available for the three watersheds within Marion County.

According to the Iowa Department of Natural Resources, other flood plain mapping projects in Marion County are currently underway. The state is in the process of collecting lidar data undergoing 2D base level engineering and data development activities across the state.[93]

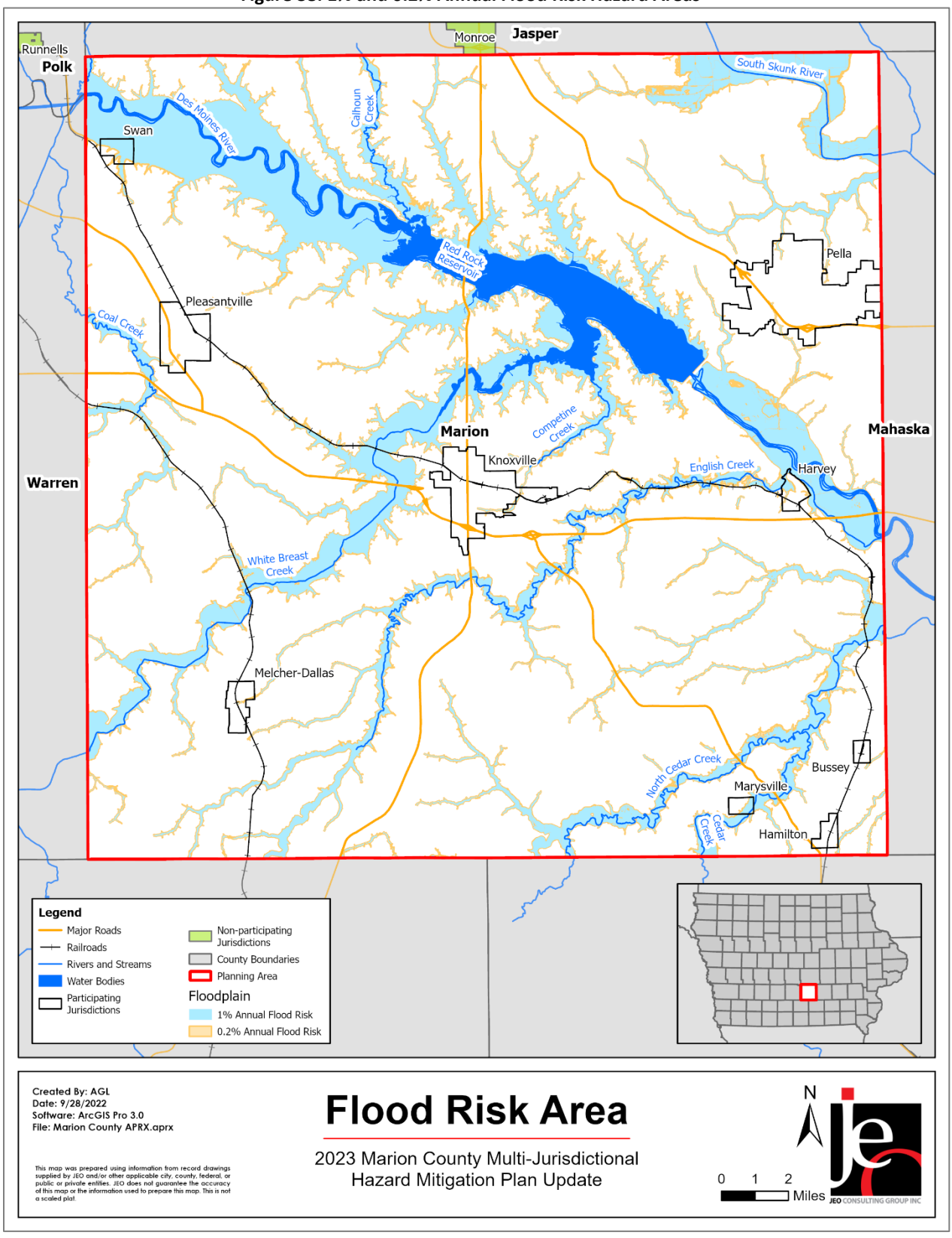
The Iowa Flood Center hosts flood risk maps on an interactive web map that contains tools for analyzing scour-prone areas, flood risk gradients, and flood depths. The interactive flood risk maps can be viewed at: https://ifis.iowafloodcenter.org/ifis/newmaps/risk/map/.

[91] Federal Emergency Management Agency. 2022. "FEMA Flood Map Service Center." Accessed December 2022. http://msc.fema.gov/portal/advanceSearch.

[92] Federal Emergency Management Agency. 2022. "Community Status Book Report." Accessed December 2022. https://www.fema.gov/national-flood-insurance-program-community-status-book

[93] Iowa Department of Natural Resources. 2022. "Flood Plain Mapping." https://www.iowadnr.gov/Environmental-Protection/Land-Quality/Flood-Plain-Management/Flood-Plain-Mapping.

Figure 38: 1% and 0.2% Annual Flood Risk Hazard Areas



Historical Occurrences

The NCEI reports events as they occur in each community. A single flooding event can affect multiple communities and the county at the same time; however, NCEI reports these large scale, multi-county events as separate events. The result is a single flood event covering a large portion of the planning area could be reported by the NCEI as several events. According to the NCEI, 34 flash flooding events resulted in $2,117,000 in property damage, while 99 riverine flooding events resulted in $5,037,070 in property damage. USDA RMA data does not distinguish the difference between riverine flooding damages and flash flooding damages. The total crop loss according to the RMA is $4,759,232.59. Descriptions of the most damaging flood events from the NCEI are below:

- **6/8/2008 – Flood – Marion County:** Heavy rain fell once again across a large part of Iowa, especially across the north and northeast. This rain fell on rivers that were already close to flood stage as they were just beginning to fall after the flooding from earlier in the month. The rainfall of the first week of June set the state for what would become record flooding over a large part of the northeast half of Iowa, even eclipsing the records set just 15 years previous in 1993. Damage became widespread, both to property and infrastructure as well as agriculturally.

- **7/29/2015 – Flood – Marion County:** A boundary was pushing through the state with ongoing convection through central Iowa through the day. As the boundary neared the area, the convection intensified and impacted central and southern Iowa in the evening to early morning hours. Two thunderstorm complexes moved through portions of central and southern Iowa with very heavy rainfall causing flash flooding. The severe thunderstorm complexes produced some hail but mainly strong damaging winds. Precipitable water values were near 2 inches in some areas with deep warm cloud depths during the event. This heavy rainfall further exacerbated conditions as some of the area had just received heavy rainfall in previous days. This led to some extended flooding for a few days and flooding on some area rivers. ... The Emergency Manager for Marion County mentioned widespread reports of 8 to 10 inches with one report close to 12 inches of accumulated rainfall over the past few days.

Average Annual Damages

The average damage per event estimate was determined based upon NCEI Storm Events Database since 1996 and the number of historical occurrences. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. Flooding causes an average of $264,966 in property damages and $216,329 in crop losses per year for the planning area.

Table 77: Flood Loss Estimate

Hazard Type	Number of Events[1]	Average Events Per Year	Total Property Loss[1]	Average Annual Property Loss [1]	Total Crop Loss[2]	Average Annual Crop Loss [2]
Flooding	133	4.9	$7,154,070	$264,966	$4,759,233	$216,329

Source: 1 Indicates data is from NCEI (1996 to 2022); 2 Indicates data is from USDA RMA (2000 to 2021)

Extent

The NWS has three categories to define the severity of a flood once a river reaches flood stage as indicated in Table 78.

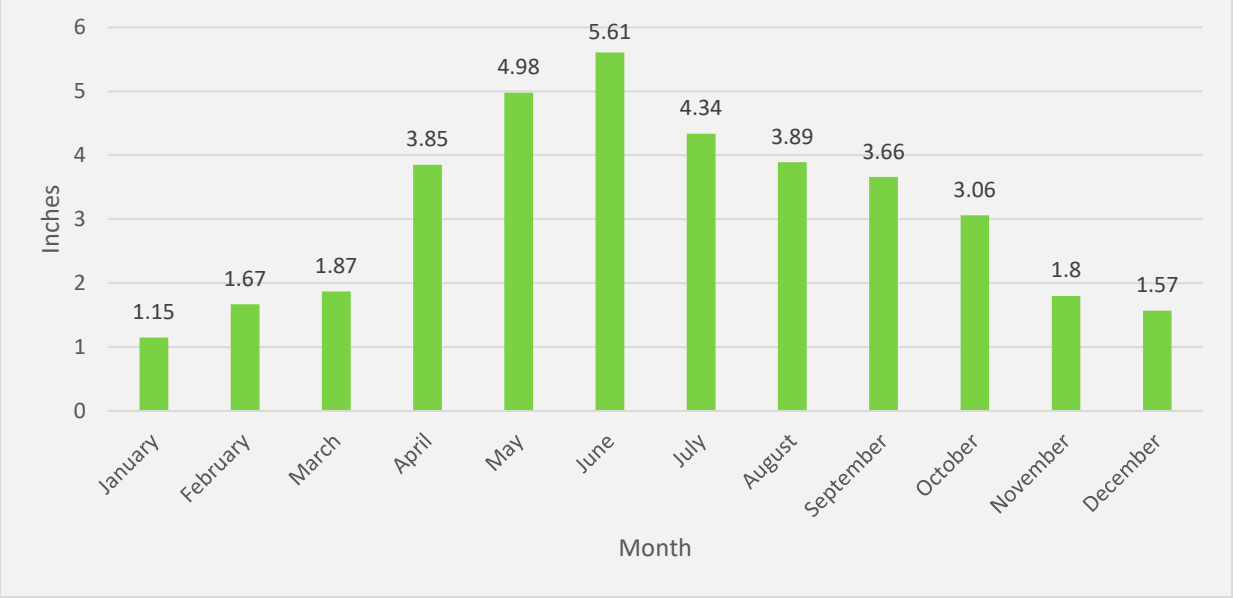
Table 78: Flooding Stages

Flood Stage	Description of Flood Impacts
Minor Flooding	Minimal or no property damage, but possibly some public threat or inconvenience
Moderate Flooding	Some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary
Major Flooding	Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations

Source: NOAA, 2017[94]

Figure 39 shows the normal average monthly precipitation for the planning area, which is helpful in determining whether any given month is above, below, or near normal in precipitation. As indicated in Figure 40, the most common months for flooding within the planning area are May and June.

Figure 39: Average Monthly Precipitation for Planning Area

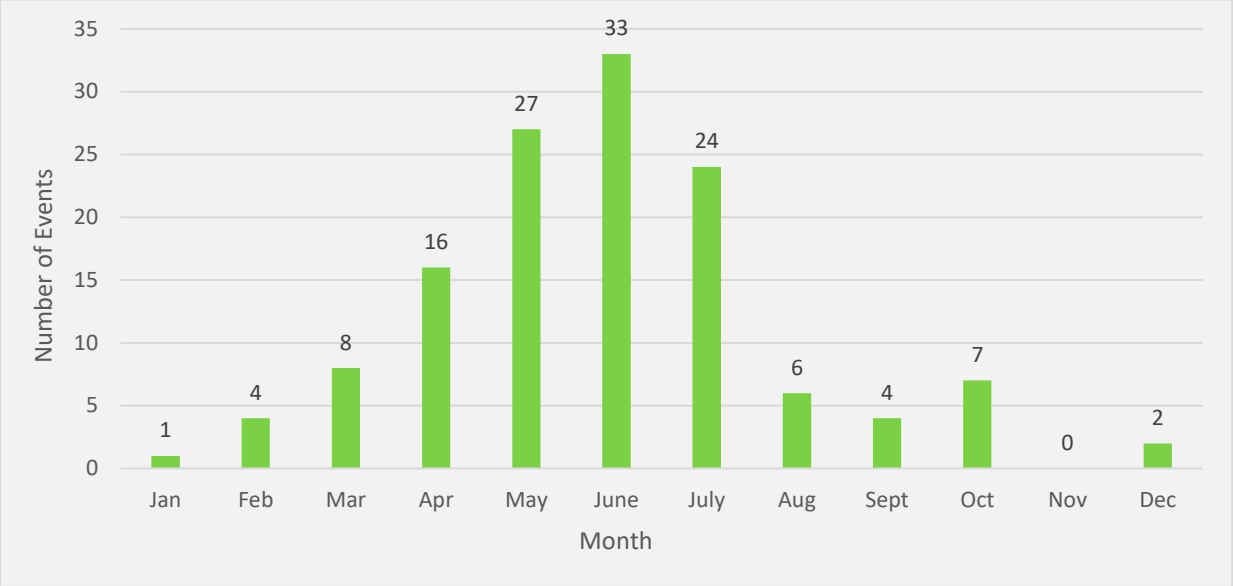


Source: NCEI, 1991-2020[95]

[94] National Weather Service. 2017. "Flood Safety." https://www.weather.gov/safety/flood.

[95] NOAA National Centers for Environmental Information. October 2022. "Data Tools: 1991-2020 Normals." [datafile]. https://www.ncdc.noaa.gov/cdo-web/datatools/normals.

Figure 40: Monthly Events for Floods/Flash Floods



Source: NCEI, 1996-2022

National Flood Insurance Program (NFIP)

The NFIP was established in 1968 to reduce flood losses and disaster relief costs by guiding future development away from flood hazard areas where feasible; by requiring flood resistant design and construction practices; and by transferring the costs of flood losses to the residents of floodplains through flood insurance premiums. In return for availability of federally backed flood insurance, jurisdictions participating in the NFIP must agree to adopt and enforce floodplain management standards to regulate development in special flood hazard areas as defined by FEMA's flood maps. One of the strengths of the program has been keeping people away from flooding rather than keeping the flooding away from people—through historically expensive flood control projects.

This plan highly recommends and strongly encourages plan participants to enroll, participate, and remain in good standing with the NFIP. Compliance with the NFIP should remain a top priority for each participant. Jurisdictions are encouraged to initiate activities above the minimum participation requirements, which are described in the Community Rating System (CRS) Coordinator's Manual.[96] Currently no jurisdictions in the planning area participate in the CRS program. The following tables summarize NFIP participation and active policies within the planning area as of December 2022.

Table 79: NFIP Participants

Jurisdiction	In NFIP?	Eligible-Regular Program	Date Current Map	Sanction	Suspension	Rescinded
Marion County	Yes	11/07/2001	2/16/2018 (M)	-	-	-
Bussey	Yes	11/16/2007	2/16/2018 (M)	-	-	-
Hamilton	No	11/16/2007	2/16/2018	11/16/2008	-	-

[96] Federal Emergency Management Agency. 2017. "National Flood Insurance Program Community Rating System: Coordinator's Manual FIA-15/2017." Accessed January 2023. https://www.fema.gov/sites/default/files/documents/fema_community-rating-system_coordinators-manual_2017.pdf.

Jurisdiction	In NFIP?	Eligible-Regular Program	Date Current Map	Sanction	Suspension	Rescinded
Harvey	Yes	11/16/2007	2/16/2018 (M)	-	-	-
Knoxville	Yes	11/16/2007	2/16/2018 (M)	-	-	-
Marysville	Yes	11/16/2007	2/16/2018 (M)	-	-	-
Melcher-Dallas	Yes	11/16/2007	2/16/2018 (M)	-	-	-
Pella	Yes	11/16/2007	2/16/2018 (M)	-	-	-
Pleasantville	Yes	11/16/2007	2/16/2018 (M)	-	-	-
Swan	Yes	11/16/2007	2/16/2018 (M)	-	-	-

Source: Federal Emergency Management Agency, National Flood Insurance Program, 2022[97]
**(M) indicates no elevation determined – All Zone A, C, and X*

Table 80: NFIP Policies in Force and Total Payments

Jurisdiction	Policies In-force	Total Coverage	Total Premiums	Total Losses	Total Payments
Marion County	12	$2,315,000	$5,516	15	$340,170
Bussey	-	-	-	-	-
Hamilton	-	-	-	-	-
Harvey	0	$0	$0	2	$4,521
Knoxville	1	$350,000	$568	1	$0
Marysville	1	$105,000	$411	0	$0
Melcher-Dallas	1	$210,000	$530	0	$0
Pella	0	$0	$0	2	$4,655
Pleasantville	0	$0	$0	1	$6,316
Swan	-	-	-	-	-

Source: HUDEX, September 2022

NFIP Repetitive Loss Structures

IDNR was contacted to determine if any existing buildings, infrastructure, or critical facilities are classified as NFIP Repetitive Loss Structures. As of November 2022, there are two repetitive loss properties in unincorporated Marion County. Both properties are single-family homes with no mitigation work currently planned per property owner desires. There are no additional repetitive loss or severe repetitive loss properties located in the county. It is important that the county works with the property owner to identify a solution to mitigate the repetitive flood damages into the future and is included as a project in the county's profile. Definitions of a structure identified as a NFIP Repetitive Loss (RL) and Severe Repetitive Loss (SRL) are given below.

NFIP RL: Repetitive Loss Structure refers to a structure covered by a contract for flood insurance under the NFIP that has incurred flood-related damage on two occasions during a 10-year period, each resulting in at least a $1,000 claim payment.

[97] Federal Emergency Management Agency. 2022. "Community Status Book Report." Accessed January 2023. https://www.fema.gov/cis/IA.html

NFIP SRL: Severe Repetitive Loss Properties are defined as single or multifamily residential properties that are covered under an NFIP flood insurance policy and:

(1) That have incurred flood-related damage for which four or more separate claims payments have been made, with the amount of each claim (including building and contents payments) exceeding $5,000, and with the cumulative amount of such claim payments exceeding $20,000; or
(2) For which at least two separate claims payments (building payments only) have been made under such coverage, with cumulative amount of such claims exceeding the market value of the building.
(3) In both instances, at least two of the claims must be within 10 years of each other, and claims made within 10 days of each other will be counted as one claim.

***HMA RL*:** A repetitive loss property is a structure covered by a contract for flood insurance made available under the NFIP that:

(1) Has incurred flood-related damage on two occasions, in which the cost of the repair, on the average, equaled or exceeded 25 percent of the market value of the structure at the time of each such food event; and
(2) At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.

***HMA SRL*:** A severe repetitive loss property is a structure that:

(1) Is covered under a contract for flood insurance made available under the NFIP.
(2) Has incurred flood related damage –
    (a) For which four or more separate claims payments (includes building and contents) have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claim payments exceeding $20,000; or
    (b) For which at least two separate claims payments (includes only building) have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

***Purpose of the HMA definitions*:** The HMA definitions were allowed by the Biggert-Waters Flood Insurance Reform Act of 2012 to provide an increased federal cost share under the FMA grant when a property meets the HMA definition.

Economic Impacts

Flooding can cause large economic impacts to buildings, crop land, and infrastructure. A flood event can also range in size from impacting a single community or waterway to impacting the entire county or watershed. Assessor and floodplain data was used to determine the value of property improvements located in both the 1% annual flood risk area and 0.2% annual flood risk area. It was found that the value of improvements in the 1% floodplain was $297,663,107 and $300,728,135 in the 0.2% floodplain.

During a large flood event it is possible that any roadway or bridge located in the floodplain may face road closures and delays. These closures and delays would continue until floodwaters have receded and any damages have been repaired. Long term closures and delays will have a trickle-down effect on local

businesses due to shipping delays, reduced customer access, and other impacts. Highways 5, 14, and 92 all have stream crossings and are partially located in the floodplain. In addition, Highway 14 has a mile long bridge that crosses Red Rock Reservoir. The Risk Factor tool estimates that Marion County has 199 out of 1,599 miles of road at risk to flooding.

Water lines can also be damaged by flooding with stream crossings being especially vulnerable. Both Knoxville and Pella have stream crossings where water lines could be damaged. FEMA standard values for traffic delays and potable water can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development

Any future development in floodplains should be discouraged to protect future assets. Land-use regulations should be used to limit development in floodplains and other flood prone areas as well as a way to protect natural flood mitigation features. Buyout programs can be used to eliminate properties located in floodplains, especially properties that have experienced repetitive losses. Communities may also consider incorporating "Green Infrastructure" to address flooding concerns, and examples of this would include using permeable surfaces for parking areas, using rainwater retention swales, developing rain gardens, developing green roofs, and establishing greenways. Marion County is emphasizing the importance of green or open space around Red Rock Lake and major waterways through zoning.

According to the Iowa DNR, building in floodplains can increase flood problems through the following:

- Development anywhere in the watershed can increase the amount of stormwater runoff that goes to the rivers and streams, increasing flood heights.
- Fill and buildings in the floodplain can obstruct flood flows.
- Floodplain development reduces the amount of room available to store floodwaters, increasing flood heights.
- Floodplain development can destroy habitat and other natural floodplain functions.

According to Iowa's floodplain regulations, the minimum level of flood protection for a building depends on the damage potential of the building and contents. Minimum standards for floodplain management require that all new construction and substantial improvements of residential structures shall have the lowest floor (including basements) elevated to or above one foot above the base flood elevation.

Climate Change

In the warmer months, convective storms are common and include flash flood-producing rainstorms. As temperatures continue to rise, more water vapor evaporates into the atmosphere, creating increased humidity, which can increase the frequency and intensity of these storms. An increase in heavy rain events will lead to more flooding and larger magnitude flood events. NOAA has created the Climate Mapping for Resilience and Adaptation tool that looks at how different emission scenarios affect climatological hazards. Table 81 shows that the annual total precipitation is expected to increase in both low emissions and high emission scenarios. During the next century, spring rainfall and average precipitation are likely to increase, and severe rainstorms are likely to intensify. Each of these factors will tend to further increase the risk of flooding in Iowa.[98] Table 82 shows the annual number of days that exceed the 99th percentile precipitation increases as time goes on in both the lower emissions and higher emissions scenario.

[98] EPA. 2016. "What Climate Change Means for Iowa". https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ia.pdf

Table 81: Average Annual Total Precipitation

County	Emission Scenario	Historical (1976-2005)	Early Century (2015-2044)	Mid Century (2035-2064)	Late Century (2070-2099)
Marion County	Lower Emissions (RCP 4.5)	33.6	35.0	34.9	35.1
	Higher Emissions (RCP 8.5)	33.6	34.4	35.0	36.0

Source: NOAA[99]

Table 82: Annual Days that exceed 99th Precipitation

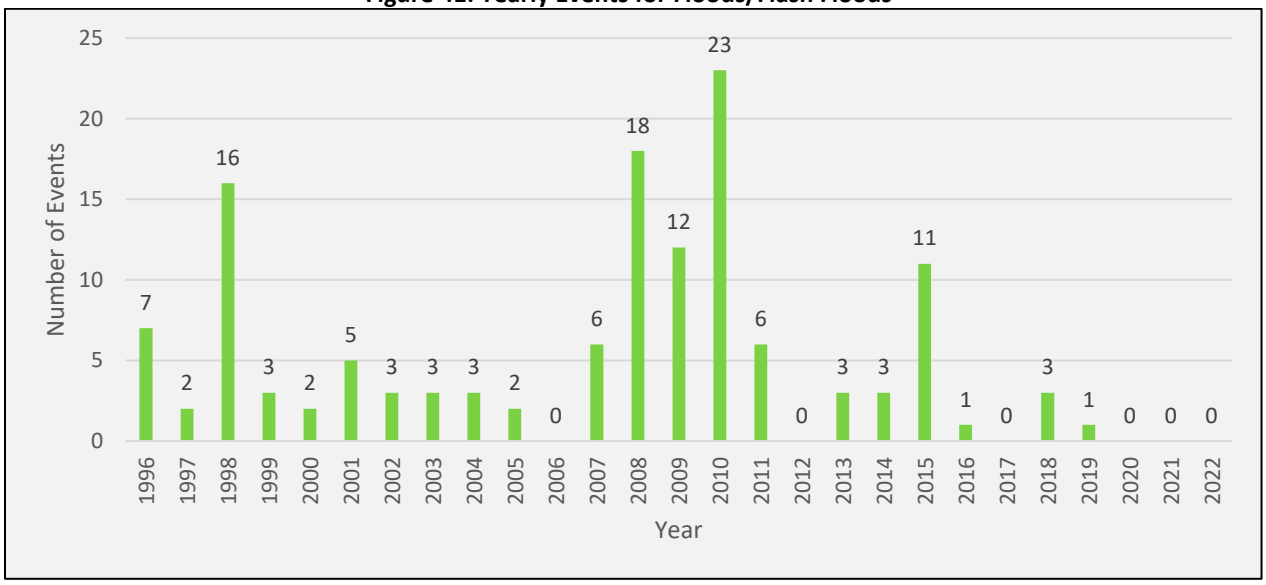
County	Emission Scenario	Historical (1976-2005)	Early Century (2015-2044)	Mid Century (2035-2064)	Late Century (2070-2099)
Marion County	Lower Emissions (RCP 4.5)	5 Days	6 Days	6.3 Days	6.3 Days
	Higher Emissions (RCP 8.5)	5 Days	5.7 Days	6.4 Days	7.3 Days

Source: NOAA

Probability

The NCEI reports 99 flooding and 34 flash flooding events for a total of 133 events from 1996 to 2022. Some years had multiple flooding events. Figure 41 shows the events broken down by year which displays flood events occurred in 21 out of 27 years. Based on the historic record and reported incidents by participating communities, there is a 77% percent probability that flooding will occur annually in any given year for the county.

Figure 41: Yearly Events for Floods/Flash Floods



Source: NCEI, 1996-2022

Community Top Hazard Status

The following jurisdictions identified Flooding as a top hazard of concern:

[99] NOAA. August 2022. "Climate Mapping for Resilience and Adaptation". https://livingatlas.arcgis.com/assessment-tool/explore/details.

- Marion County
- City of Harvey
- City of Pleasantville

Regional Vulnerabilities

To analyze parcels and populations located in the floodplain, GIS parcel data were acquired from the Marion County Assessor. This data was analyzed for the location, number, and value of property improvements at the parcel level. Property improvements include any built structures such as roads, buildings, and paved lots. The data did not contain the number of structures on each parcel. A summary of the results of this analysis for the planning area is provided in the following table. Specific jurisdictional parcel improvements in the floodplain can be found in the corresponding community profiles in *Section Seven*.

Table 83: Parcel Improvements and Value in the 1% Annual Flood Risk Area

Number of Improvements	Total Improvement Value	Number of Improvements in Floodplain	Value of Improvements in Floodplain	Percentage of Improvements in Floodplain
25,874	$3,723,466,390	4,541	$297,663,107	18%

Source: Marion County Assessor, 2022

Table 84: Parcel Improvements and Value in the 0.2% Annual Flood Risk Area

Number of Improvements	Total Improvement Value	Number of Improvements in Floodplain	Value of Improvements in Floodplain	Percentage of Improvements in Floodplain
25,874	$3,723,466,390	4,320	$300,728,135	17%

Source: Marion County Assessor, 2022

In Iowa, Watershed Management Authorities (WMA) are a tool to help cities, counties, Soil and Water Conservation Districts, and stakeholders to work towards watershed planning and management. The South-Central Iowa Cedar Creek WMA is the only watershed management authorities in Marion County and covers the southeastern corner. WMAs are directed by a board of directors and may perform activities to reduce flood risk. More information on Watershed Management Authorities can be found at the following link: https://www.iowadnr.gov/Environmental-Protection/Water-Quality/Watershed-Management-Authorities.

Low-income and minority populations are disproportionately vulnerable to flood events.[100] These groups may lack needed resources to mitigate potential flood events as well as resources that are necessary for evacuation and response. In addition, low-income residents are more likely to live in areas vulnerable to the threat of flooding but lack the resources necessary to purchase flood insurance. The study found that flash floods are more often responsible for injuries and fatalities than prolonged flood events.

Other groups that may be more vulnerable to floods, specifically flash floods, include the elderly, those outdoors during rain events, and those in low-lying areas. Elderly residents may suffer from a decrease or complete lack of mobility and as a result, be caught in flood-prone areas. Residents in campgrounds or

[100] Cutter, Susan and Finch, Christina. February 2008. "Temporal and Spatial Changes in Social Vulnerability to Natural Hazards".

public parks may be more vulnerable to flooding events. Many of these areas exist in natural floodplains and can experience rapid rise in water levels resulting in injury or death.

The following table is a summary of regional vulnerabilities. For jurisdictional-specific vulnerabilities, refer to *Section Seven.*

Table 85: Regional Flooding Vulnerabilities

SECTOR	VULNERABILITY
People	-Low income and minority populations may lack the resources needed for evacuation, response, or to mitigate the potential for flooding -Elderly or residents with decreased mobility may have trouble evacuating -Residents in low-lying areas, especially campgrounds, are vulnerable during flash flood events -Residents living in the floodplain may need to evacuate for extended periods
Economic	-Business closures or damages may have significant impacts -Agricultural losses from flooded fields or cattle loss -Closed roads and railways would impact commercial transportation of goods
Built Environment	-Buildings may be damaged
Infrastructure	-Damages to roadways and railways
Critical Facilities	-Wastewater facilities are at risk, particularly those in the floodplain -Critical facilities, especially those in the floodplain, are at risk to damage (critical facilities are noted within individual community profiles)
Climate	-Changes in seasonal and annual precipitation normals will likely increase frequency and magnitude of flood events
National Risk Index Values (Riverine Flooding)	Risk Index – Very Low Expected Annual Loss – Very Low

Source: FEMA National Risk Index, 2022

Grass and Wildland Fire

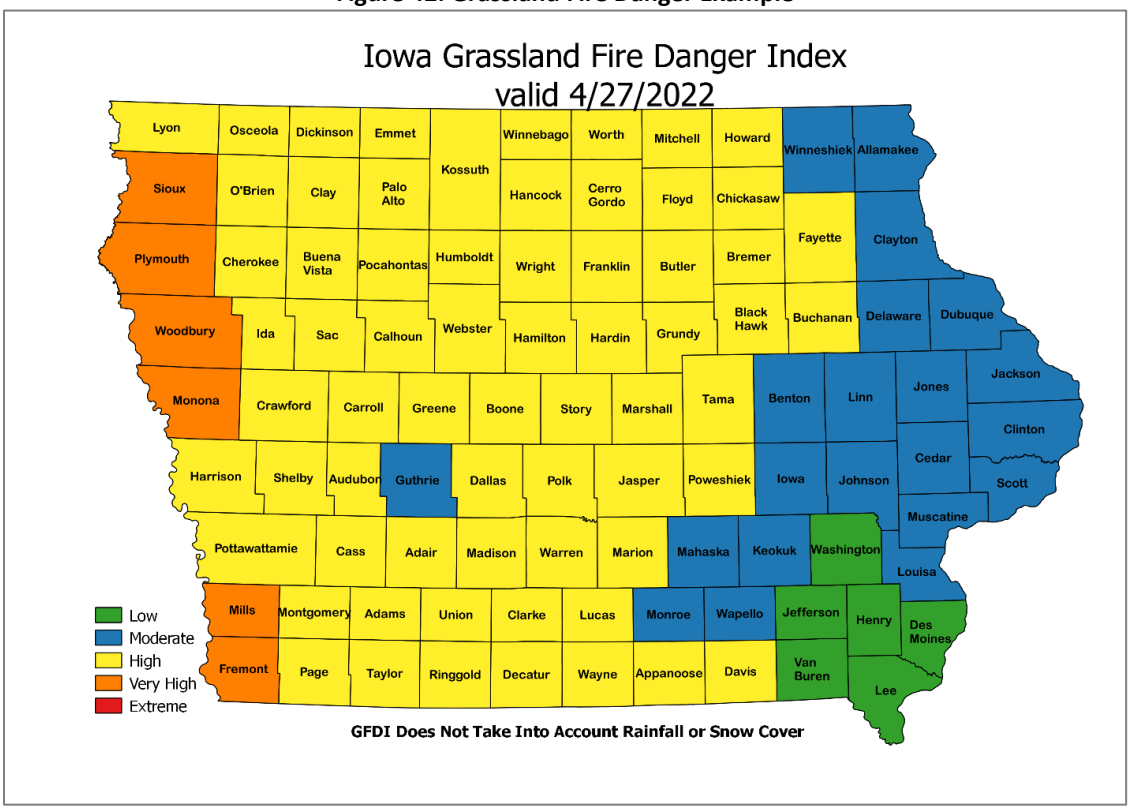
Wildfires, also known as grass fires, brush fires, forest fires, or wildland fires, are uncontrolled fires that occur in the countryside or wildland. Wildland areas may include but are not limited to grasslands, forests, woodlands, agricultural fields, pastures, and other vegetated areas. Wildfires differ from other fires by their potential extensive size, the speed at which they can spread from the original source, their ability to change direction unexpectedly, and to jump gaps (such as roads, rivers, and fire breaks). While some wildfires burn in remote forested and grassland regions, others can cause extensive destruction of homes and other property located in the wildland-urban interface (WUI), the zone of transition between developed areas and undeveloped wilderness.

> Lightning starts approximately 10,000 forest fires each year, yet ninety percent of forest fires are started by humans.
> ~National Park Service

Wildfires are a growing hazard in most regions of the United States, posing a threat to life and property, particularly where native ecosystems meet urban developed areas or where local economies are heavily dependent on open agricultural land. Although fire is a natural and often beneficial process, fire suppression can lead to more severe fires due to the buildup of vegetation, which creates more fuel and increases the intensity and devastation of future fires. As new development encroaches into the WUI, the number of structures and people at risk from wildfires increases.

Wildfires are characterized in terms of their geographical characteristics including topography, weather, and fuels; or physical properties such as flame length and propagation. Wildfire behavior is often complex and variably dependent on factors such as fuel type and moisture content, humidity, wind speed, topography, geographic location, and ambient temperature. Fuel is the only one of these factors that humans can control and is the target of most mitigation efforts. To control the fuel levels, ranchers, farmers, and other land managers will intentionally set fire to vegetation and restore soil nutrients. Causes of wildfires can range from lightning strikes to small burns that get out of control such as campfires or burn piles. The NWS monitors the risk factors including high temperature, high wind speed, fuel moisture (greenness of vegetation), low humidity, and cloud cover in the state on a daily basis (Figure 42). These fire danger predictions are updated regularly and should be reviewed frequently by community leaders and fire department officials.

Figure 42: Grassland Fire Danger Example



Source: NWS, 2022[101]

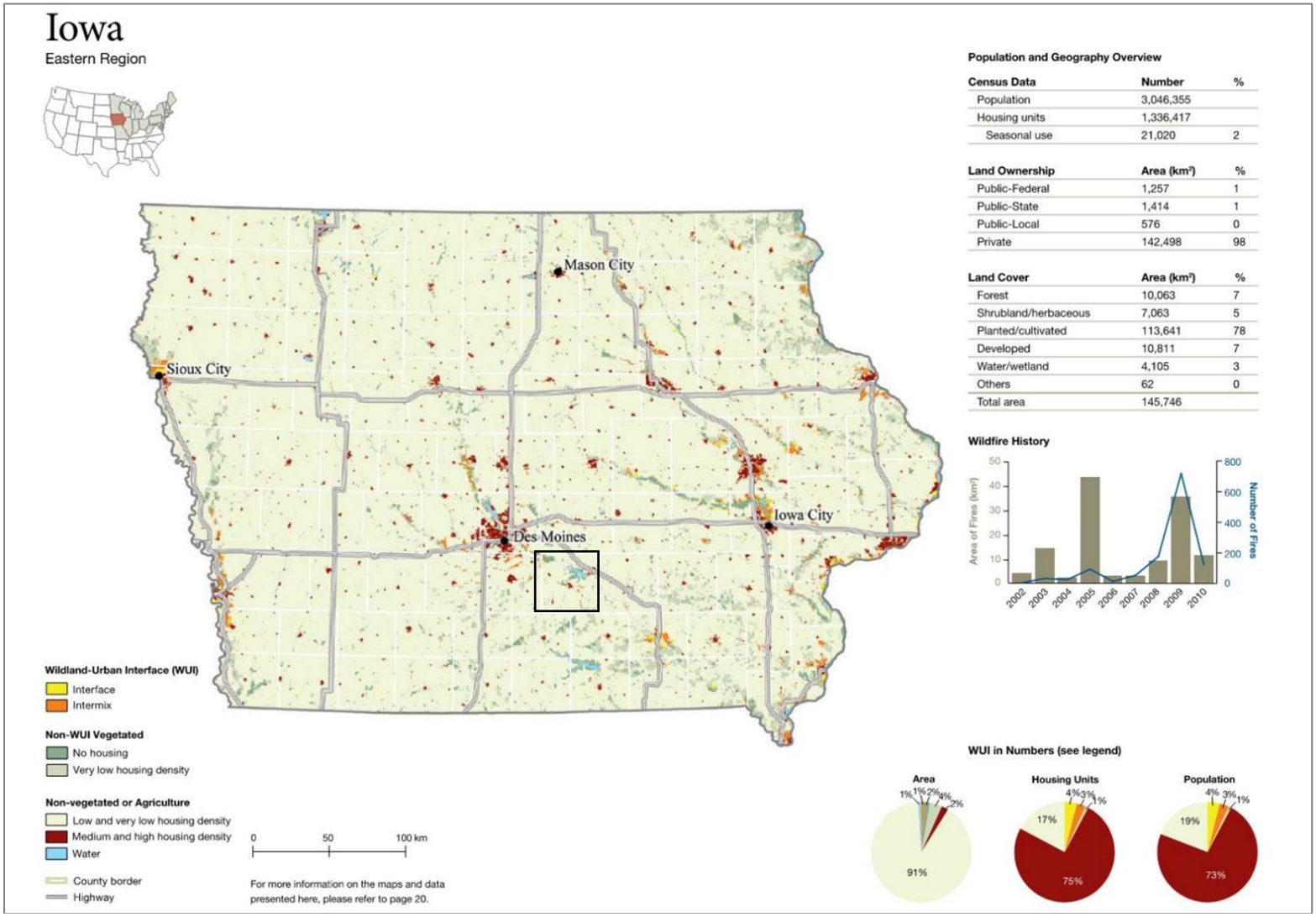
In recent decades, as the population of the United States has decentralized and residents have moved farther away from the center of cities, the WUI has developed significantly, both in terms of population and building stock. The WUI is defined as the zone of transition between developed areas and undeveloped wilderness where structures and other human development meet wildland. The expansion of the WUI increases the likelihood that wildfires will threaten people and homes, making this area the focus of most wildfire mitigation efforts. Iowa's WUI is growing as metro areas expand into natural forest, prairies, and agricultural areas that are in permanent vegetative cover through the Conservation Reserve Program (CRP), of which the state has over 1.5 million acres. Additionally, Iowa has roughly 230,000 acres in federal ownership and conservation easements.

Location

Grass and wildland fires can occur throughout the planning area. The following figure produced by the USDA Forest Service displays the State of Iowa's WUI conditions as of 2010. The approximate location of the planning area is indicated by the black outline. According to this WUI map (Figure 43), intermix areas (orange) are primarily found on the eastern portion of Marion County, near the state highways. An interface area (yellow) is located in the northwest and southeast corners of the county, near the Des Moines River and the Paul Todd Wildlife Area respectively. The rest of the planning area is primarily non-WUI vegetated designated areas, with no or low-density housing with a mix of vegetated, non-vegetated, and agricultural land. Figure 44 shows the WUI map for Marion County.

[101] National Weather Service. April 2022. "Iowa Grassland Fire Danger Index." https://www.weather.gov/dmx/fire.

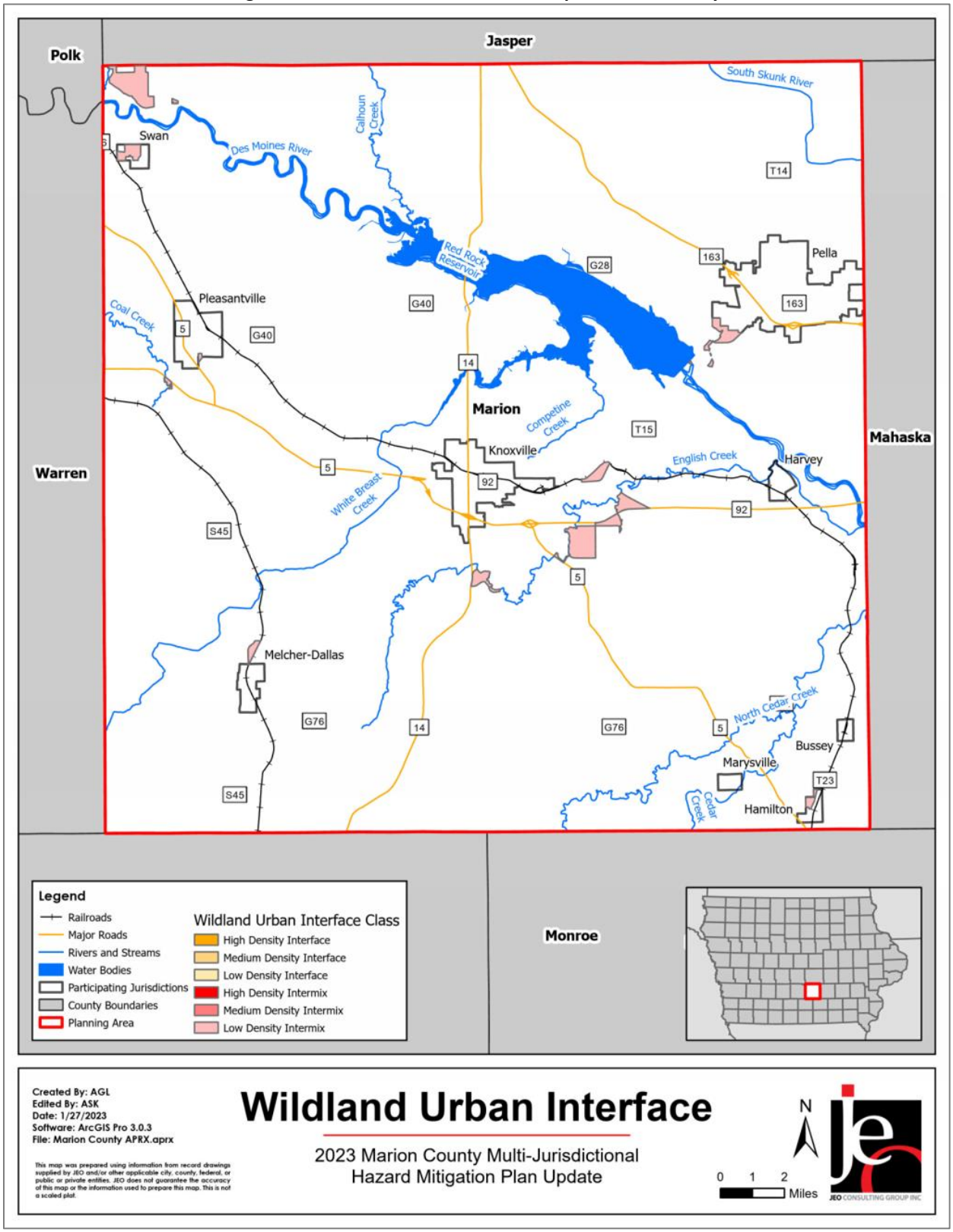
Figure 43: Wildland Urban Interface Map - Iowa



Source: USDA, 2015[102]

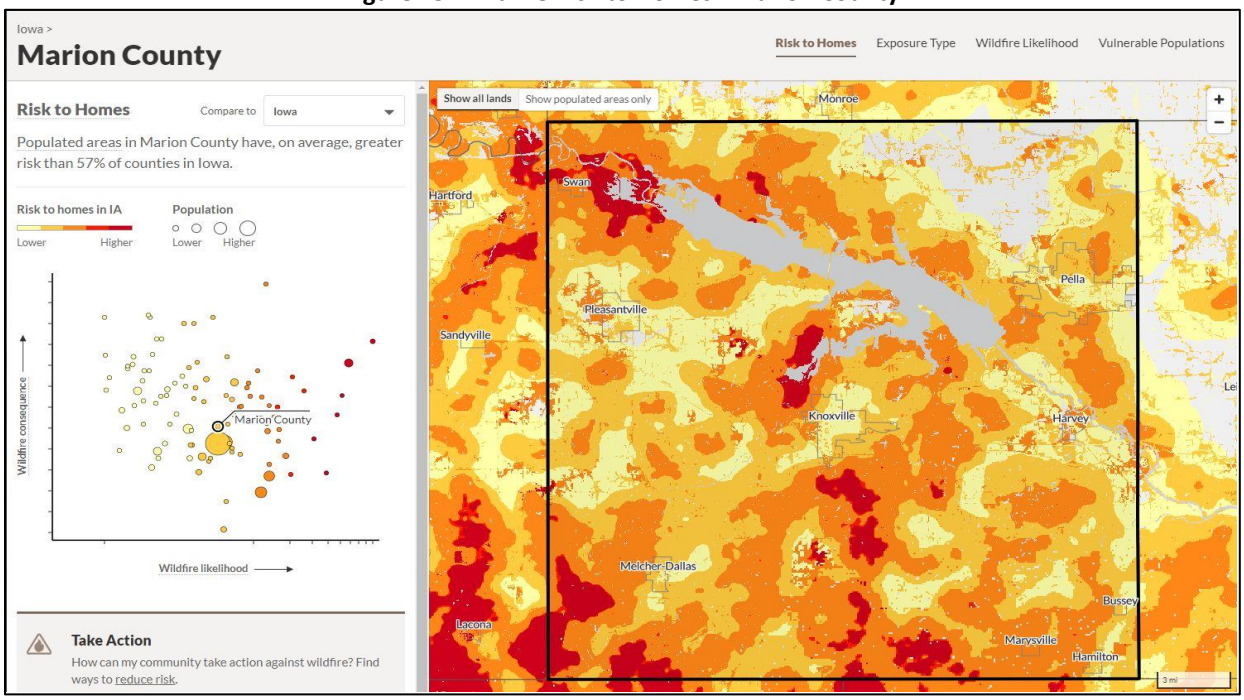
[102] USDA, USFS, & University of Wisconsin. 2015. "The 2010 Wildland-Urban Interface of the Conterminous United States." https://www.fs.fed.us/nrs/pubs/rmap/rmap_nrs8.pdf.

Figure 44: Wildland Urban Interface Map – Marion County



The United States Department of Agriculture Forest Service created the interactive web resource, *Wildfire Risk to Communities,* to help communities and jurisdictions understand, explore, and reduce wildfire risk. Figure 45 displays wildfire risk to homes in Marion County, as of January 2023.

Figure 45: Wildfire Risk to Homes - Marion County



Source: Wildfire Risk to Communities[103]

Table 86: Wildfire Vulnerabilities

County	Risk to Homes (compared to Iowa Counties)	Exposure Type	Wildfire Likelihood (compared to Iowa Counties)
Marion	57%	Indirect exposure	55%

Source: Wildfire Risk to Communities, 2022[104]

Table 87: Wildfire Vulnerable Populations

County	Families in Poverty	People with Disabilities	People over 65	Difficulty with English	Households with no Vehicle	Mobile Homes
Marion	5.3%	14.6%	17.8%	0.3%	4.5%	5.1%

Source: Wildfire Risk to Communities, 2022

[103] United States Department of Agriculture, United States Forest Service. 2022. "Wildfire Risk to Communities." Accessed January 2023. https://wildfirerisk.org/.

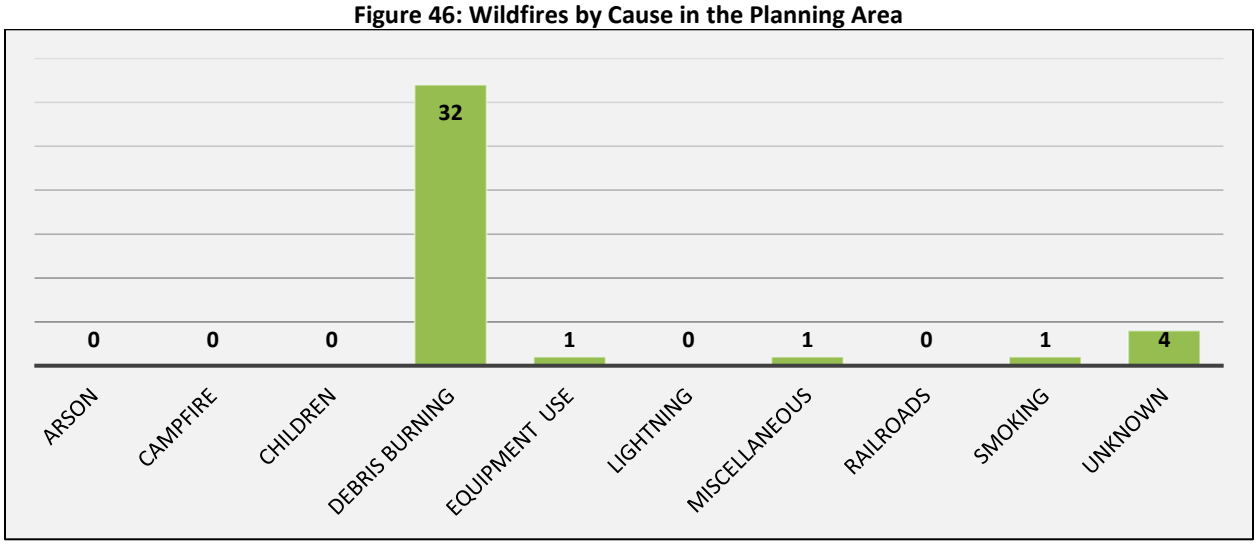
[104] United States Department of Agriculture, United States Forest Service. 2022. "Wildfire Risk to Communities." https://wildfirerisk.org/.

Historical Occurrences

It is important to note that there is no comprehensive wildfire event database. Fire events, magnitude, and local responses were reported voluntarily by local fire departments and local reporting standards can vary between departments. Actual fire events and their impacts are likely underreported in the available data. According to IDNR wildland fire supervisor, fire report data in Marion County reports from 2008 to 2022. Local fire districts reported a total of 39 wildfires during that time that burned a total of 209 acres. The most fires occurred in 2015, with ten of them being handled by Knoxville Rural Fire District. The largest fire reported occurred in 2014 by the Pleasantville Emergency Services and burned 40 acres.

The majority of wildfires in the planning area are caused by debris burning (82%), with equipment use as the second leading cause being unknown (10%) (Figure 46). Wildfires in the planning area have ranged from one to 40 acres, with an average event burning six acres.

Figure 46: Wildfires by Cause in the Planning Area



Source: IDNR Wildland Fire Supervisor (personal correspondence), 2008-2022

Average Annual Damages

No damages were reported by NCEI or from IDNR, so it is not possible to calculate the average annual damages for wildfire. Additionally, no crop damage was reported to the USDA RMA as being caused by wildfires.

Table 88: Wildfire Loss Estimation

Hazard Type	Number of Events[1]	Events Per Year	Total Property Loss[1]	Average Annual Property Loss[1]	Total Crop Loss[2]	Average Annual Crop Loss[2]
Wildfires	39	2.6	N/A	N/A	$0	$0

Source: 1 Indicates data is from IDNR (2008-2022); 2 Indicates data is from USDA RMA (2000-2021)

Extent

For Marion County, the following fire departments reported wildfire events: Indiana Township Fire Department, Knoxville Rural Fire Department, Knoxville Township Fire Department, Pleasantville Emergency Services, and Pleasantville Fire Department. Fire districts respond to both wildfires and structural fires in cities.

As the reported wildfires by department indicates, wildfire is a threat throughout the planning area. Pleasantville Emergency Services has reported the greatest number of fires and the greatest number of acres burned.

Table 89: Reported Wildfires by Fire Department

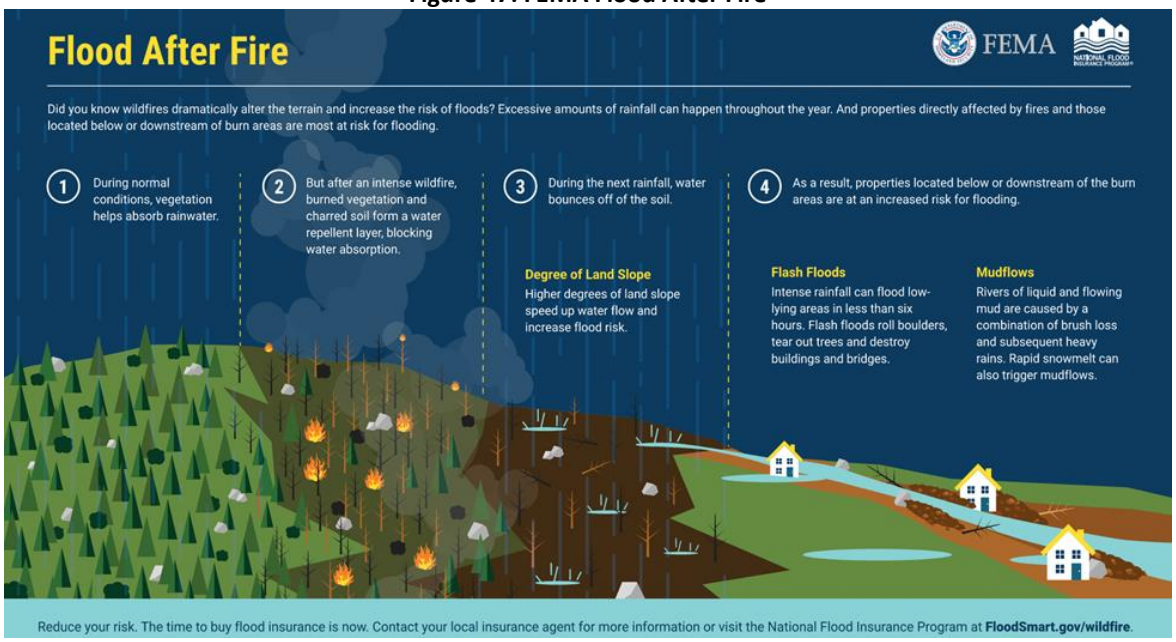
Fire Department	Reported Wildfires	Acres Burned
Indiana Township Fire Department	1	14
Knoxville Rural Fire Department	10	31
Knoxville Township Fire Department	1	2
Pleasantville Emergency Services	12	106
Pleasantville Fire Department	10	44
City of Monroe	1	10
DNR Wildlife	3	N/A
Lovilia	1	2
Total	**39**	**209**

Source: IDNR Fire Supervisor (personal correspondence), 2008-2022

As seen in Table 89 above, wildfires have burned 209 acres of land. In total, there were 39 reported wildfires in the planning area. The largest wildfire burning 40 acres in 2014.

Wildfire also contributes to an increased risk from other hazard events, compounding damages and straining resources. FEMA has provided additional information in recent years detailing the relationship between wildfire and flooding (Figure 47). Wildfire events remove vegetation and harden soil, reducing infiltration capabilities during heavy rain events. Subsequent severe storms that bring heavy precipitation can then escalate into flash flooding, dealing additional damage to jurisdictions.

Figure 47: FEMA Flood After Fire



Source: FEMA, 2020[105]

[105] FEMA and NFIP. 2020. "Flood After Fire." Accessed September 2020. https://www.fema.gov/media-library-data/1573670012259-3908ab0344ff8fbf5d537ee0c6fb531d/101844-019_FEMA_FAF_Infographic-ENG-web_v8_508.pdf.

Climate Change

Rising temperatures will likely increase the frequency and intensity of grass/wildfires. Warmer temperatures cause snow to melt sooner and create drier soils and forests, which can ignite fires quicker and cause them to spread rapidly. Damages caused by wildfires extend past the loss of building stock, recreation areas, timber, forage, wildlife habitat, and scenic views. Secondary effects of wildfires, including erosion, landslides, introduction of invasive species, and changes in water quality, all increase due to the exposure of bare ground and loss of vegetative cover following a wildfire, and can often be more disastrous than the fire itself in long-term recovery efforts. Additionally, warmer nighttime temperatures contribute to the continued spread of wildfires over multiple days.[106] With increased drought conditions, grass/wildfires will also likely increase due to dry vegetation and less access to water. Changes in climate can lead to the spread of invasive species, increasing potential fuel loads in wildland areas. The table below shows the change in wildfire danger days in three-county region with different warming scenarios.

Table 90: Change in Wildfire Danger Days

	Warming Scenarios			
	1° C	1.5° C	2° C	3° C
Change in Wildfire Danger Days	-6 - 6 Days/Year	-6 - 6 Days/Year	7 - 13 Days/Year	14 - 29 Days/Year

Source: Probable Futures[107]

Economic Impacts

Economic impacts from grass and wildland fire would be to crop land, buildings, and power lines. Road closures may occur due to poor visibility or if in the direct line of the fire. However, closures will be heavily dependent on the size, wind direction, and spread of the fire. Power outages from burned poles and downed lines is very likely but would typically only impact small areas. While grass and wildland fires can occur anywhere in the county, the northwestern corner, area sounding Red Rock Reservoir, and southern portion of the county have the highest wildfire risk and therefore are more likely to see economic impacts. FEMA standard values for traffic delays and electric power can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development

Future development in the WUI would increase the number of structures and populations vulnerable to wildfires. Of most concern would be development on the edges of communities or other areas that encroach on wildland or natural areas. Local officials can adopt codes and ordinances that can guide growth in ways to mitigate potential losses from wildfires. These may include more stringent building code standards, setback requirements, or zoning regulations. Additionally, it is advisable to enact a defensible space ordinance which limits availability of fuel in close proximity to residences. Problems can arise if new development increases without coordinated fuels reduction and the creation of defensible space around homes.

[106] NASA Global Climate Change. September 2019. "Satellite Data Record Shows Climate Change's Impact on Fires." Accessed 2022. https://climate.nasa.gov/news/2912/satellite-data-record-shows-climate-changes-impact-on-fires/.

[107] Probable Futures. "Maps of Dryness". Accessed December 2022. https://probablefutures.org/ .

Probability

The probability of wildfire occurrence is based on the historic record provided by the IDNR and reported potential by participating jurisdictions. With a grass/wildfire occurring in 5 of the 15-year period of record, there is a 33 percent annual probability of grass/wildfires occurring in the county in any given year.

Community Top Hazard Status

No jurisdictions identified Grass and Wildland Fire as a top hazard of concern.

Regional Vulnerabilities

The potential for and magnitude of wildland fires will be exacerbated by periods of drought throughout the year and extreme heat conditions during summer months. Drought has a high probability of occurring in the planning area and the planning area sees, on average, two days above 100°F each year. During a severe drought, dry conditions, and/or windy conditions, large wildfires can more easily spread.

Wildfire poses a threat to a range of demographic groups. Wildfire, wildfire within the WUI, and urban fire could result in major evacuations of residents in impacted and threatened areas. Groups and individuals lacking reliable transportation could be trapped in dangerous locations. Lack of transportation is common among the elderly, low-income individuals, and racial minorities. Wildfires can cause extensive damage to both urban and rural building stock and properties including critical facilities and infrastructure, as well as agricultural producers which support the local industry and economy. Damaged homes can reduce available housing stock for residents, causing them to leave the area. Additionally, fire events threaten the health and safety of residents and emergency response personnel. An increase in air pollutants can occur from the increased number of grass/wildfires. The public can be exposed to harmful particulate matter from smoke and ash that can cause various health issues. Depending on the length of exposure, age, and individual susceptibility, effects from wildfire smoke can range from eye and respiratory irritation to severe disorders like bronchitis, asthma, and aggravation of pre-existing respiratory and cardiovascular diseases.[108] Recreation areas, timber and grazing land, wildlife habitat, and scenic views can also be threatened by wildfires.

Development across the planning area may be located within the WUI, particularly in larger municipalities such as Knoxville or Pella with a larger amount of intermix overlap. Local officials can adopt codes and ordinances that can guide growth in ways to mitigate potential losses from wildfires. These may include more stringent building code standards, setback requirements, or zoning regulations. Other notable vulnerabilities exist for fire departments which service both urban and rural areas as some fire districts lack adequate staff to respond to multi-fire complexes or events in separate areas. The utilization and development of mutual aid agreements or memorandum of understandings are an important tool for districts to share resources and/or coverage.

The following table provides information related to regional vulnerabilities and FEMA's National Risk Index values for Wildfire. For jurisdictional specific vulnerabilities, refer to *Section Seven*.

[108] AirNow. 2019. "Wildfire Smoke: A Guide for Healthcare Professionals." Accessed 2022. https://www.airnow.gov/wildfire-smoke-guide-publications/

Table 91: Regional Wildfire Vulnerabilities

SECTOR	VULNERABILITY
People	-Risk of injury or death for residents and firefighting personnel -Displacement of people and loss of homes -Lack of transportation poses risk to low-income individuals, families, and elderly -Transportation routes may be blocked by fire, preventing evacuation efforts
Economic	-Damages to buildings and property can cause significant losses to business owners -Loss of businesses
Built Environment	-Property damages
Infrastructure	-Damage to power lines and utility structures -Potential loss of firefighting equipment and resources
Critical Facilities	-Risk of damages
Climate	-Changes in seasonal temperature and precipitation normals can increase frequency and severity of wildfire events -Changes in climate can help spread invasive species, changing potential fuel loads in wildland areas
National Risk Index Values	Risk Index – Very Low Expected Annual Loss – Very Low
Other	-Increased chance of landslides, erosion, and land subsidence -May lead to poor water quality -Post fire, flash flooding events may be exacerbated.

Source: FEMA National Risk Index, 2022

Hazardous Materials Release

(*Includes Radiological Releases*)

The following description for hazardous materials is provided by the Federal Emergency Management Agency (FEMA):

> *Chemicals are found everywhere. They purify drinking water, are used in agriculture and industrial production, fuel our vehicles and machines, and simplify household chores. But chemicals also can be hazardous to humans or the environment if used or released improperly. Hazards can occur during production, storage, transportation, use, or disposal. The community is at risk if a chemical is used unsafely or released in harmful amounts.*

Hazardous materials in various forms can cause fatalities, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are used and stored in homes routinely. Chemicals posing a health hazard include carcinogens, toxic agents, reproductive toxins, irritants, and many other substances that can harm human organs or vital biological processes.

Chemical manufacturers are one source of hazardous materials, but there are many others, including service stations, hospitals, and hazardous materials waste sites. Varying quantities of hazardous materials are manufactured, used, or stored at an estimated 4.5 million facilities in the United States—from major industrial plants to local dry-cleaning establishments or gardening supply stores.

Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. Hazardous material incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale releases of chemical, biological or radiological materials. Hazardous materials incidents generally involve releases at fixed-site facilities that manufacture, store, process or otherwise handle hazardous materials or along transportation routes such as major highways, railways, navigable waterways, and pipelines.

Fixed sites are those that involve chemical manufacturing sites and stationary storage facilities. The Environmental Protection Agency (EPA) requires the submission of the types and locations of hazardous chemicals being stored at any facility within the state over the previous calendar year. This is completed by submitting a Tier II form to the EPA as a requirement of the Emergency Planning and Community Right-to-Know Act of 1986. Likewise, the U.S. Department of Transportation, through the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA), has broad jurisdiction to regulate the transportation of hazardous materials, including the discretion to decide which materials shall be classified as hazardous. These materials are placed into one of nine hazard classes based on their chemical and physical properties. The hazard schedules may be further subdivided into divisions based on their characteristics. Because the properties and characteristics of materials are crucial in understanding the dynamics of a spill during a transportation incident, it is important for response personnel to understand the hazard classes and their divisions.

Radiological incidents occur when radiological material is released from a designated facility or during transit. Facilities or transport containers must meet strict federal regulations; however, during major natural disaster events facilities can be damaged and incidents can occur. The transport of any radioactive material is licensed and regulated by the federal government. When materials are moved across Iowa

highways or rail lines, state officials are notified and provided appropriate escort. Both Low-level and High-level waste may be shipped via highway. Emergency classifications defined by the United States Nuclear Regulatory Commission are divided into four categories: Unusual event, Alert, Site Area Emergency, and General Emergency.

The transportation of hazardous materials is defined by PHMSA as "…a substance that has been determined to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce…" When radiological materials are moved across Iowa highways, state officials are notified, and appropriate escorts are provided. According to PHMSA, hazardous materials traffic in the U.S. now exceeds 1,000,000 shipments per day. Nationally, the U.S. has had 108 fatalities associated with the transport of hazardous materials between 2007 through 2016. While such fatalities are a low probability risk, even one event can harm many people. The table below demonstrates the nine classes of hazardous material according to the 2020 Emergency Response Guidebook.

Table 92: Hazardous Material Classes

CLASS	TYPE OF MATERIAL	DIVISIONS
1	Explosives	Division 1.1 – Explosives which have a mass explosion hazard Division 1.2 – Explosives which have a projection hazard but not a mass explosion hazard Division 1.3 – Explosives which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard Division 1.4 – Explosives which present no significant hazard Division 1.5 – Very insensitive explosives with a mass explosion hazard Division 1.6 – Extremely insensitive articles which do not have a mass explosion hazard
2	Gases	Division 2.1 – Flammable gases Division 2.2 – Non-flammable, non-toxic* gases Division 2.3 – Toxic* gases
3	Flammable liquids (and Combustible liquids)	-
4	Flammable solids; Substances liable to spontaneous combustion; Substances which, on contact with water, emit flammable gases	Division 4.1 – Flammable solids, self-reactive substances and solid desensitized explosives Division 4.2 – Substances liable to spontaneous combustion Division 4.3 – Substances which in contact with water emit flammable gases
5	Oxidizing substances and Organic peroxides	Division 5.1 – Oxidizing substances Division 5.2 – Organic peroxides
6	Toxic Substances and infectious substances	Division 6.1 – Toxic substances Division 6.2 – Infectious substances
7	Radioactive materials	-
8	Corrosive substances	-
9	Miscellaneous hazardous materials/dangerous goods and articles	-

**The words "poison" or "poisonous" are synonymous with the word "toxic".*
Source: Emergency Response Guidebook, 2020[109]

[109] U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration. 2022. "2020 Emergency Response Guidebook." https://www.phmsa.dot.gov/hazmat/erg/emergency-response-guidebook-erg.

Location

Iowa has approximately 4,365 facilities across the state that house hazardous materials according to the Tier II reports submitted to the Iowa Department of Natural Resources. Within Marion County, there are 30 Tier II facilities. These locations are shown in the following figure and a list of hazardous material storage sites can be found in *Section Seven: Community Profiles* for each jurisdiction. Additionally, Marion County is home to a variety of hazardous materials, based on the industries which occur within it. Chemicals are frequently transported through Marion County for both agricultural and industrial uses. These chemicals are transported over highways, pipelines, and rail lines.

Hazardous material releases during transportation primarily occur on major transportation routes as identified in (Figure 49). Railroads providing service through the planning area have developed plans to respond to chemical releases along rail routes. A large number of spills also typically occur during the loading and unloading of chemicals for highway and pipeline chemical transport. Transportation corridors in the planning area are primarily State Highways.

According to PHMSA, there are several gas transmission and hazardous liquid pipelines located in the planning area. A map of the pipelines and incidents from PHMSA for Marion County can be seen below (Figure 50).[110] According to the U.S. Energy Information Administration (EIA) there is the one natural gas pipelines that run through the county. [111] There is one nuclear power plant within Iowa's borders, the Duane Arnold Energy Center, but it is in Linn County and is over 50 miles away from Marion County (Figure 51).

Iowa has established a Weapons of Mass Destruction (WMD)/HazMat team to provide statewide coverage for identifying, assessment and support of render-safe procedures involving explosive devices and those that may contain chemical, biological, radioactive, nuclear, or explosive (CBRNE) materials. The team is made up of personnel from Council Bluffs, Davenport, and Des Moines and helps enhance the capabilities of existing fire department hazmat teams across the state.[112]

[110] Pipeline and Hazardous Materials Safety Administration. 2022. "National Pipeline Mapping System." https://www.npms.phmsa.dot.gov/ .

[111] U.S. Energy Information Administration. 2022. "Maps – Crude Oil Pipelines, Natural Gas Interstate and Intrastate Pipelines, Petroleum Products Pipelines." https://www.eia.gov/maps/layer_info-m.php

[112] HSEMD. 2020. "Iowa's Emergency Response Teams." https://homelandsecurity.iowa.gov/programs/special-teams/.

Figure 48: Fixed Chemical Sites in the County

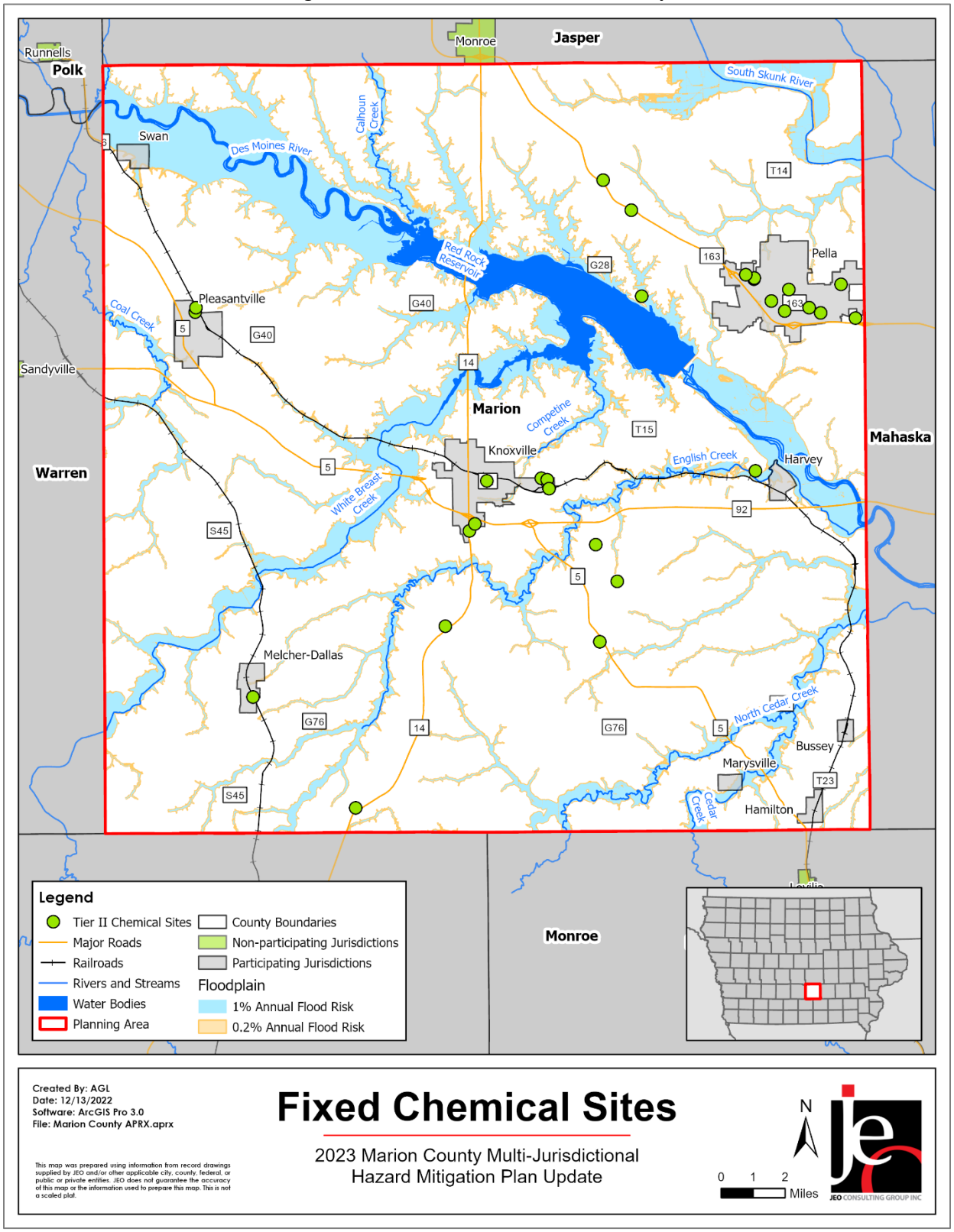


Figure 49: Major Transportation Routes with Half Mile Buffer

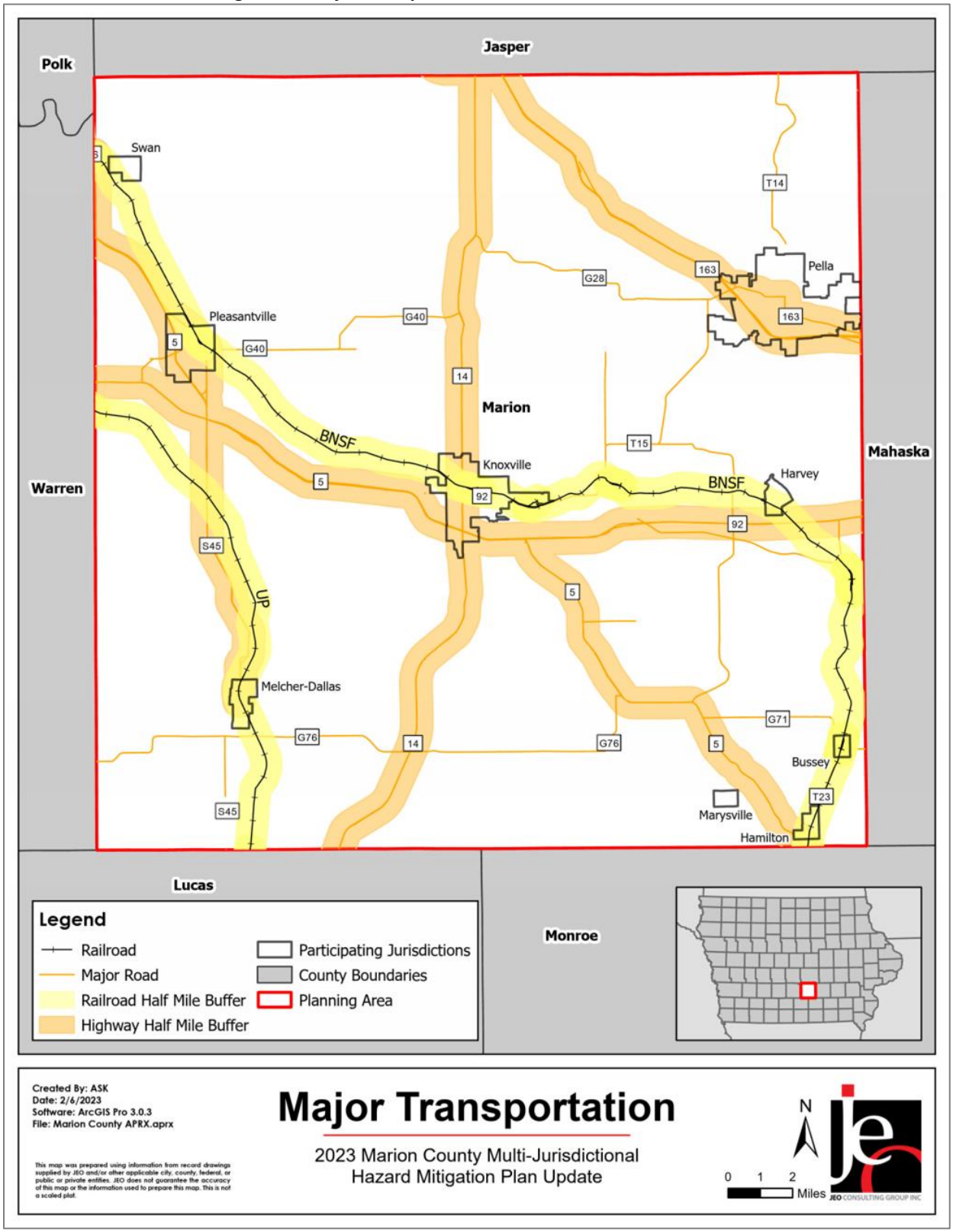
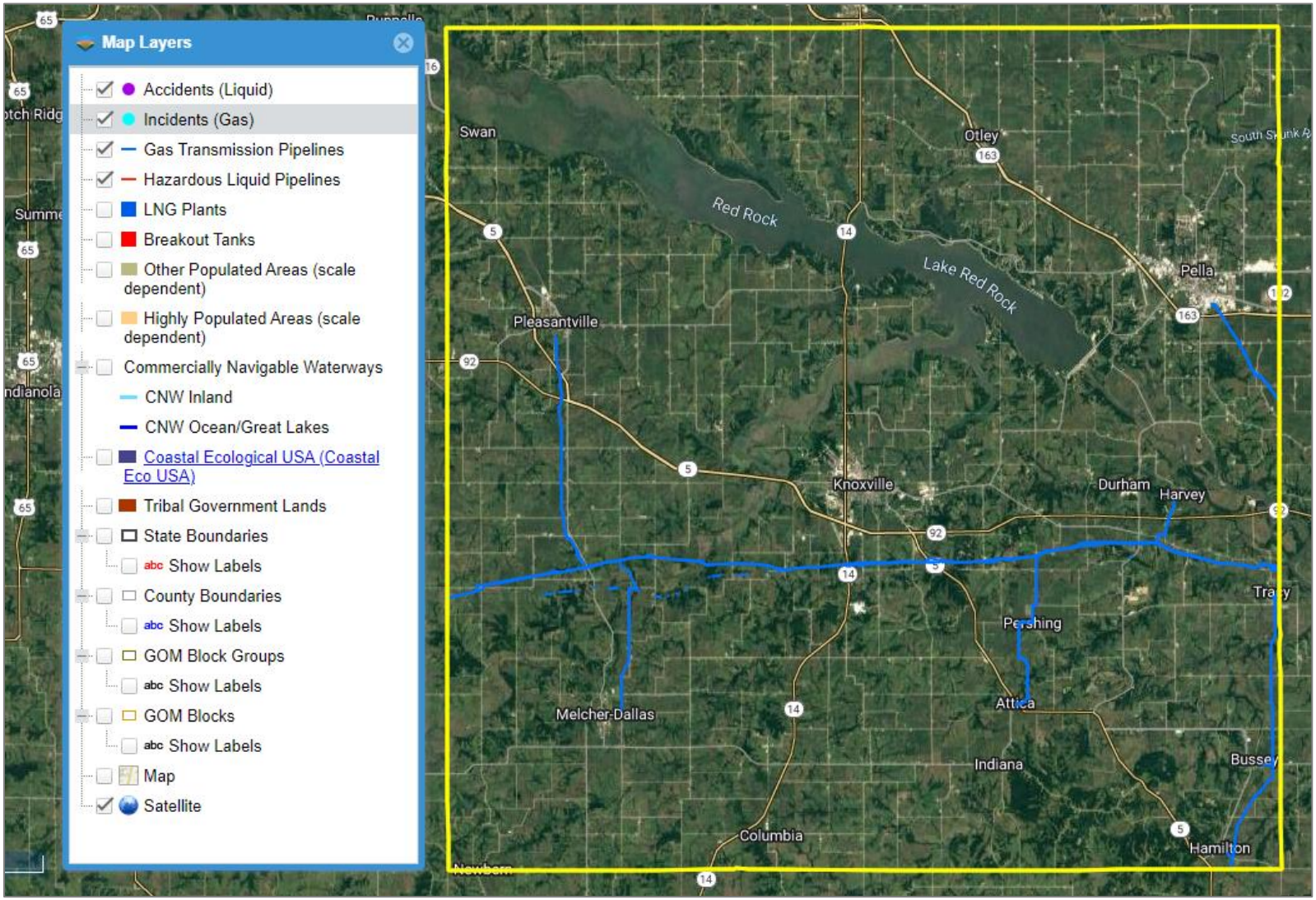
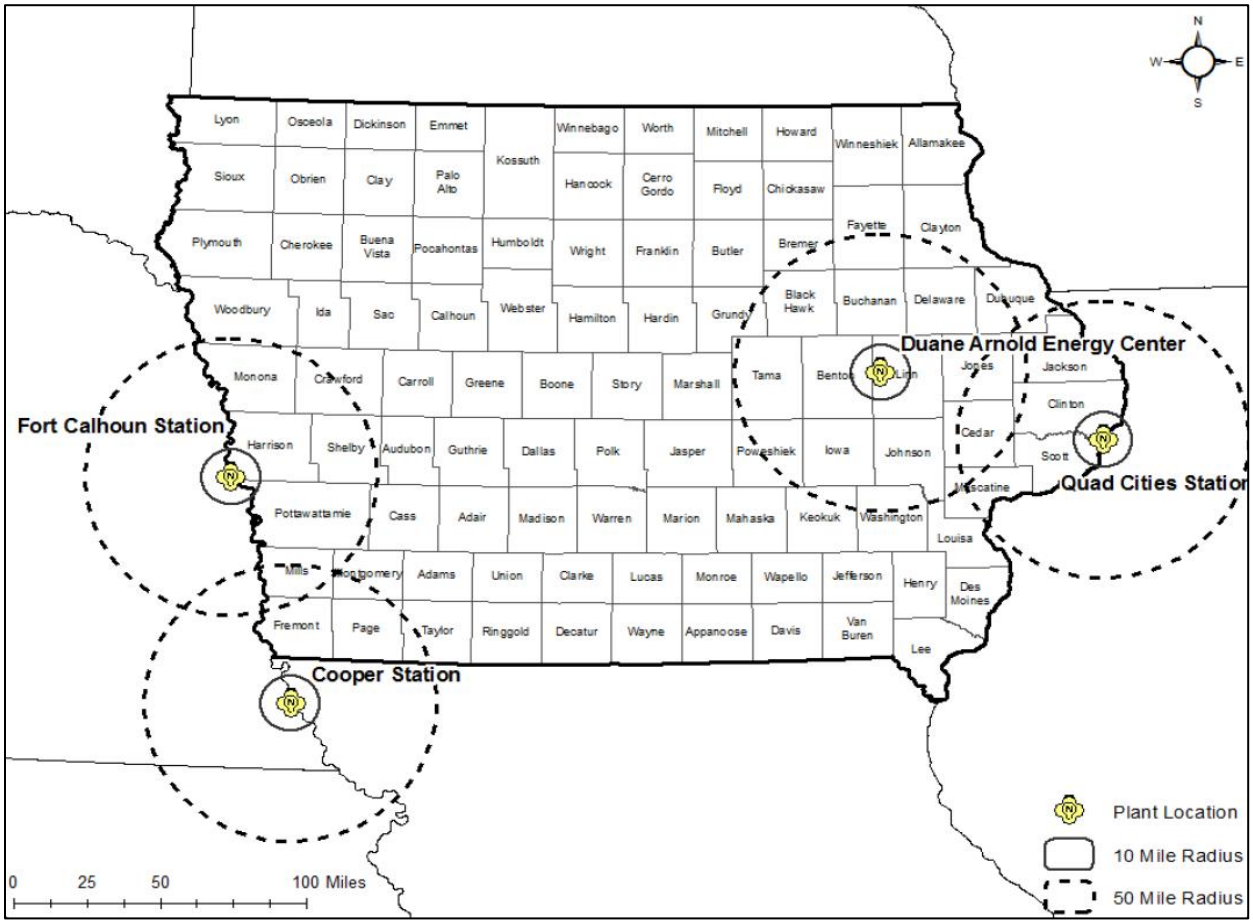


Figure 50: Marion County Public Pipeline Viewer Map



In 1984, 641 Iowa Administrative Code, Chapter 136C was amended to give the Governor authority to enter into an agreement with the U.S. Nuclear Regulatory Commission (NRC) to regulate the use of all radioactive materials in Iowa. There is one radiological fixed site in Iowa, the Duane Arnold Energy Center Plant in Linn County. The Fort Calhoun Station and Cooper Station are located in Nebraska and the Quad Cities Station located on the eastern border of Iowa within Illinois. Marion County is located closest to the Duane Arnold Energy Center but is outside of the 50-mile radius from any station.

Figure 51: Iowa Nuclear Power Impact, 2018

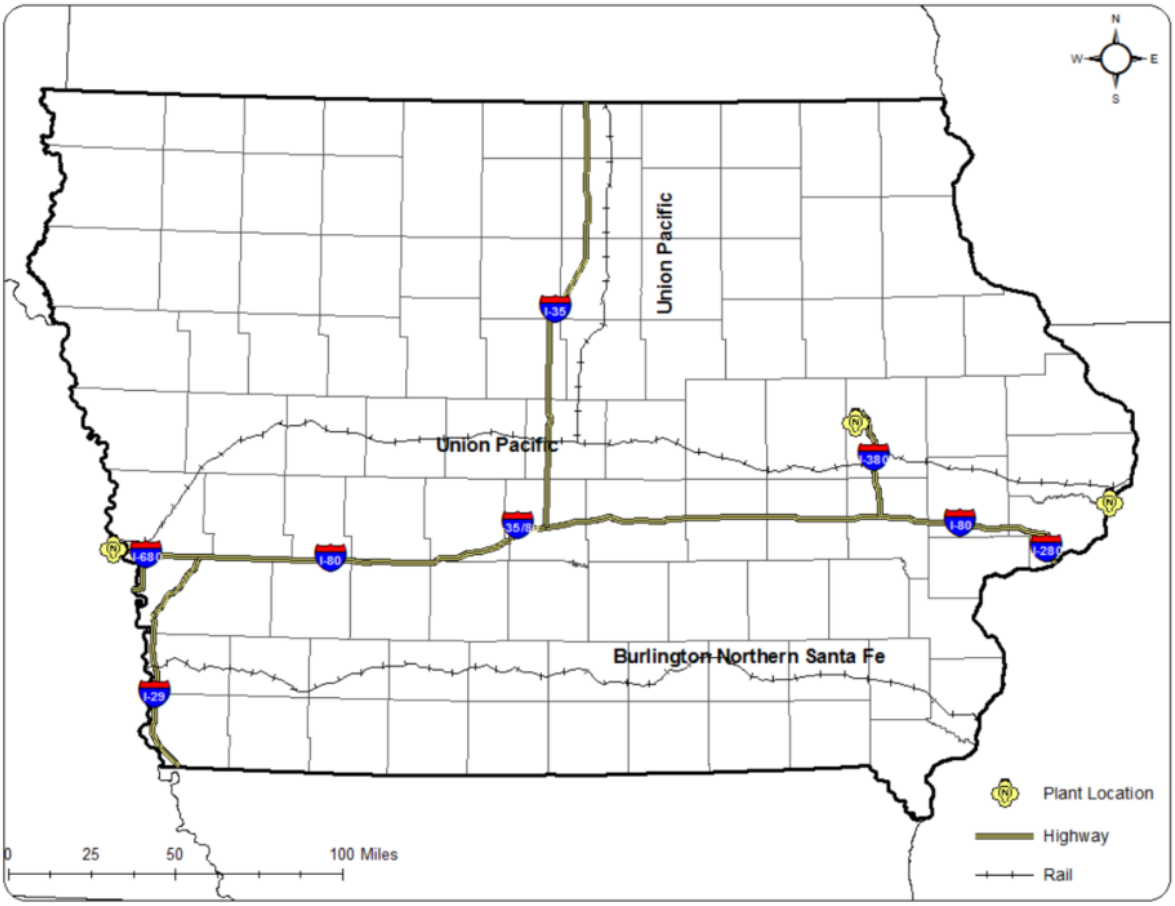


Source: Iowa Hazard Mitigation Plan, 2018

There are no specific major highways or railroads in Marion County which have been identified as major thoroughfares for nuclear waste (Figure 52).

Figure 52: Nuclear Waste Transport Routes

Potential Transportation Routes for Nuclear Waste. Source: Nevada Agency for Nuclear Projects



Source: Iowa Hazard Mitigation Plan, 2018

Historical Occurrences

Fixed Site Spills

According to the U.S. Coast Guard's National Response Center database (NRC), there have been 25 fixed site chemical spills from 1990 to 2022 in the planning area. There was one event with property damages reported, one event with three injuries, and one event with 15 evacuations. The following table displays the larger spills or spills which caused damages that have occurred throughout the planning area (>500 gallons).

Table 93: Large Fixed Site Chemical Spills

Date	Location of Release	Quantity Spilled	Material Involved	Number of Injuries	Property Damage
1993	Knoxville	500 gallons	Glycol Ether	0	$0
1998	Knoxville	500 lbs.	Nitrogen Dioxide	0	$0
		500 lbs.	Xylene	0	$0
		5,000 lbs.	Sulfur Dioxide	0	$0
		15,000 lbs.	Toluene	0	$0
2000	Pella	500 gallons	Xylene	0	$0

Date	Location of Release	Quantity Spilled	Material Involved	Number of Injuries	Property Damage
2001	Knoxville	Unknown	Unknown	3	$0
2010	Knoxville	Unknown	Natural Gas	0	$200,000

Source: National Response Center, 1990- 2022

Transportation Spills

According to PHMSA, six hazardous materials releases occurred during transportation in the planning area between 1971 and 2022. During these events, there were no evacuations, injuries, or fatalities; however, the spills cost a total of $885,874 in damages. The following table provides historical transportation chemical spills.

Table 94: Chemical Transportation Spills

Date of Event	Location of Release	Failure Description	Material Involved	Mode	Injuries or Fatalities	Total Damage
11/12/1991	Knoxville	Unknown	11LGA Acid	Highway	-	$100
1/17/1992	Bussey	Vehicle Accident, Punctured	7,000 LGA Gasoline with Ethyl Alcohol	Highway	-	$231,500
6/17/1999	Knoxville	Unknown	30 LGA Fuel Oil	Highway	-	$215
4/18/2001	Bussey	Derailment, Puncture	13,067 LGA Fuel Oil	Rail	-	$653,359
4/24/2001	Knoxville	Loose Closure	40 LGA Fuel Oil	Rail	-	$700
3/27/2008	Pella	Unknown	2 SLB Solid N.O.S.	Highway	-	$0

Source: PHMSA, 1971-2022

Radiological Incidents

There have been no incidents reported in the planning area or the state. Radiological transport incidents are the most common type of incident due to sheer volume of shipments made; however, there have been no events that have required assistance beyond what is considered regular roadside services. Further, the transportation of radiological materials is heavily regulated and monitored. There are other plans across the state that have thoroughly addressed this threat.

Average Annual Damages

There have been 25 fixed site spills in the planning area reported from the NRC and six transportation spills as reported by PHMSA. Neither the NRC nor PHMSA track crop losses from chemical spills. These events reported $1,085,874 in property damages. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life.

Table 95: Hazardous Materials Release Loss Estimate

Hazard Type	Number of Events	Events Per Year	Injuries	Total Evacuated	Total Damages	Average Annual Loss
Hazardous Materials Release (Fixed Site)	25	0.8	3	15	$200,000	$6,061
Hazardous Materials Release (Transportation)	6	0.12	0	0	$885,874	$17,036

Source: National Response Center, 1990-2022; PHMSA, 1971-2022

Extent

The extent of chemical spills at fixed sites varies and depends on the type of chemical that is released. The probable extent of chemical spills during transportation is difficult to anticipate and depends on the type and quantity of chemical released. In total 25 fixed site releases have occurred in the planning area[113], and the total amount spilled ranged from five gallons to 500 gallons and half a pound to 15,000 pounds of product. Of the chemical spills, one spill led to the evacuation of 15 employees and a separate spill caused injury to three individuals.

In total, six releases have occurred during transportation in the county. Transportation spills ranged from 11 liquid gallons of material released to 13,067 liquid gallons released. No events led to evacuations, injuries, or fatalities. Based on historic records, it is likely that any spill involving hazardous materials will not affect an area larger than a quarter mile from the spill location.

Climate Change

Climate trends are not anticipated to have a direct impact on hazardous materials releases. However, as events continue to impact infrastructure used by and for hazardous materials, future spills will likely occur. For example, flooding is likely to increase, which could damage roadways and pipelines causing more spills to occur.

Economic Impacts

Transportation is the most likely sector to see economic impacts from a hazardous materials release. During a chemical spill nearby roads may be partially or fully closed until the spill has been cleaned up and the area is deemed safe. For most releases, delays will be minimal with nearby alternate routes available. However, if a large spill were to occur on one of the state highways, delays and closures could last longer. Since many transportation spills occur during vehicle accidents, delays may take longer as the crashes get cleaned up as well. FEMA standard values for traffic delays can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development

To reduce the risk to people and property damage, future development should encourage chemical storage and manufacturing facilities to be built away from critical facilities such as hospitals, schools, daycares, nursing homes, and other residential areas. Likewise, development and critical facilities should be built away from major transportation corridors used for chemical transport. Specific vulnerabilities exist for critical facilities or vulnerable population centers (schools, daycares, hospital, etc.) which are most heavily populated during the daytime as most chemical transportation incidents occur during the weekday daytime hours.

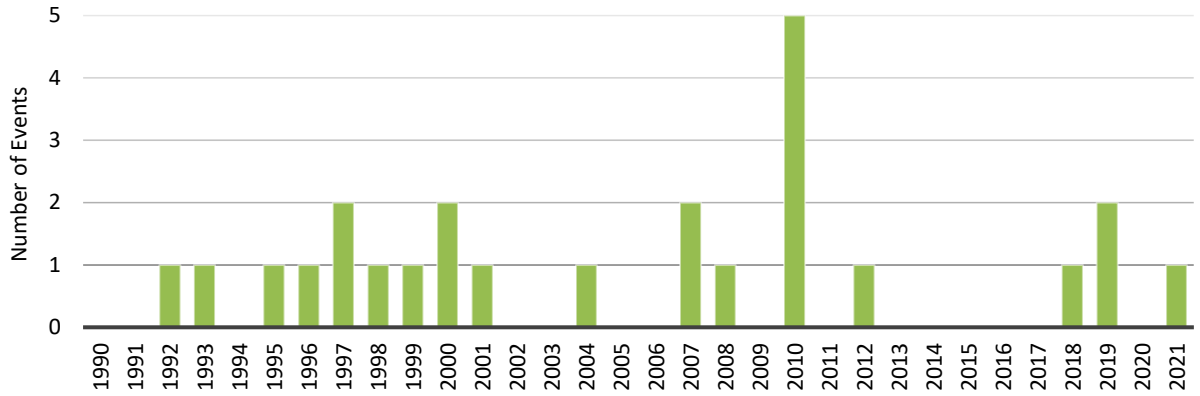
[113] U.S. Coast Guard National Response Center. 2022. "Chemical Pollution and Railroad Incidents, 1990-2022.". http://nrc.uscg.mil/.

Probability

Given the historic record of occurrence for fixed chemical spill events (at least one chemical spill reported in 17 of 33 years), for the purposes of this plan, the annual probability of a fixed chemical spill is 52 percent. Given the historic record of occurrence for chemical transportation spill events (five out of 52 years with a reported event), for the purposes of this plan, the annual probability of chemical transportation occurrence is 10%.

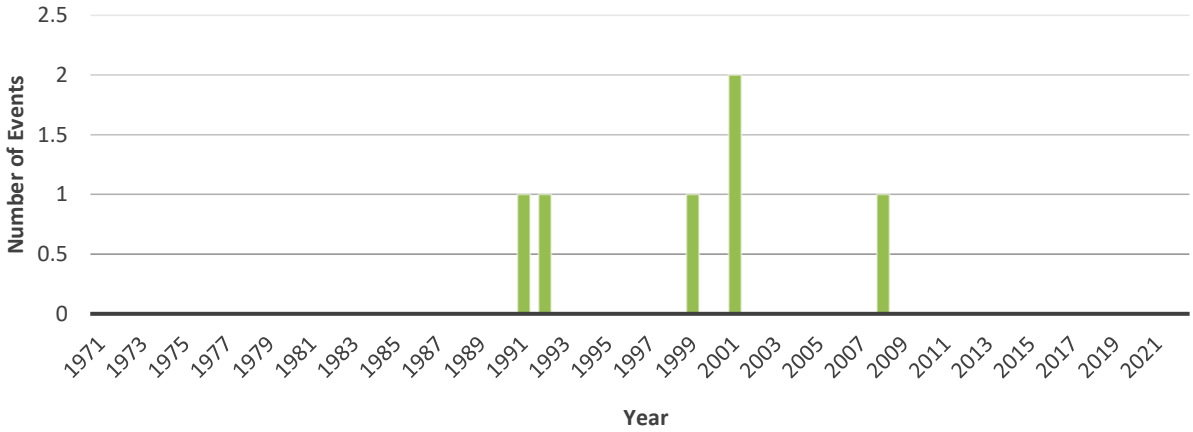
No nuclear plant evacuations or incidents have occurred which have impacted Marion County. As the county is outside the localized evacuation extent (i.e. 10-mile radius) and the greater evacuation extent (50-mile radius) it is unlikely such an event would directly impact the planning area. If an event were to occur at the Duane Arnold Energy Center station, the surrounding radius may not be affected depending on the type of accident and the weather conditions.

Figure 53: Chemical Fixed Site Spills by Year



Source: National Response Center, 1990-2022

Figure 54: Chemical Transportation Spills by Year



Source: PHMSA, 1971-2022

Community Top Hazard Status

The following jurisdictions identified Hazardous Materials Releases as a top hazard of concern:

- Marion County

- City of Knoxville
- City of Melcher-Dallas
- City of Pleasantville
- Melcher-Dallas School District

Regional Vulnerabilities

The following table summarizes regional vulnerabilities; for jurisdictional-specific vulnerabilities, refer to *Section Seven: Community Profiles*.

Table 96: Regional Hazardous Materials Release Vulnerabilities

SECTOR	VULNERABILITY
People	-Those in close proximity could have minor to severe health impacts -Possible evacuation -Hospitals, nursing homes, and the elderly at greater risk due to low mobility
Economic	-A chemical plant shutdown in smaller communities would have significant impacts on the local economy -Evacuations and closed transportation routes could impact businesses near spill
Built Environment	-Risk of fire or explosion
Infrastructure	-Transportation routes can be closed during evacuations or cleanup
Critical Facilities	-Risk of fire, explosion, or other damages -Risk of evacuation
Climate	-More extreme weather events and flood events put sites at risk of flooding at greater risk

Human Infectious Diseases

According to the World Health Organization (WHO), a public health emergency is:

> *"an occurrence or imminent threat of an illness or health condition, caused by bio terrorism, epidemic or pandemic disease, or (a) novel and highly fatal infectious agent or biological toxin, that poses a substantial risk of a significant number of human fatalities or incidents or permanent or long-term disability" (WHO, 2001). The declaration of a state of public health emergency permits the governor to suspend state regulations and change the functions of state agencies.*[114]

The Iowa Hazard Mitigation Plan defined a human disease incident as "a medical, health, or sanitation threat to the general public, including contamination, epidemics, plagues, or infestations".

The number of cases that qualifies as a public health emergency depends on several factors including the illness, its symptoms, ease in transmission, incubation period, and available treatments or vaccinations. With the advent of sanitation sewer systems and other improvements in hygiene since the 19th century, the spread of infectious disease has greatly diminished. Additionally, the discovery of antibiotics and the implementation of universal childhood vaccination programs have played a major role in reducing human disease impacts. Today, human disease incidences are carefully tracked by the Centers for Disease Control and Prevention (CDC) and state organizations for possible epidemics and to implement control systems. Novel illnesses or diseases have the potential to develop annually and significantly impact residents and public health systems.

Some of the best actions or treatments for public health emergencies are nonpharmaceutical interventions (NPI). These are readily available behaviors or actions, and response measures people and communities can take to help slow the spread of respiratory viruses such as influenza. Understanding NPIs and increasing the capacity to implement them in a timely way, can improve overall community resilience during a public health emergency. Using multiple NPIs simultaneously can reduce influenza transmission in communities even before vaccination is available.[115]

Pandemics are global or national disease outbreaks. These types of illnesses, such as influenza, can easily spread person-to-person, cause severe illness, and are difficult to contain. An especially severe pandemic can lead to high levels of illness, death, social disruption, and economic turmoil. Past pandemic events include:

- 1918 Spanish Flu: the H1N1 influenza virus spread world-wide during 1918 and 1919. It is estimated that at least 50 million people worldwide died during this pandemic with about 675,000 deaths alone in the United States. No vaccine was ever developed, and control efforts included self-isolation, quarantine, increased personal hygiene, disinfectant use, and social distancing.

[114] World Health Organization. 2008. Accessed April 2020. "Glossary of humanitarian Terms." https://www.who.int/hac/about/definitions/en/.
[115] U.S. Department of Health and Human Services. 2017. "Pandemic Influenza Plan: 2017 Update." https://www.cdc.gov/flu/pandemic-resources/pdf/pan-flu-report-2017v2.pdf.

- 1957 H2N2 Virus: a new influenza A virus emerged in Eastern Asia and eventually crossed into coastal U.S. cities in summer of 1957. In total 1.1 million people worldwide died of the flu with 116,000 of those in the United States.

- 1968 H3N2 Virus: an influenza A virus discovered in the United States in September 1968 which killed over 100,000 citizens. The majority of deaths occurred in people 65 years and older.

- 2009 H1N1 Swine Flu: a novel influenza A virus discovered in the United States and spread quickly across the globe. This flu was particularly prevalent in young people while those over 65 had some antibody resistance. The CDC estimated the U.S. had over 60.8 million cases and 12,469 deaths.

- 2019 COVID-19: the novel influenza A virus which originated in Wuhan China and spread globally. As of February 2, 2021, the CDC reported over 78,900,375 cases and 950,112 deaths attributed to COVID-19 in the United States. Efforts to control and limit the virus included self-isolation, quarantine, increased cleaning measures, social distancing and vaccinations. Significant impacts to the national and global economy have been caused by COVID-19.

The Iowa Department of Public Health requires doctors, hospitals, and laboratories to report on many communicable diseases and conditions to monitor disease rates for epidemic events. Additionally, regional or county health departments monitor local disease outbreaks and collect data relevant to public health. The Marion County Public Health serves all of Marion County.

Location

Human disease outbreaks can occur anywhere in the planning area. Public heath emergencies or pandemic threshold levels are dependent on the outbreak type, transmission vectors, location, and season. Normal infectious disease patterns are changing due to increasing human mobility and climate change. Rural populations are particularly at risk for animal-related diseases while urban areas are at greater risk from community spread type illnesses. All residents throughout the planning area are at risk during public health emergencies. All areas within the planning area experienced impacts from COVID-19 specifically between 2019 and 2022.

Historical Occurrences

Cases and fatalities associated with Human Infectious Diseases vary between illness types and severity of outbreak. Past major outbreaks in Iowa have specifically included the H1N1 Swine Flu in 2009 and COVID-19 in 2020.

- H1N1 Swine Flu (2009) – outbreaks were first reported in mid-April 2009 and spread rapidly. The new flu strand for which immunity was nonexistent in persons under 60 years old was similar in many ways to typical seasonal influenza. Symptoms of H1N1 included fever greater than 100°F, cough, and sore throat. County specific counts of H1N1 are not available, however a total of 92 confirmed cases were reported for Iowa by June 12, 2009.[116] Outbreaks in Iowa were typically seen sporadically. The U.S. Public Health Emergency for the H1N1 Influenza outbreak expired on June 23, 2010. The CDC developed and encouraged all US residents to receive a yearly flu vaccination to protect against potential exposures. The H1N1 continues to appear annually and persons in the planning area are at risk of infection in the future.

[116] Centers for Disease Control and Prevention. June 2009. "Novel H1N1 Flu Situation Update." https://www.cdc.gov/h1n1flu/updates/061209.htm.

- COVID-19 (2020) – In January 2020, the CDC confirmed the first case of COVID-19 in the United States, and it quickly spread across the country. By March 2020, the World Health Organization declared COVID-19 a pandemic and travel bans were instituted around the globe. Primary symptoms of the infection included cough, fever or chills, shortness of breath or difficulty breathing, fatigue, muscle and body aches, headache, loss of taste or smell, sore throat, and others. The first confirmed cases of COVID-19 in the State of Iowa were three residents in Johnson County. Governor Kim Reynolds issued a Public Health Disaster Emergency Proclamation on March 17, 2020, which lasted until February 14, 2022.

The table below displays COVID-19 confirmed cases and deaths as of September 26, 2022 in Marion County. Note that due to health data privacy concerns and political considerations during the COVID-19 pandemic, reported numbers are likely much lower than what actually occurred.

Table 97: COVID-19 Cases in Marion County

POPULATION	TOTAL NUMBER OF TESTS	CONFIRMED CASES	FATALITIES
33,380	9,937	8,784	133

Source: Iowa Department of Public Health, 2022[117]

Average Annual Losses

The national economic burden of influenza medical costs, medical costs plus lost earnings, and total economic burden was $10.4 billion, $26.8 billion, and $87.1 billion respectively in 2007.[118] However, associated costs with pandemic response are much greater. Current estimated costs for COVID-19 in the United States exceed $16 trillion. Specific costs do not include losses from displacement, functional downtime, economic loss, injury, or loss of life. The direct and indirect effects of significant health impacts are difficult to quantify.

Extent

Those most affected by human infectious disease outbreaks are typically the very young, the very old, the immune-compromised, the economically vulnerable, and the unvaccinated. Roughly 23% of the planning area's population is 18 years or younger, and 19% of the planning area is 65 years or older. These factors increase vulnerability to the impacts of outbreaks. It is not possible to determine the extent of individual public health emergency events, as the type and severity of a novel outbreak cannot be predicted. However, depending on the disease type, a significant portion of residents may be at risk to illness or death.

The extent of human infectious diseases is closely tied to the proximity or availability of health centers and services. There are two hospitals in the county and several nursing facilities and health clinics. Immunodeficiency disorders (such as diabetes), obesity, or other pre-existing health complications reduce the ability of the body to fight infection. Diabetes prevalence is slightly lower in Marion County (8.5%) than compared to the State of Iowa (9%). [119]

[117] Iowa Department of Public Health. September 26, 2022. "COVID-19 Reporting". https://idph.iowa.gov/Emerging-Health-Issues/Novel-Coronavirus/COVID-19-Reporting

[118] Molinari, N.M., Ortega-Sanchez, I.R., Messonnier, M., Thompson, W.W., Wortley, P.M., Weintraub, E., & Bridges, C.B. April 2007. "The annual impact of seasonal influenza in the US: measuring disease burden and costs." DOI: 10.1016/j.vaccine.2007.03.046.

[119] Centers for Disease Control and Prevention. 2019. "Diagnosed diabetes prevalence – Iowa." https://gis.cdc.gov/grasp/diabetes/DiabetesAtlas.html.

Iowa Code, Chapter 139a.8(6) and Iowa Administrative Code, 641-7.7(139) outline the immunization requirement for students attending licensed childcare centers and elementary or secondary schools. Requirements are for the following vaccinations: Pneumococcal, diphtheria, pertussis, tetanus, polio, measles, rubella, Hepatitis B, meningococcal, and varicella (chicken pox). The Vaccines for Children program is a federally funded and state-operated vaccine supply program that provides free vaccines to children under 18 who are of American Indian or Alaska Native descent, enrolled in Medicaid, uninsured, or underinsured. Additionally, the HPV vaccination series is recommended for teenagers and influenza vaccinations are recommended yearly for those over six months old. Individuals without vaccinations are at greater risk of contracting diseases or carrying diseases to others.

Climate Change

Shifting climatic conditions can alter the geographic range of disease-carrying insects and pests. Mosquitoes that transmit viruses such as Zika, West Nile, and Dengue may become more prevalent in Nebraska. These types of zoonotic disease may initially spread faster as the local population is not aware of the proper steps to reduce their risk. Rising temperatures will also impact air quality. Harmful air pollutants and allergens increase as temperatures increase. More extended periods of warmth contribute to longer pollen seasons that allow plant spores to travel farther and increase exposure to allergens. More prolonged exposure to allergens can increase the risk and severity of asthma attacks and worsen existing allergies in individuals.[120]

Increasing temperatures, shifting precipitation patterns, and extreme weather events impact water quality throughout the state. With the increasing intensity and frequency of extreme precipitation events, impacts to water systems ultimately threaten human health. Events can lead to flooding and stormwater runoff that can carry pollutants across landscapes and threaten human health by contaminating water wells, groundwater, and other bodies of water. Common pollutants include pesticides, bacteria, nutrients, sediment, animal waste, oil, and hazardous waste.

It is estimated that over the next 30 years, 143 million people are likely to migrate to other areas due to the effects of climate change like increasing sea levels, drought, and other climate disaster events.[121] This global migration could lead to increased public health emergencies as different population groups come more in contact with each other and are exposed to different pathogens.

Economic Impacts

As seen with the COVID-19 pandemic, human disease can have economic impacts on nearly every sector of the economy. A localized community or county outbreak can stress local governments and businesses with employees out sick. However, it is not likely to have large impacts on the cost of shipping, goods, and other raw materials. A large-scale state, national, or global outbreak will see similar stresses with employees out sick but could also see those larger impacts. During the COVID-19 pandemic, costs of raw materials and shipping increased dramatically due to production slowdowns and shutdowns across the globe. This forced many local businesses to increase prices of their products in order to stay viable. Some businesses in the county were forced to close due to increased costs and less customers.

[120] Asthma and Allergy Foundation of America. 2010. “Extreme Allergies and Climate Change.” Accessed 2022. https://www.aafa.org/extreme-allergies-and-climate-change/.

[121] Intergovernmental Panel on Climate Change. 2022. “Climate Change 2022: Impacts, Adaptation and Vulnerability”. https://www.ipcc.ch/report/ar6/wg2/.

IRUA identified human disease as a hazard of concern. The major concern associated with this hazard is if there is an outbreak, such as Covid, it could impact personnel staffing for the district, thereby affecting its ability to operate the water system effectively. With 61 staff members, any significant outbreak that results in a large number of employees being unable to work could cause a major problem for the district.

Future Development

To limit further vulnerability from future human disease events, it is recommended that those involved in public health initiatives continue to emphasize educational materials. The county intends to pursue further training opportunities for first responders. Areas with dramatic increases in development should prioritize the development of adequate health care facilities, staff, and resources. As of 2022, there is a severe lack of adequate staff for public health departments in Marion County.

Probability

There is no pattern as to when public health emergencies will occur. Based on historical records, it is likely that small-scale disease outbreaks will occur annually within the county. However, large scale emergency events (such as COVID-19) cannot be predicted.

Community Top Hazard Status

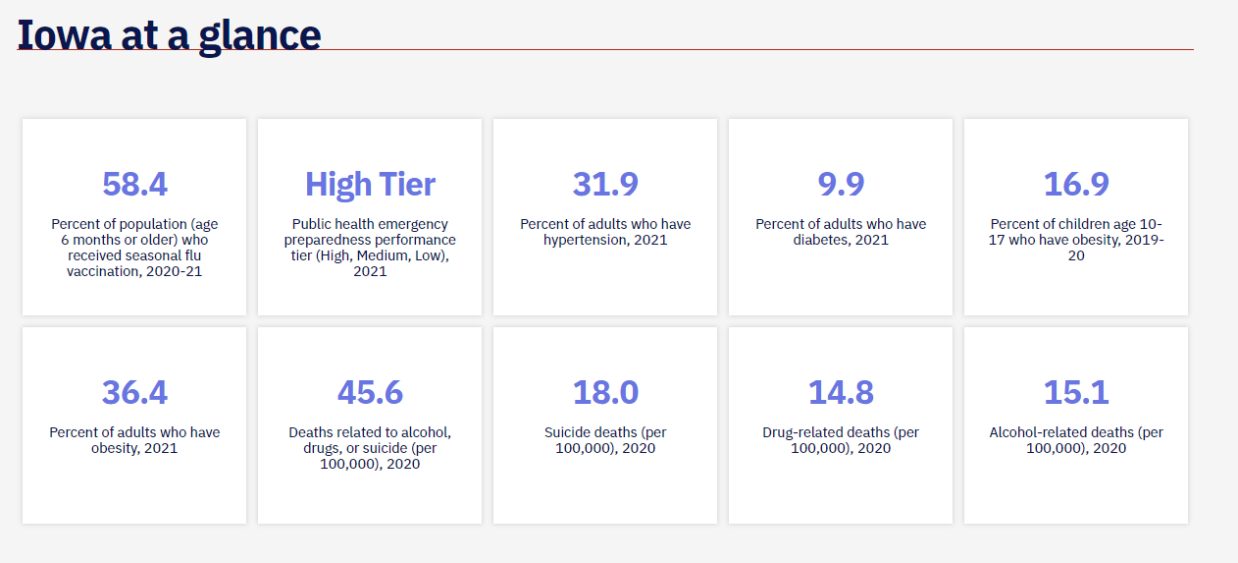
The following jurisdictions identified Human Infectious Disease as a top hazard of concern:

- Marion County

Regional Vulnerabilities

An independent study conducted in 2019 by Trust for America's Health gave Iowa a score of four out of ten for their efforts to reduce vulnerability to the spread of infectious diseases. The report noted: "Iowa's public health outcomes stack up unevenly against those of the United States, and it has not taken several steps that would strengthen its preparedness for public health emergencies. Deaths owed to drug misuse, alcohol, or suicide trail the country as a whole. Its rates of obesity and related conditions indicate a mixed picture, with the percentage of adults with obesity higher than the U.S. median, even as rates of diabetes and hypertension rank in the middle of the pack. Finally, the state achieved a score of four out of a possible 10 measures of public health preparedness for diseases, disasters, and bioterrorism." The following figure describes Iowa's overall statistics.

Figure 55: Trust for America Public Health Statistics



Source: Trust for America's Health, 2019

The following table summarizes regional vulnerabilities; for jurisdictional-specific vulnerabilities, refer to *Section Seven: Community Profiles*.

Table 98: Regional Human Infectious Disease Vulnerabilities

SECTOR	VULNERABILITY
People	-Vulnerable populations include the very young, the very old, the unvaccinated, the economically vulnerable, and those with immunodeficiency disorders.
Economic	-Institutional settings such as prisons, dormitories, long-term care facilities, day cares, and schools are at higher risk to contagious diseases
Built Environment	-Poverty, rurality, underlying health conditions, and drug or alcohol use increase chronic and infectious disease rates
Infrastructure	-Transportation routes may be closed if a quarantine is put in place -Large scale or prolonged events may cause businesses to close, which could lead to significant revenue loss and loss of income for workers
Critical Facilities	-Increased number of unoccupied business structures
Climate	-Spread of insects or pests carrying zoonotic diseases -Increases spread and exposure to allergens and pollutants in air and water

Infrastructure Failure

The Iowa Hazard Mitigation Plan notes a variety of different occurrences which may be classified as infrastructure failure, including communication failure, energy failure, structural failure, and structural fire. The plan goes on to note that one potential cause of infrastructure failure is space weather/solar flares. Any sort of disruption in cell, electric, radio or other service may be considered a form of infrastructure failure. Community infrastructure that provides vital supplies such as electrical and water utilities are also vulnerable to both natural and technological hazards.

Vulnerability can largely be measured as a result of aging infrastructure. According to FEMA's *Strategic Foresight Initiative* published in June 2011, "…infrastructure in the United States is becoming more prone to failure as the average age of structures increases." The publication goes on to state that many necessary updates to infrastructure failure may be considered cost prohibitive due to rising construction costs.

According to the American Society of Civil Engineers' (ASCE) 2019 Infrastructure Report Card, Iowa received an overall grade of C. The Infrastructure Report Card is updated every four years with the goal of depicting the condition and performance of infrastructure systems. The Report Card utilizes letter grades similar to those used for school report cards. Using this classification, an "A" would indicate a state is exceeding expectations; an "F" is failing to meet expectations. Thus, a "C" indicates slightly below expected standards. Specifically, for Iowa, bridges, dams, wastewater, inland waterways, received a below expected score (C- to D-). This is largely consistent with reports from residents and members of the local planning teams.[122]

Location

Infrastructure failure is not correlated to a specific geographic area.

Historical Occurrences

There is no known database for recording infrastructure failure, and thus, previous occurrences may not be calculated.

Average Annual Losses

Due to lack of data, potential losses are not calculated for this hazard.

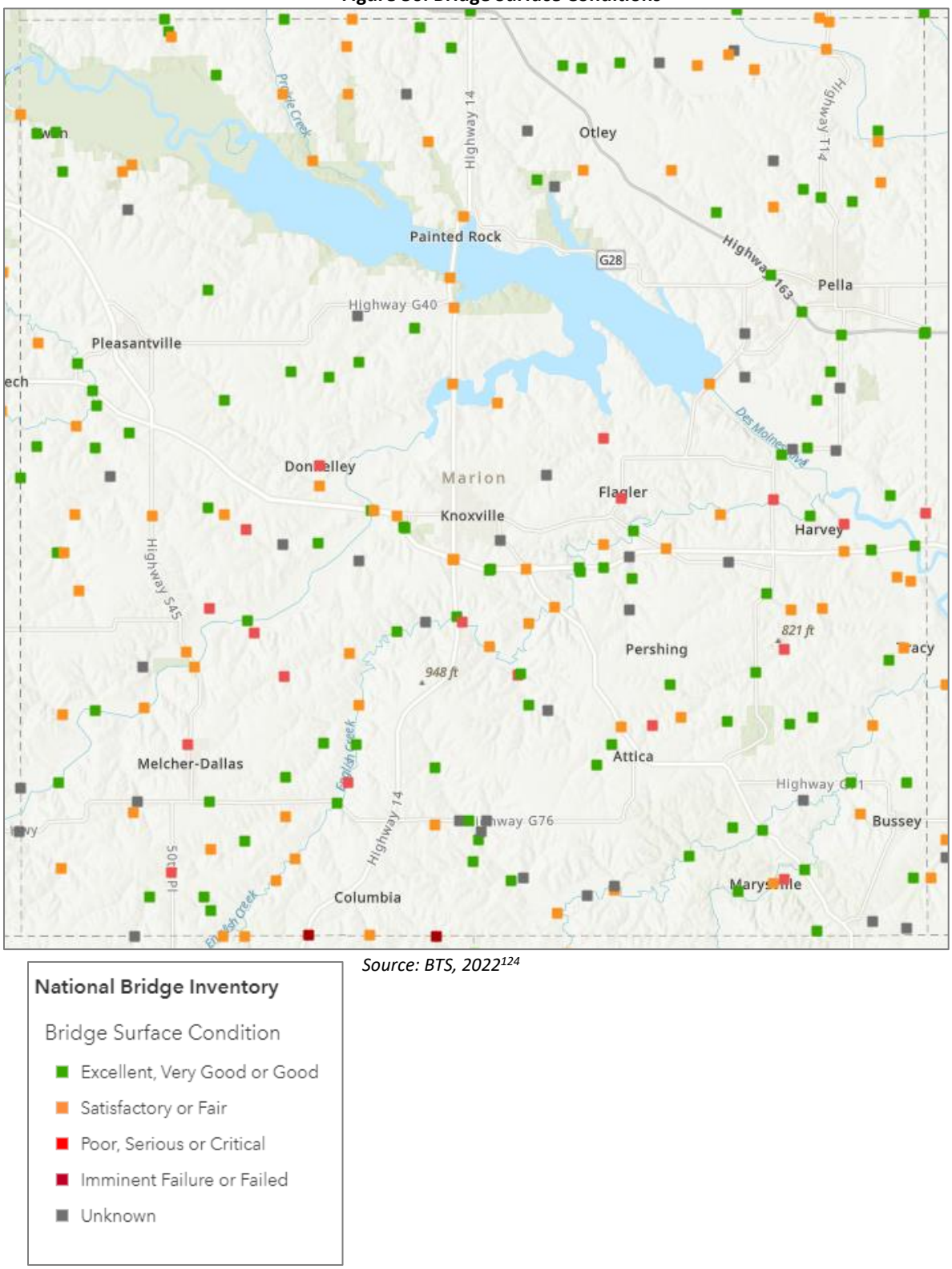
Extent

The extent of infrastructure failure events is hard to quantify given the lack of recorded events. Potential losses will likely be related to aging structures. The BTS National Bridge Inventory displays information describing the location, description, classification, and general condition of bridges located on public roads, such as interstate highways, U.S. highways, state and county roads, and publicly accessible bridges on federal and tribal lands. According to BTS, Marion County has 224 bridges with 23% of those bridges in poor condition and 77% in medium to fair condition.[123] Figure 56 displays the bridge surface conditions for Marion County.

[122] American Society of Civil Engineers. 2019. "2019 Iowa Infrastructure Report Card." https://infrastructurereportcard.org/state-item/iowa/

[123] Bureau of Transportation Statistics. July 2022. "County Transportation Profiles." https://data.bts.gov/Research-and-Statistics/County-Transportation-Profiles/qdmf-cxm3/data

Figure 56: Bridge Surface Conditions



Source: BTS, 2022[124]

[124] Bureau of Transportation Statistics. July 2022. "National Bridge Inventory." https://www.arcgis.com/home/item.html?id=a0fa29a39fe444ac97d4337c569b9801

Climate Change

According to the Fourth National Climate Assessment severe weather is more likely due to climate change. Severe weather events stress emergency production, infrastructure transmission, and transportation. Roads, pipelines, and rail lines are all at risk of damages from flooding, extreme heat, erosion, or added stress from increased residential demands.[125] Critical facilities and vulnerable populations that are not prepared to handle periods of power outages, particularly during heat waves, will be at risk. Increased failures of infrastructure not built to withstand heavy rain, flooding, ice, hail, heavy snowfall, or other severe weather is likely.

Economic Impacts

Infrastructure failure can cause large economic impacts to the county and local communities. Roadway failure is unlikely to cause major delays unless it occurs on one of the state highways the travel through county. This is because the roadway failure will likely be limited to a small area with alternate routes available. Bridge failure could cause longer delays as there may be fewer alternate routes available for people to take. Other infrastructure failure like water lines, sewer lines, power lines, and communication equipment may have larger impacts depending on the population served and redundancies available. FEMA standard values for traffic delays, electric power loss, potable water loss, wastewater loss, and IT/communication loss can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development

To limit vulnerability from infrastructure failure events, it is recommended that aging infrastructure be replaced or updated as communities grow or improve local infrastructure.

Probability

There is no data available that would provide a basis for estimating infrastructure failure in Marion County. However, as infrastructure throughout the county is aging and deteriorating, it is reasonable to assume a failure of some form will occur annually.

Community Top Hazard Status

The following jurisdictions identified Infrastructure Failure as a top hazard of concern:

- City of Melcher-Dallas
- City of Pleasantville

Regional Vulnerabilities

The following table summarizes regional vulnerabilities; for jurisdictional-specific vulnerabilities, refer to *Section Seven: Community Profiles*.

Table 99: Regional Infrastructure Failure Vulnerabilities

SECTOR	VULNERABILITY
People	-Vulnerable populations including the very young and the very old may not have the capability to properly care for their aging private infrastructure
Economic	-Building, bridge, or road closures may cause businesses to close temporarily, which could lead to significant revenue loss and loss of income for workers

[125] USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Report-in-Brief [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 186 pp.

SECTOR	VULNERABILITY
Built Environment	-Aging fixtures such as roofs and siding make buildings vulnerable to failure
Infrastructure	-Aging infrastructure is particularly vulnerable
Critical Facilities	-Critical facilities may close if they are not properly maintained
Climate	-Space weather/solar flares can disrupt cell, electric, and radio services which could result in infrastructure failure - Worsening severe winter storms, severe thunderstorms, and tornadoes can exacerbate this hazard

Landslide

Landslides are the downward and outward movement of slopes with debris. These events include names such as slumps, rockslides, debris slide, lateral spreading, debris avalanche, earth flow, and soil creep. The size of a landslide usually depends on the geology and landslide triggering mechanism. Landslides initiated by rainfall tend to be smaller, while those initiated by earthquakes may be very large. Slides associated with volcanic eruptions can include as much as one cubic mile of material.

Landslides are typically triggered by periods of heavy rainfall or rapid snowmelt. Earthquakes, changes to the local hydrology, removal of vegetation, and excavations may also trigger landslides. Certain geologic formations are more susceptible to landslides than others. Human activities, including locating development near steep slopes, can increase susceptibility to landslide events as well. Landslides on steep slopes are more dangerous because movements can be rapid. Some characteristics that determine the type of landslide are slope of the hillside, moisture content, and the nature of the underlying materials. Slow moving landslides can occur on relatively gentle slopes and can cause significant property damage. However, slow moving landslides are far less likely to result in serious injuries than rapidly moving landslides that can leave little time for evacuation.

Development sites with the greatest risk from landslides are against the base of very steep slopes, in confined stream channels (small canyons), and on fans (rises) at the mouth of these confined channels. Landslides can affect utility services, transportation systems, and critical lifelines. Communities may suffer immediate damages and loss of service. Disruption of infrastructure, roads, and critical facilities may also have a long-term effect on the economy. Utilities, including potable water, wastewater, telecommunications, natural gas, and electric power are all essential community needs. Loss of electricity has the most widespread impact on other utilities and on the whole community. Natural gas pipes may also be at risk of breakage from landslide movements as small as one to two inches.

Roads and bridges are subject to closure during landslide events. Because many of the planning areas rural residents are dependent on roads and bridges for travel to work, delays and detours are likely to have an economic impact. Lifelines and critical facilities should remain accessible, if possible, during a natural hazard event. The impact of closed transportation arteries may increase if the closed road or bridge is a critical lifeline to hospitals or other emergency facilities. Therefore, inspection and repair of critical transportation facilities and routes are essential and should receive high priority. Losses of power and phone service are also potential consequences of landslide events. Due to heavy rains, soil erosion in hillside areas can be accelerated, resulting in loss of soil support beneath high voltage transmission towers in hillsides and remote areas. Flood events can also cause landslides, which can have serious impacts on gas lines.

Location

This hazard is correlated with elevation change; thus, this hazard is more likely to occur in the sloped areas of the county.

Historical Occurrences

According to the USGS Landslide Inventory Map, no recorded landslides occurred in Marion County from 1878 to 2022.[126]

Average Annual Losses

With no historical reported landslide events, it is not possible to calculate average annual losses for property and crops. Any landslides that could occur are likely to have minimal impacts on the built environment.

Extent

Rapidly moving landslides (debris flows and earth flows) present the greatest risk to human life. Persons living in or traveling through areas more prone to rapidly moving landslides should take caution if the conditions warrant. Slow moving landslides can cause significant property damage but are less likely to result in serious human injuries. Landslides can be massive, or they may disturb only a few cubic feet of material. Events in Marion County are likely to cause limited property damage; limited or no deaths and injuries; and little or no impacts to critical facilities and infrastructure. However, single events near populated areas or key infrastructure may have significant impacts.

Climate Change

Landslides are intricately linked to weather and climate. Landslides caused by heavy rainfall occur as the rain water enters a slope and saturates the soil, causing the land to move. The increase in heavy rainfall events may lead to an increase in landslide events as more rainfall saturates slopes and waterlogs the soil. "Researchers have detected a rise in the frequency of landslides in recent decades and this can, at least in part, be linked to climate change."[127]

Economic Impacts

Landslides have the capability to impact roadways, underground pipes, power lines, and buildings. Roadways may become blocked with debris if located below a landslide or can be damaged when the ground below it moves. Delays may occur while debris is moved, or the roadway is repaired and stabilized. However, these impacts will likely be limited to a small area with many alternate routes available. Underground water and wastewater pipes can be damaged and exposed during a landslide event. Power can be lost if power poles are moved during the landslide. Building foundations may also be impacted by the moving soil. FEMA standard values for traffic delays, electric power loss, potable water loss, and wastewater loss can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*. With no historical reported landslide events in the county, any landslides that do occur are likely to be small with minimal economic impacts.

Future Developments

Although landslides are a natural geologic process, the incidence of landslides and their impacts on people can be exacerbated by human activities. Grading for road construction and development can increase slope steepness and decrease the stability of a hill slope by adding weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities affecting landslides include excavation, drainage and groundwater alterations, and changes in vegetation. Future

[126] United States Geological Survey. 2022. "U.S. Landslide Inventory". https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=ae120962f459434b8c904b456c82669d.

[127] Len Williams. 2022. "Climate change and landslides: the slippery slope towards disaster?" https://eandt.theiet.org/content/articles/2022/01/climate-change-and-landslides-the-slippery-slope-towards-disaster/

development could be vulnerable to landslides, as well as the infrastructure required to support this growth, if not accounted for in sitting and design.

Probability

For the purpose of this plan, the probability of landslide will be stated at less than one percent annually as there have been zero recorded by the USGS. Landslides can be sporadic and somewhat unpredictable. These events are more likely to occur in the rural and hilly parts of the county, typically in areas where they won't get recorded. Large mudflows can occur when a relatively common rainfall event happens over a watershed that has been exposed to wildfire. As the vegetation and soil in a burned area recover and the watershed returns to its pre-burn hydrologic condition, the depth and intensity of rainfall necessary to generate a mudflow will generally increase for a given location. However, in the case of a post-wildfire condition and in combination of heavy precipitation, it is more likely that landslides, debris flows, and mudslides will occur more frequently.

Community Top Hazard Status

No jurisdictions identified Landslides as a top hazard of concern:

Regional Vulnerabilities

The following tables provides information related to county vulnerabilities and FEMA's National Risk Index values for Landslides. For jurisdictional specific vulnerabilities, refer to *Section Seven*.

Table 100: Regional Landslide Vulnerabilities

SECTOR	VULNERABILITY
People	-Exposure is more likely to occur driving on roadways and in sloped recreation areas
Economic	-People living in homes located on steep slopes
Built Environment	-First responders in areas that are still geologically unstable
Infrastructure	-Limited loss of accessibility and potential damage to businesses
Critical Facilities	-Damage to roadways and bridges -Damage or breaking of underground utility lines -Power loss from downed lines and towers
Climate	-More extreme weather events, such as severe thunderstorms, severe winter storms, and grass/wildfire events put areas at greater risk to landslides
National Risk Index Values	Risk Index – Relatively Low Expected Annual Loss – Relatively Low

Source: FEMA National Risk Index, 2022

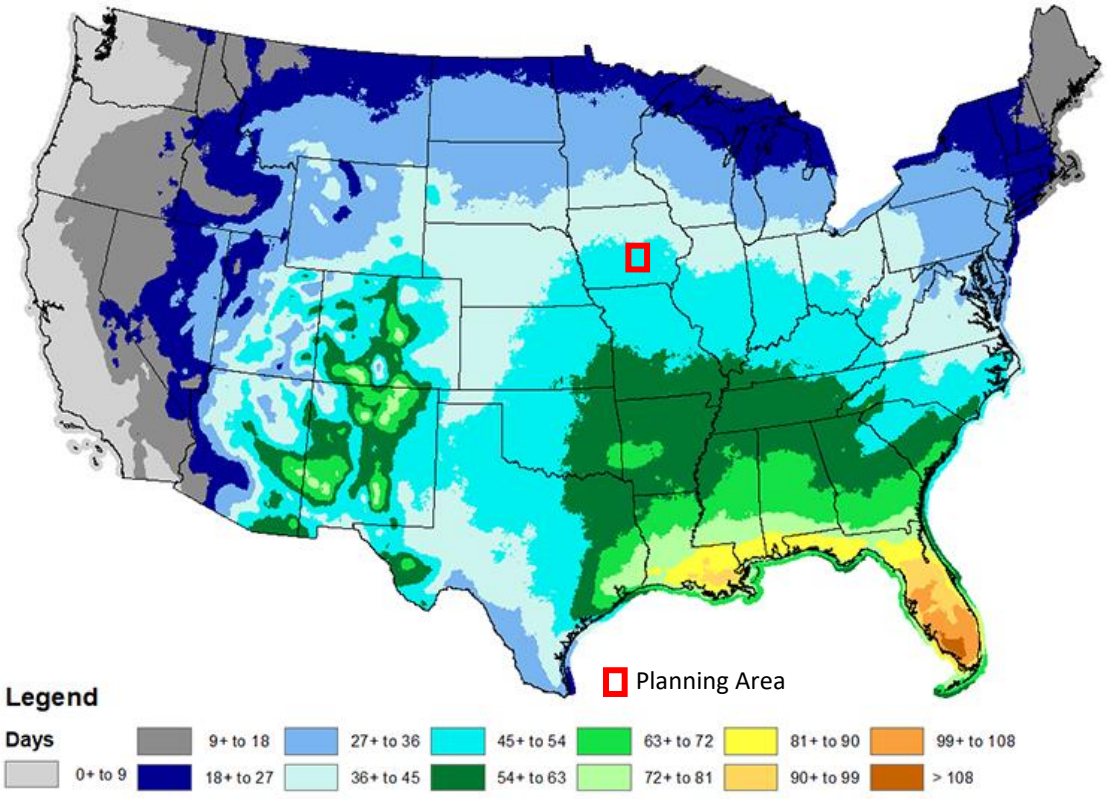
Severe Thunderstorms

(*Includes Hail and Lightning*)

Severe thunderstorms are common and unpredictable seasonal events throughout Iowa. When the cold upper air sinks and the warm, moist air rises, storm clouds or "thunderheads" develop, resulting in thunderstorms. This can occur singularly, in clusters, or in lines. Thunderstorms can develop in fewer than 30 minutes and can grow to an elevation of eight miles into the atmosphere.

Lightning, by definition, is present in all thunderstorms and can cause harm to humans and animals, fires to buildings and agricultural lands, and electrical outages in municipal electrical systems. Lightning generally occurs when warm air mixes with colder air masses resulting in atmospheric disturbances necessary for polarizing the atmosphere. Lightning can strike up to 10 miles away from the rainfall area. There are three primary types of lightning: intra-cloud, inter-cloud, and cloud to ground. While intra and inter-cloud lightning are more common, communities are most impacted when lightning meets the ground. Severe thunderstorms most often occur in Iowa in the spring and summer, during the afternoon and evenings, but can occur at any time. Figure 57 displays the average number of days with thunderstorms across the country each year. The planning area experiences an average of 40 to 50 thunderstorms over the course of one year.

Figure 57: Average Number of Thunderstorms (1993-2018)



Source: NWS, 2018[128]

[128] National Weather Service. 2022. "Introduction to Thunderstorms." https://www.weather.gov/jetstream/tstorms_intro#:~:text=It%20is%20estimated%20that%20there.

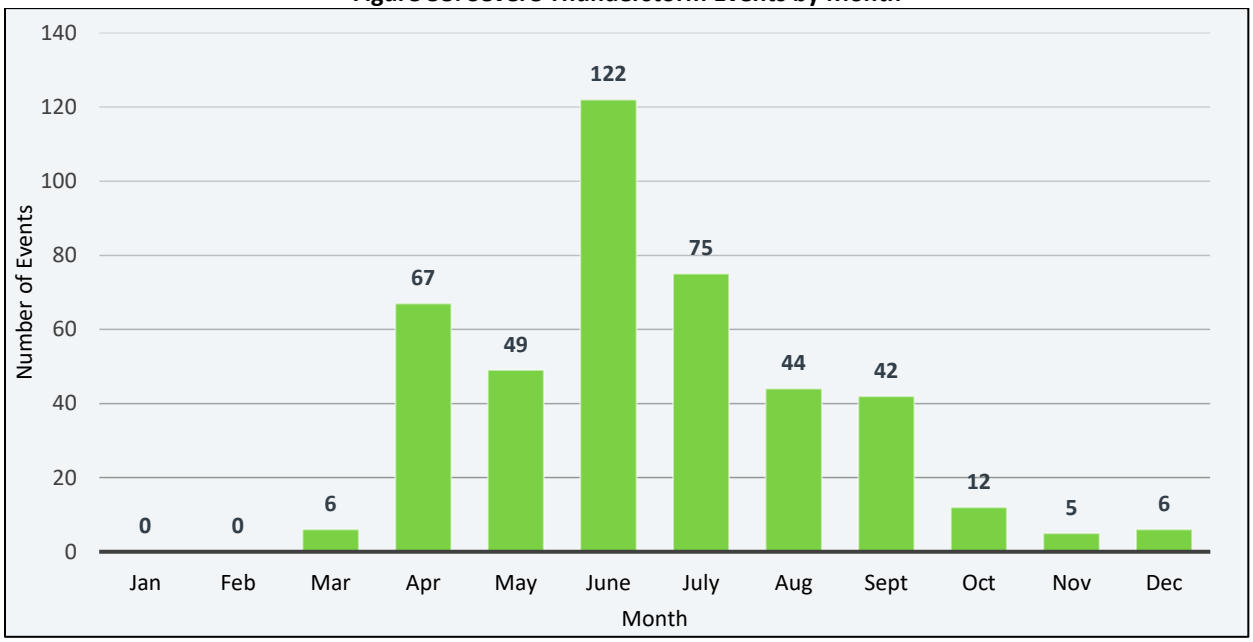
Location

The entire county is at risk of severe thunderstorms and associated damages from heavy rain, lightning, hail, and thunderstorm level wind. Although, these storms occur similarly throughout the planning area, they are more frequently reported in densely settled areas. Additionally, damages are more likely to occur in the densely populated areas.

Historical Occurrences

Severe thunderstorms in the planning area usually occur in the afternoon and evening from June through August (Figure 58).

Figure 58: Severe Thunderstorm Events by Month



Source: NCEI, 1996-2022

The NCEI reports events as they occur in each community. A single severe thunderstorm event can affect multiple communities and counties at a time; the NCEI reports these large scale, multi-county events as separate events. The result is a single thunderstorm event covering the entire region could be reported by the NCEI as several events.

The NCEI reports a total of 424 total severe thunderstorm events. Of those there were:

- Hail 144 events
- Heavy Rain 93 events
- Lightning 6 events
- Thunderstorm Wind 185 events 1 injury

In total these events were responsible for $4,375,000 in property damage. The USDA RMA data does not specify severe thunderstorms as a cause of loss, however heavy rains and hail which may be associated with severe thunderstorms caused $22,844,644 in crop damages. There was one injury reported in association with a thunderstorm wind event in 2019.

A powerful derecho (a long lived and damaging thunderstorm) that occurred on August 10, 2020, was one of the most destructive thunderstorms to ever affect the state. The storm produced widespread winds greater than 100 mph and caused significant damage to millions of acres of corn and soybean crops across central Iowa. Homes, businesses, and vehicles were also severely damaged.

Average Annual Damages

The average damage per event estimate was determined based upon recorded damages from NCEI Storm Events Database since 1996 and number of historical occurrences. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. In general, hail can cause damages to people, the local economy, the built environment, infrastructure, and critical facilities.

In general, assets in the County are vulnerable to severe thunderstorm events, including people, crops, vehicles, and built structures. Most damage seen occurs due to hail or strong thunderstorm winds. People may experience damages due to standing near windows, not seeking adequate shelter, or shattering windshields. Economic losses may be a result of damages to the place of business itself. Hail may damage roofs, siding, windows, gutters, HVAC systems, which all may compromise the built environment. Hail stones may damage power and utility lines, which can be of critical importance, especially in a disaster scenario. Communications equipment and warning transmitters and receivers can also be knocked out by lightning strikes or hail. Additionally, while less likely, lightning strikes may cause a building fire.

Severe thunderstorms have caused over $162,000 per year in property damages and over $1 million per year in crop damages.

Table 101: Severe Thunderstorms Loss Estimate

Hazard Type	Number of Events[1]	Average Events Per Year	Total Property Loss[1]	Average Annual Property Loss	Total Crop Loss[2]	Average Annual Crop Loss
Hail	144	5.3	$755,000	$27,963	$22,844,644	$1,038,393
Heavy Rain	93	3.4	$0	$0		
Lightning	6	0.2	$117,000	$4,333		
Thunderstorm Wind	185	6.9	$3,503,000	$129,741		
Total	**428**	**15.9**	**$4,375,000**	**$162,037**	**$22,844,644**	**$1,038,393**

Source: 1 Indicates data is from NCEI (1996 to 2022); 2 Indicates data is from USDA RMA (2000 to 2021)

Over the 22-year data period associated with insured crop losses, $416,600 in claims were due to hail damages and $22,428,044 due to excessive moisture or precipitation. Together a total of $22,844,644 in claims were paid from 2000-2021, resulting in an annual insured loss of $1,038,393.

Table 102:Annual Losses for Insured Crops Due to Severe Thunderstorms in Marion County

Year	Excessive Moisture or Precipitation	Hail	Year	Excessive Moisture or Precipitation	Hail
2000	$43,456	$3,636	**2011**	$1,741,694	$0
2001	$634,888	$894	**2012**	$33,570	$0
2002	$39,096	$165	**2013**	$909,089	$117,980
2003	$14,920	$0	**2014**	$1,149,115	$58,535

Year	Excessive Moisture or Precipitation	Hail	Year	Excessive Moisture or Precipitation	Hail
2004	$110,972	$2,465	**2015**	$870,225	$0
2005	$16,916	$1,480	**2016**	$45,062	$0
2006	$1,271	$33,449	**2017**	$4,234	$132,079
2007	$151,891	$0	**2018**	$324,017	$0
2008	$5,086,011	$0	**2019**	$1,083,961	$25,006
2009	$657,694	$0	**2020**	$105,538	$38,308
2010	$9,325,356	$796	**2021**	$79,068	$1,807

Extent

The geographic extent of a severe thunderstorm event may be large enough to impact the entire planning area (such as in the case of a squall line, derecho, or long-lived supercell) or just a few square miles, in the case of a single cell that marginally meets severe criteria.

The NWS defines a thunderstorm as severe if it contains hail that is one inch in diameter or capable of wind gusts of 58 mph or higher. The Tornado and Storm Research Organization (TORRO) scale is used to classify hailstones and provides some detail related to the potential impacts from hail. The table below outlines the TORRO Hail Scale.

Table 103: TORRO Hail Scale

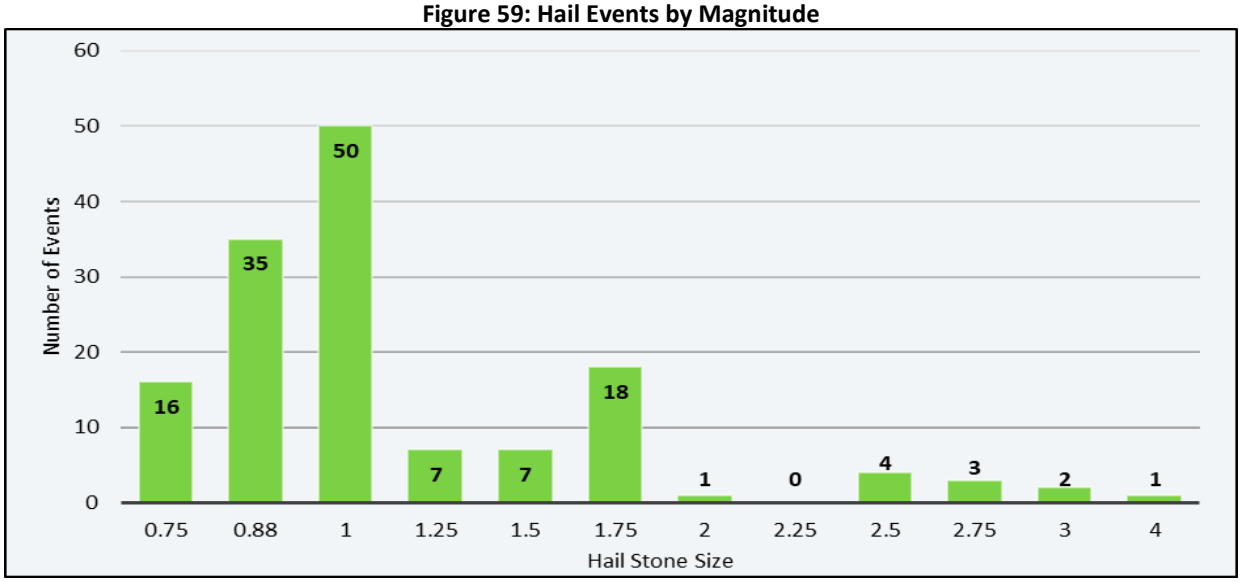
TORRO Classification/Intensity	Typical Hail Diameter	Typical Damage Impacts
H0: Hard Hail	5 mm; (Pea size); 0.2 in	No damage
H1: Potentially Damaging	5 -15 mm (Marble) 0.2 – 0.6 in	Slight general damage to plants and crops
H2: Significant	10 -20 mm (Grape) 0.4 – 0.8 in.	Significant damage to fruit, crops, and vegetation
H3: Severe	20 -30 mm (Walnut) 0.8 – 1.2 in	Severe damage to fruit and crops, damage to glass and plastic structures
H4: Severe	30 -40 mm (Squash Ball) 1.2 – 1.6 in	Widespread damage to glass, vehicle bodywork damaged
H5: Destructive	40 – 50 mm (Golf ball) 1.6 – 2.0 in.	Wholesale destruction of glass, damage to tiled roofs; significant risk or injury
H6: Destructive	50 – 60 mm (Chicken Egg) 2.0 – 2.4 in	Grounded aircrafts damaged; brick walls pitted; significant risk of injury
H7: Destructive	60 – 75 mm (Tennis Ball) 2.4 – 3.0 in	Severe roof damage; risk of serious injuries
H8: Destructive	75 – 90 mm (Large Orange) 3.0 – 3.5 in.	Severe damage to structures, vehicles, airplanes; risk of serious injuries
H9: Super Hail	90 – 100 mm (Grapefruit) 3.5 – 4.0 in	Extensive structural damage; risk of severe or even fatal injuries to persons outdoors

TORRO Classification/Intensity	Typical Hail Diameter	Typical Damage Impacts
H10: Super Hail	>100mm (Melon); >4.0 in	Extensive structural damage; risk of severe or even fatal injuries to persons outdoors

Source: TORRO, 2019[129]

The NCEI reported a total of 144 hail events for the planning area, the average hailstone size was 1.2 inches. Events of this magnitude correlate to an H3 classification. It is reasonable to expect H3 classified events to occur several times in a year throughout the county. In addition, it is reasonable, based on the number of occurrences, to expect larger hailstones to occur in the county annually. The county has endured one H9 hail event (3.5 – 4 inches) during the period of record. Figure 59 shows hail events based on the size of the hail.

Figure 59: Hail Events by Magnitude



Source: NCEI, 1996-2022

Climate Change

According to the Fourth National Climate Assessment, "modeling studies consistently suggest that the frequency and intensity of severe thunderstorms in the United States could increase as climate changes."[130] There is also some suggestion in the models that the atmosphere will become more favorable to severe thunderstorm development and increased intensity. The Iowa Department of Natural Resources report that Climate Change in Iowa will lead to increased frequency of precipitation extremes that lead to flooding and a larger increase in precipitation in eastern Iowa than in western Iowa[131]. These severe storm and flooding events can cause increased damages to structures and put more people at risk of injury or death.

[129] Tornado and Storm Research Organization. 2019. "Hail Scale." http://www.torro.org.uk/hscale.php.

[130] Fourth National Climate Assessment. 2018. "Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Chapter 2". https://nca2018.globalchange.gov/chapter/2/.

[131] Iowa Department of Natural Resources. "Climate Change". https://www.iowadnr.gov/Conservation/Climate-Change.

Economic Impacts

Economically, thunderstorms are generally beneficial in that they provide moisture necessary to support Iowa's largest industry, agriculture. The majority of thunderstorms do not cause damage, but when they escalate to severe storms, the potential for damages increases. Damages can include crop losses from wind; property losses due to building and automobile damages from high wind, flash flooding, and death or injury to humans and animals from lightning, drowning, or getting struck by falling or flying debris.

The electrical system is the most likely piece of infrastructure to be impacted during severe thunderstorms. Thunderstorm winds and lightning can cause tree branches to fall on powerlines resulting in power outages. During a large thunderstorm event this can occur in several areas causing power to be lost for a significant portion of a community. Severe thunderstorms pose a hazard to the IRUA with potential damage to the water system from excessive rainfall, lightning strikes, hail damage, or high winds. This hazard could cause power outages or damage assets causing issues with water delivery as well as personnel's ability to access sites and report in to work. Downed trees, branches, and power lines can also block roadways causing delays until they can be removed. Typically, these delays are minimal with several alternate routes available. Severe thunderstorms can also cause major damages to buildings. Hail can also damage crops depending on the time of year and size of the hail. FEMA standard values for traffic delays and electric power loss can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development

Future development will increase the risk of damages to buildings and infrastructure from severe thunderstorms. Additionally, an increased reliance on technology could increase vulnerabilities to lightning strikes associated with the use of electronic equipment. It is recommended that hail resistant materials and hail guards be considered for HVAC systems during construction and renovations, building codes be updated to require or recommend the use of hail resistant material, and existing structures incorporate hail resistant products such as concrete roof tiles and siding. Communities can also establish a Tree Board and tree ordinances to ensure urban canopies are safe and healthy, reducing the potential impacts of downed tree limbs during severe thunderstorms.

Probability

Based on historical records and reported events, severe thunderstorms events are likely to occur on an annual basis. The NCEI reported a severe thunderstorm event (hail, lightning, heavy rain, or thunderstorm winds) in every year on record (1996-2022), resulting in a 100 percent chance for thunderstorms to occur annually.

Community Top Hazard Status

The following jurisdictions identified Severe Thunderstorms as a top hazard of concern:

- City of Harvey
- City of Knoxville
- City of Pella
- City of Pleasantville
- Pella Christian Schools
- Pella School District
- Twin Cedars School District

Regional Vulnerabilities

The following tables provide information related to regional vulnerabilities and FEMA's National Risk Index values for Severe Thunderstorms. For jurisdictional specific vulnerabilities, refer to *Section Seven*.

Table 104: Regional Thunderstorm Vulnerabilities

SECTOR	VULNERABILITY
People	-Elderly citizens with decreased mobility may have trouble evacuating or seeking shelter -Mobile home residents are risk of injury and damage to their property if the mobile home is not anchored properly -Injuries can occur from not seeking shelter, standing near windows, and shattered windshields in vehicles
Economic	-Damages to buildings and property can cause significant losses to business owners and employees
Built Environment	-Buildings are at risk to hail damage -Downed trees and tree limbs -Roofs, siding, windows, gutters, HVAC systems, etc. can incur damage
Infrastructure	-High winds and lightning can cause power outages and down power lines -Roads may wash out from heavy rains and become blocked from downed tree limbs
Critical Facilities	-Power outages are possible -Critical facilities may sustain damage from hail, lightning, and wind
Climate	-Changes in seasonal precipitation and temperature normals can increase frequency and magnitude of severe storm events
National Risk Index Values	**Hail** Risk Index – Relatively Low Expected Annual Loss – Relatively Low **Lightning** Risk Index – Very Low Expected Annual Loss – Very Low

Source: FEMA National Risk Index, 2022

Severe Winter Storms & Extreme Cold

Severe winter storms are an annual occurrence in Iowa and may last for several days. Winter storms can bring extreme cold, freezing rain, heavy or drifting snow, and blizzards. Blizzards are particularly dangerous due to drifting snow and the potential for rapidly occurring whiteout conditions which greatly inhibit vehicular traffic. Generally, winter storms occur between the months of November and March but may occur as early as October and as late as April. Heavy snow is usually the most defining element of a winter storm. Large snow events can cripple an entire area by hindering transportation, knocking down tree limbs and utility lines, and structurally damaging buildings. Heavy accumulations of ice, often the result of freezing rain, can bring down trees, utility poles, and communications towers and disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians.

Extreme Cold

Along with snow and ice storm events, extreme cold can be dangerous to the well-being of people and animals. Prolonged exposure to cold causes the human body to lose heat faster than it can be produced and use up the body's stored energy. As a result, abnormally low body temperature can lead to hypothermia and frostbite. What constitutes extreme cold varies from region to region but is generally accepted as being temperatures that are significantly lower than the average low temperature. For the purposes of this plan, extreme cold is being defined as the high temperature being 10°F or below. Cold can cause fuel to congeal in storage tanks and supply lines, stopping electric generators, overpower a building's heating system, and cause water and sewer pipes to freeze and rupture. Extreme cold also increases the likelihood of ice jams on flat rivers or streams. When combined with high winds from winter storms, extreme cold becomes extreme wind chill, which is extremely hazardous to health and safety.

Freezing Rain

Along with snow events, winter storms also have the potential to deposit significant amounts of ice. Ice buildup on tree limbs and power lines can cause them to collapse. This is most likely to occur when rainfall freezes upon contact, especially in the presence of wind. Freezing rain is the name given to rain that falls when surface temperatures are below freezing. Unlike a mixture of rain and snow, ice pellets or hail, freezing rain is made entirely of liquid droplets. Freezing rain can also lead to many problems on the roads, as it makes them slick, causing automobile accidents, and making vehicle travel difficult.

Blizzards

A blizzard can be defined as "blowing and/or falling snow with winds of at least 35 mph, reducing visibilities to a quarter of a mile or less for at least three hours".[132] Blizzards are particularly dangerous due to drifting snow and the potential for rapidly occurring whiteout conditions, which greatly inhibits vehicular traffic. Heavy snow is usually the most defining element of a winter storm. Large snow events can cripple an entire jurisdiction for several days by hindering transportation, knocking down tree limbs and utility lines, structurally damaging buildings, and injuring or killing crops and livestock.

Location

The entire county is at risk of severe winter storms and extreme cold temperatures.

[132] National Weather Service. 2022. "Winter Weather Safety." https://www.weather.gov/dmx/wintersafety.

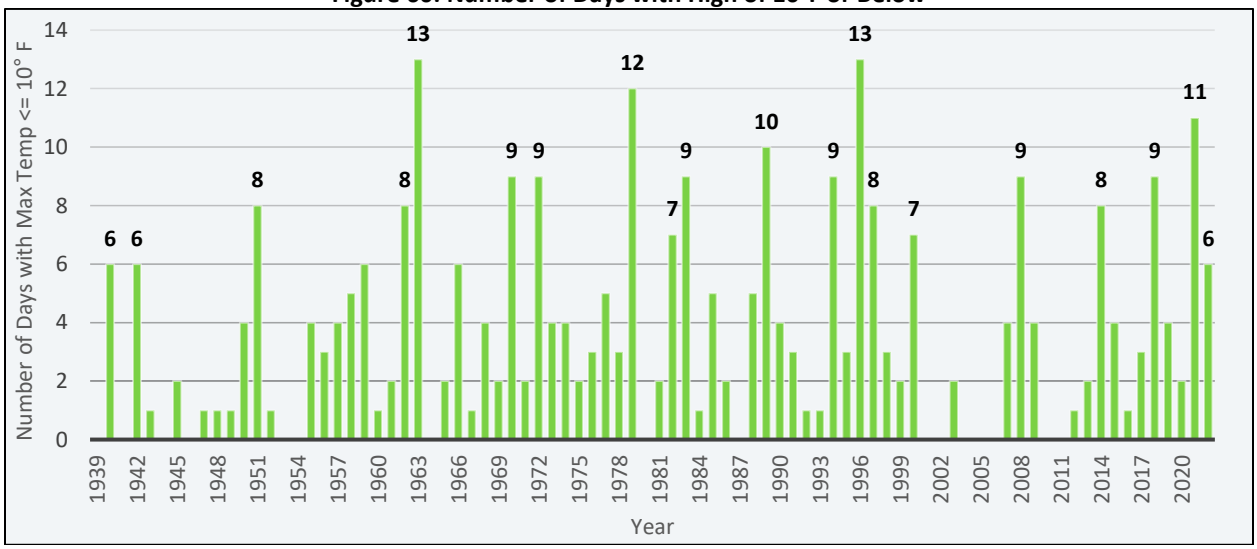
Historical Occurrences

The planning area experiences an annual average of four days with a high of 10°F or below and saw the most days below 10°F in 1963 and 1996 with 13 days (Figure 60).

Due to the regional scale of severe winter storms and extreme cold, the NCEI reports events as they occur in each county. According to the NCEI, there were a combined 72 severe winter storm events , while according the HPRCC there were 310 days with max temperatures below 10F between 1939 and 2022.

January had the most recorded events for the planning area. These recorded events caused a total of $2,084,790 in reported property damages. The RMA does not identify losses as severe winter storms, the RMA uses “cold wet weather”, “frost”, “cold winter”, and “freeze” to identify a severe winter storm. The RMA reports $971,532 in crop damages from 2000 to 2021, which are shown in **Error! Reference source n ot found.**. According to the NCEI, there were no injuries or fatalities associated with winter storms or extreme cold in the planning area.

Figure 60: Number of Days with High of 10°F or Below



Source: HPRCC, 1939-2022

Average Annual Damages

The average property damage per event estimate was determined based upon NCEI Storm Events Database since 1996 and includes aggregated calculations for each of the five types of winter weather as provided in the database. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. Crop damage is estimated based on the USDA RMA from 2000 to 2021. Severe winter storms have caused an average of $28,955 per year in property damage and $14,720 per year in crop damages for the planning area. The NCEI did not list any property damage due to extreme cold events and crop damages are included in the severe winter storm crop loss estimates.

Table 105: Severe Winter Storm Loss Estimate

Hazard Type	Number of Events[1]	Average Events Per Year[1]	Total Property Loss[1]	Average Annual Property Loss[1]	Total Crop Loss[2]	Average Annual Crop Loss [2]
Blizzard	11	0.4	$335,000	$12,407	$971,532	$14,720
Heavy Snow	24	0.9	$861,560	$31,910		
Ice Storm	11	0.4	$323,330	$11,975		
Winter Storm	25	0.9	$564,900	$20,922		
Winter Weather	1	0.04	$0	$0		
Total	72	2.67	$2,084,790	$77,214	$971,532	$14,720

Source: 1 Indicates data is from NCEI (1996-2022); 2 Indicates data is from USDA RMA (2000-2021)

Extent

The entire planning area is vulnerable to the effects of severe winter storms. Winter storms tend to make driving more treacherous and can impact the response of emergency vehicles. The probability of utility and infrastructure failure increases during winter storms due to freezing rain accumulation on utility poles and power lines. Secondary effects from loss of power could include burst water pipes in homes without electricity during winter storms. Public safety hazards include risk of electrocution from downed power lines. Buildings with overhanging tree limbs are more vulnerable to damage during winter storms and businesses experience loss of income as a result of closure during power outages or winter storms. In general heavy winter storms increase wear and tear on roadways though the cost of such damages is difficult to determine.

Populations at highest risk are those without shelter or who are stranded, or who live in a home that is poorly insulated or without heat. Other impacts of extreme cold include asphyxiation (unconsciousness or death from a lack of oxygen) from toxic fumes from emergency heaters; household fires, which can be caused by fireplaces and emergency heaters; and frozen/burst pipes. Elderly populations are considered particularly vulnerable to the impacts of winter storm and extreme cold events.

The Sperry-Piltz Ice Accumulation Index (SPIA) was developed by the NWS to predict the accumulation of ice and resulting damages. The SPIA assesses total precipitation, wind, and temperatures to predict the intensity of ice storms. Ice Storm Warnings are issued when accumulation of at least 0.25 inches is expected from a storm, which controlling for high winds, would tend to classify ice storms in Iowa as SPIA Level 2 or higher.
Figure 61 shows the SPIA index.

Along with snow and ice storm events, extreme cold is dangerous to the well-being of people and animals. What constitutes extreme cold varies from region to region but is generally accepted as temperatures that are significantly lower than the region's average low temperature. A key factor to consider regarding extreme cold situations is the wind chill. The Wind Chill Index was developed by the NWS to determine the decrease in air temperature felt by the body on exposed skin due to wind. The wind chill is always lower than the air temperature and can quicken the effects of hypothermia or frostbite as it gets lower. Figure 62 shows the Wind Chill Index used by the NWS and Figure 63 shows the normal monthly climate temperatures for the planning area.

Figure 61: SPIA Index

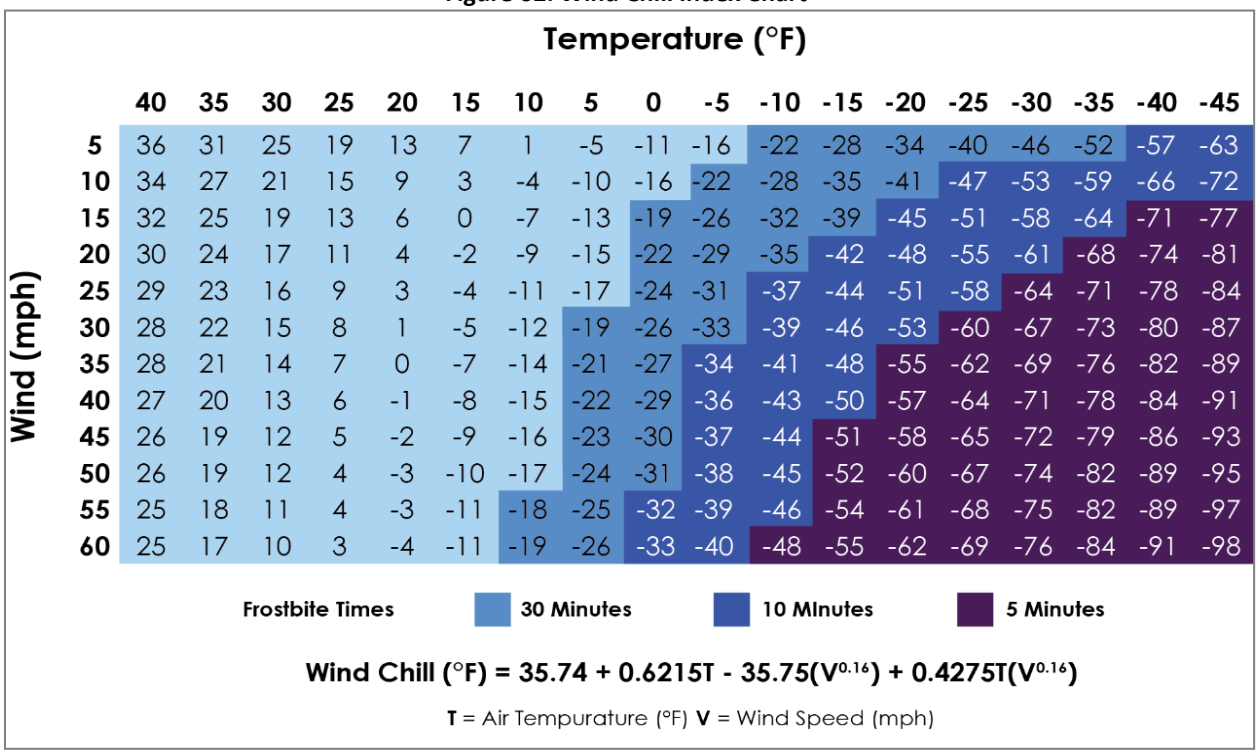
ICE DAMAGE INDEX	*AVERAGE ICE AMOUNT (in inches) *Revised: Oct. 2011*	WIND (mph)	DAMAGE AND IMPACT DESCRIPTIONS
0	<0.25	<15	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	0.10 – 0.25	15 – 25	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
	0.25 – 0.50	>15	
2	0.10 – 0.25	25 – 35	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
	0.25 – 0.50	15 – 25	
	0.50 – 0.75	>15	
3	0.10 – 0.25	> – 35	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
	0.25 – 0.50	25 – 35	
	0.50 – 0.75	15 – 25	
	0.75 –1.00	>15	
4	0.25 – 0.50	> – 35	Prolonged and widespread utility interruptions with extensive damage to main distribution feeder lines and some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
	0.50 – 0.75	25 – 35	
	0.75 –1.00	15 – 25	
	1.00 –1.50	>15	
5	0.50 – 0.75	> – 35	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeeks in some areas. Shelters needed.
	0.75 –1.00	> – 25	
	1.00 –1.50	> – 15	
	> 1.50	Any	

(Categories of damage are based upon combinations of precipitation totals, temperatures and wind speeds/directions.)

Source: SPIA-Index, 2017[133]

[133] SPIA-Index. 2009. "Sperry-Piltz Ice Accumulation Index." Accessed December 2022. http://www.spia-index.com/index.php.

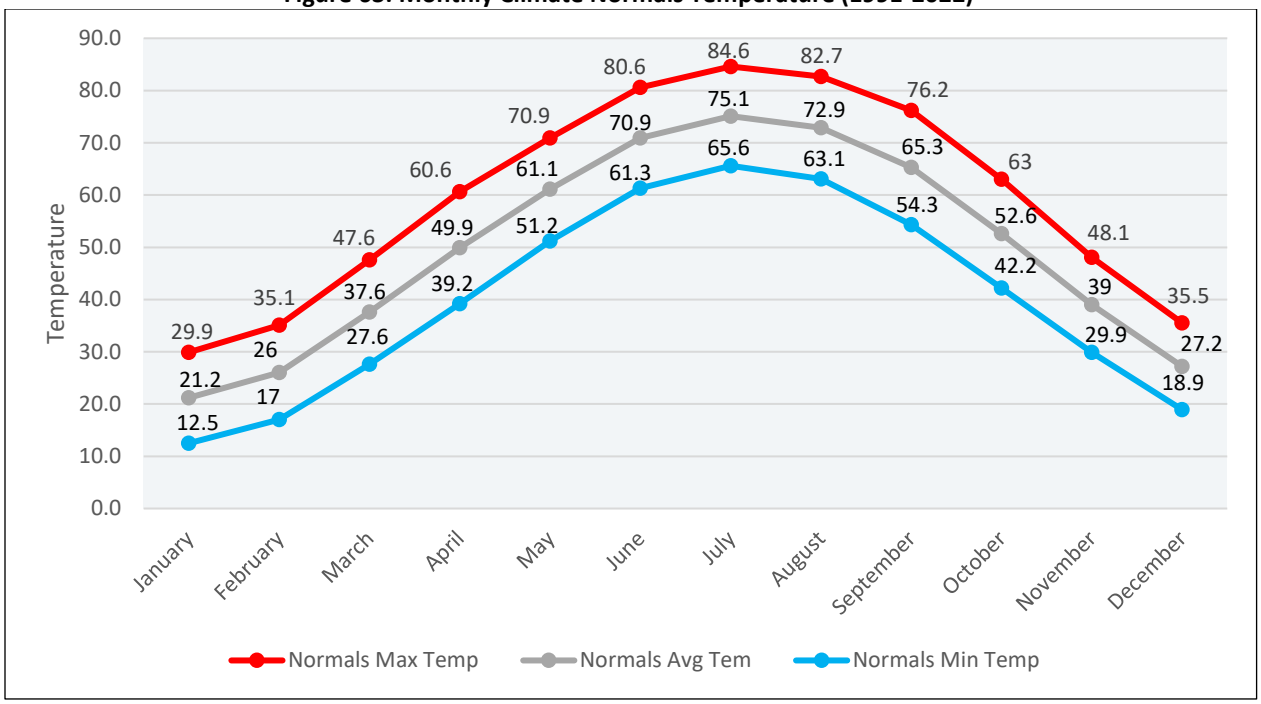
Figure 62: Wind Chill Index Chart



Wind (mph)	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	-82	-89	-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

Source: NWS[134]

Figure 63: Monthly Climate Normals Temperature (1991-2022)



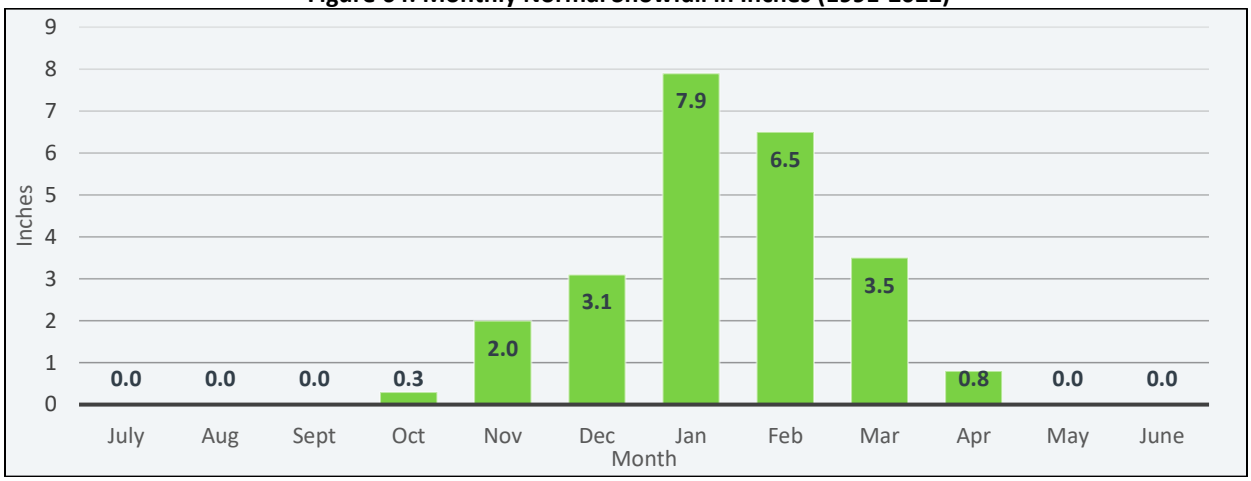
Source: NCEI, 2022

[134] National Weather Service. 2001. "Wind Chill Chart." https://www.weather.gov/safety/cold-wind-chill-chart.

Average monthly snowfall for the planning area is shown in Figure 64, which shows the snowiest months are between December and March. A common snow event (likely to occur annually) will result in accumulation totals between one and eight inches. Often these snow events are accompanied by high winds. It is reasonable to expect wind speeds of 25 to 35 mph with gusts reaching 50 mph or higher. Strong winds and low temperatures can combine to produce extreme wind chills of 20°F to 40°F below zero.

For the planning area, the coldest months of the year are December, January, and February. The average low temperatures for these months are all below freezing (average low for the three months 16.1°F). The average high temperature for these months is 33.5°F.

Figure 64: Monthly Normal Snowfall in Inches (1991-2022)



Source: High Plains Regional Climate Center, 2022

Climate Change

Iowa experiences frequent snowstorms and ice storms during winter, which can produce heavy snowfall and high wind gusts that lead to whiteout conditions. As temperatures continue to rise, more water vapor evaporates into the atmosphere, creating increased humidity, which can increase the frequency and intensity of these storms. For extreme events like severe winter storms "it is difficult to know what will happen to the frequency and intensity" of these events. However, "winter precipitation is projected to increase through the 21st century" in Iowa.[135] Some studies indicate that atmospheric circulation patterns in the Arctic could affect winter storms in midlatitude regions, and there may be a link between arctic warming and the frequency and intensity of severe winter storms in the United States.[136] Cold temperatures are likely to be impacted by climate change. The table below shows the number of freezing days in the county with different warming scenarios.

Table 106: Number of Freezing Days

	Warming Scenarios			
	1° C	1.5° C	2° C	3° C
Number of Freezing Days	31-90 Days/Year	31-90 Days/Year	31-90 Days/Year	31-90 Days/Year

Source: Probable Futures[137]

[135] University of Massachusetts. 2022. "State Climate Reports-Iowa". Accessed December 2022. https://blogs.umass.edu/csrc/state-climate-reports/

[136] Fourth National Climate Assessment. 2018. "Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Chapter 2". https://nca2018.globalchange.gov/chapter/2/.

[137] Probable Futures. "Maps of Temperature". Accessed December 2022. https://probablefutures.org/.

Economic Impacts

Large snow events, blizzards, and ice storms can cause large economic impacts to the county. These events can also range in size from impacting a single community to impacting the entire county or a multi-county region. Transportation is the most likely sector impacted by severe winter storms. During a countywide snowstorm it is possible that all or most of roadways in the county will face hazardous driving conditions, significant delays, or even road closures. These delays and closures will have a trickle-down effect on local businesses due to shipping delays, reduced customer access, and other impacts. Severe winter storms can also negatively impact the local economy even when occurring outside the county. Marion County lies adjacent to the intersection of I-35 and I-80. Large storms in nearby counties can close these vital interstates and other major highways resulting in delays for commuters and shipping. Power loss due to winter storms can also negatively impact local businesses forcing them to close until power is restored. IRUA identified power loss from severe winter storms as a concern as they can impact the treatment plant and pumping stations. Severe weather can also impact personnel's ability to access these sites.

FEMA standard values for traffic delays and loss of electrical services can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development

All future development will be affected by severe winter storms. Increased development or infrastructure in the county creates a higher probability of damage to occur from winter weather as more property is exposed to risk. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction.

Probability

Based on historical records and reported events, severe winter storm events are likely to occur regularly in the county. The NCEI reported a severe winter storm event in 24 of 27 years, resulting in 89 percent chance annually for severe winter storms. Extreme cold events have occurred at least one day with a high at or below 10°F occurred in 68 out of 84 years, resulting in 81 percent chance annually for extreme cold.

Community Top Hazard Status

The following jurisdictions identified Severe Winter Storms and Extreme Cold as a top hazard of concern:

- Marion County
- City of Bussey
- City of Harvey
- City of Melcher-Dallas
- Knoxville School District
- Melcher-Dallas School District
- Twin Cedars School District

Regional Vulnerabilities

The following tables provide information related to regional vulnerabilities and FEMA's National Risk Index values for Severe Winter Storms. For jurisdictional specific vulnerabilities, refer to *Section Seven.*

Table 107: Regional Severe Winter Storm Vulnerabilities

SECTOR	VULNERABILITY
People	-Elderly citizens are at higher risk to injury or death, especially during extreme cold and heavy snow accumulations -Citizens without adequate heat and shelter at higher risk of injury or death
Economic	-Closed roads and power outages can cripple a region for days, leading to significant revenue loss and loss of income for workers
Built Environment	-Heavy snow loads can cause roofs to collapse -Significant tree damage possible, downing power lines and blocking roads
Infrastructure	-Heavy snow and ice accumulation can lead to downed power lines and prolonged power outages -Transportation may be difficult or impossible during blizzards, heavy snow, and ice events
Critical Facilities	-Emergency response and recovery operations, communications, water treatment plants, and others are at risk to power outages, impassable roads, and other damages
Climate	-Changes in seasonal precipitation and temperature normals can increase frequency and magnitude of severe winter storm events
National Risk Index Values	**Cold Wave** Risk Index – Relatively Low Expected Annual Loss – Relatively Moderate **Ice Storm** Risk Index – Very Low Expected Annual Loss – Relatively Low **Winter Weather** Risk Index – Relatively Low Expected Annual Loss – Relatively Moderate

Source: FEMA National Risk Index, 2022

Sinkhole

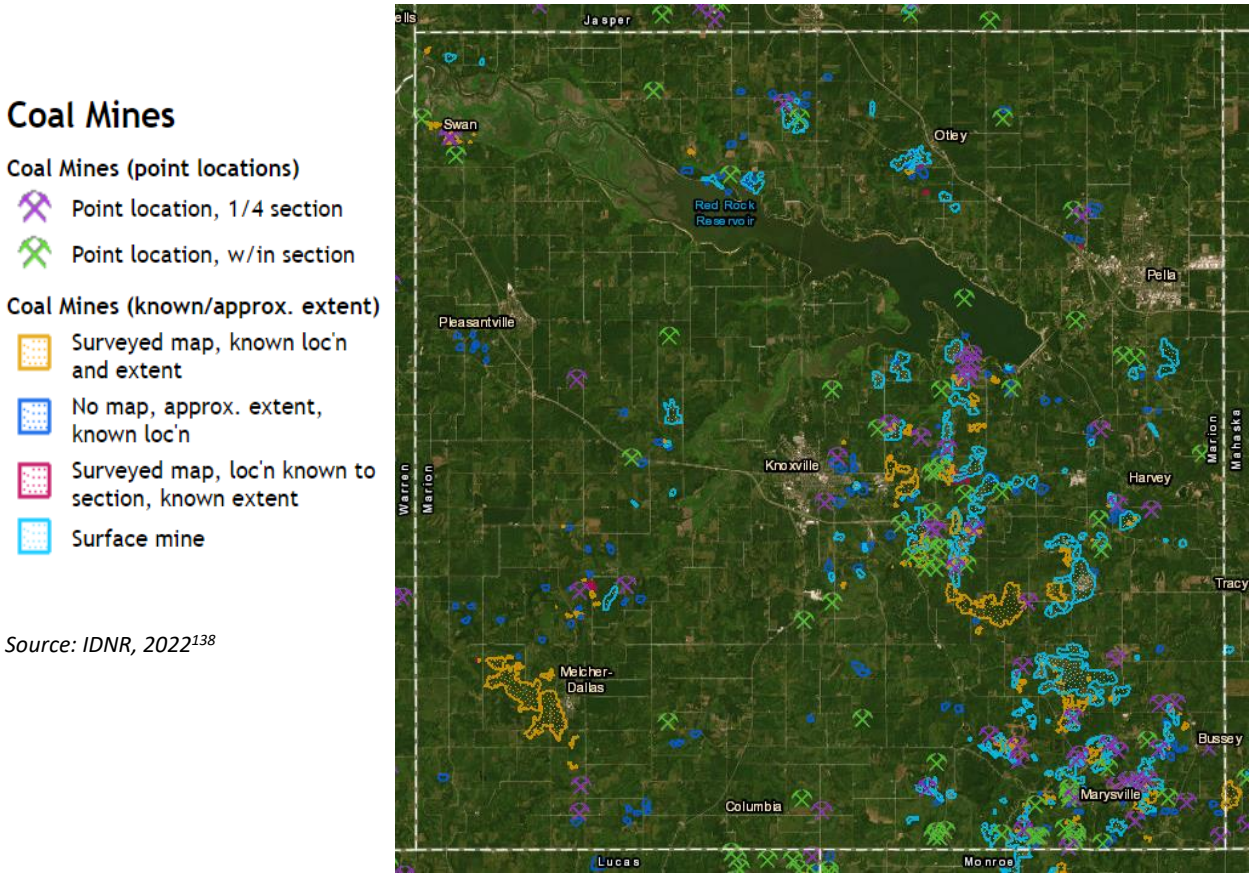
A sinkhole is defined as the loss of surface elevation due to the removal of subsurface support. Sinkholes can range from broad, regional lowering of the land surface to localized collapse. The primary causes of most subsidence are human activities such as: underground mining of coal, groundwater or petroleum withdraw, and drainage of organic soils. Sinkholes can also be due to erosion of limestone of the subsurface.

As a result of Iowa's former mining operations and unique geology, sinkholes are found throughout much of the state, but the majority of the sinkholes are located in the northeast quadrant of the state. Marion County does not have any documented sinkhole areas; however, the vulnerability still exists due to the existence of old mines.

Location

The following map (Figure 65) shows historic coal mining areas reported by IDNR. These documented coal mines may be prone to a sinkhole event.

Figure 65: Historic Coal Mining Areas



Source: IDNR, 2022[138]

[138] IDNR. Accessed April 2022. "Iowa Coal Mines." https://programs.iowadnr.gov/maps/coalmines/

Historical Occurrences
There have been no reported sinkholes within the county.

Average Annual Losses
There is no data available to determine damage estimates for this hazard. In most cases, individual property owners, local governments, and businesses pay for repairs for damages caused by this hazard.

Extent
Any sinkhole that might occur would likely be isolated to a small area.

Climate Change
The impact of climate change on sinkholes can be dependent on soil types. Calcareous soils such as sandstone, chalk, gypsum, or limestone are highly porous and easily erode during extreme groundwater saturation that occurs after heavy rainfall. Higher rainfall rates that are expected with climate change cause extreme groundwater saturation and may lead to more sinkholes in these soil types.

Economic Impacts
Similar to landslides, sinkholes have the capability to impact roadways and power lines. Buildings and pipelines could also be impacted, but most of the possible sinkhole locations in the county are located in rural areas with minimal pipelines and buildings. Roadways can be damaged if they are located on top of a sinkhole. Delays may occur until the roadways I repaired and stabilized. Power can be lost if power poles are moved during a sinkhole event. FEMA standard values for traffic delays, electric power loss, potable water loss, and wastewater loss can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*. With no historical reported sinkholes in the county, any that do occur are likely to be small with minimal economic impacts.

Future Development
Future development near historic coal mining sites should be monitored and entities wishing to build in these areas should consider studies of subterranean conditions.

Probability
Future occurrences of sinkholes are possible, but without a well-documented record of events, it is difficult to determine the overall probability of this hazard. However, for the purposes of this plan, the probability of sinkholes will be estimated as one percent annually.

Community Top Hazard Status
No jurisdictions identified Sinkhole as a top hazard of concern.

Regional Vulnerabilities

The following table summarizes regional vulnerabilities; for jurisdictional-specific vulnerabilities, refer to *Section Seven: Community Profiles*.

Table 108: Regional Sinkhole Vulnerabilities

SECTOR	VULNERABILITY
People	-Citizens living near old mining operations in the northern half of the Country are at risk
Economic	-If a business is impacted, employees may be temporarily out of work
Built Environment	-All building stock has a small risk of damage
Infrastructure	-All underground infrastructure at risk to damages
Critical Facilities	-Roadways may be damaged
Climate	-Fluctuating precipitation extremes (drought or heavy rain events) can cause sinkholes

Terrorism and Civil Disorder

According to the Federal Bureau of Investigation (FBI), there is no single, universally accepted definition of terrorism. Terrorism is defined in the Code of Federal Regulations as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof in furtherance of political or social objectives".[139] Though peaceful public demonstrations are allowed under US Federal law, any domestic situations such as a strike or riot involving three or more people could be considered civil disorder if the demonstration has devolved into having a potential for causing injuries, casualties, or property damage.[140,141]

Terrorist activities are also classified based on motivation behind the event (such as religious fundamentalism, national separatist movements, and social revolutionary movements). Terrorism can also be random with no ties to ideological reasoning. The FBI also provides clear definitions of a terrorist incident and prevention:

- A terrorist ***incident*** is a violent act or an act dangerous to human life, in violation of the criminal laws of the United States, or of any state, to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.
- Terrorism ***prevention*** is a documented instance in which a violent act by a known or suspected terrorist group or individual with the means and a proven propensity for violence is successfully interdicted through investigative activity.

There are different types of terrorism depending on the target of attack, which include: Political Terrorism, Bio-Terrorism, Cyber-Terrorism, Eco-Terrorism, Nuclear-Terrorism, Marco-Terrorism, and Agro-Terrorism. Cyber-terrorism is an incident involving the theft or modification of information on computer systems that can compromise the system or potentially disrupt essential services. A cyber- terrorism incident can impact city agencies, private utilities, or critical infrastructure/key resources like a power grid, public transportation system, and wireless networks. Cyber infrastructure includes electronic information and communications systems, and the information contained in those systems. Computer systems, control systems such as Supervisory Control and Data Acquisition (SCADA) systems, and networks such as the Internet are all part of cyber infrastructure.

Nation-states, criminal organizations, terrorists, and other malicious actors conduct attacks against critical cyber infrastructure on an ongoing basis. The impact of a serious cyber incident or successful cyber-attack would be devastating to state, local, tribal, and territorial governments' assets, systems, and/or networks; the information contained in those networks; and the confidence of those who trust governments to secure those systems.

> "Many of the Nation's essential and emergency services, as well as our critical infrastructure, rely on the uninterrupted use of the Internet and the communications systems, data, monitoring, and control systems that comprise our cyber infrastructure. A cyber-attack could be debilitating to our highly interdependent critical infrastructure and key resources and ultimately to our economy and national security."
>
> - National Strategy for Homeland Security

[139] Terrorism, 28 U.S. Code Section 0.85
[140] Civil Disorders, 18 U.S. Code § 231-233 (1992)
[141] Terrorism, 28 U.S. Code § 0.85.

A cyber incident can affect a system's:

- Confidentiality: protecting a user's private information
- Integrity: ensuring that data is protected and cannot be altered by unauthorized parties
- Availability: keeping services running and giving administration access to key networks and controls.

The Department of Homeland Security and its affiliated agencies are responsible for disseminating any information regarding terrorist activities in the country. The system in place is the National Terrorism Advisory System (NTAS). NTAS replaced the Homeland Security Advisory System (HSAS) which was the color-coded system put in place after the September 11th attacks by Presidential Directive 5 and 8 in March of 2002. NTAS replaced HSAS in 2011.

NTAS is based on a system of analyzing threat levels and providing either an imminent threat alert or an elevated threat alert.

- An ***Imminent Threat Alert*** warns of a credible, specific and impending terrorist threat against the United States.
- An ***Elevated Threat Alert*** warns of a credible terrorist threat against the United States.

The Department of Homeland Security, in conjunction with other federal agencies, will decide whether a threat alert of one kind or the other should be issued should credible information be available. Each alert provides a statement summarizing the potential threat and what, if anything should be done to ensure public safety. Primarily, threat assessment, mitigation and response to civil unrest and terrorism are federal and state directives and work primarily with local law enforcement. The Office of Infrastructure Protection within the Federal Department of Homeland Security is a component within the National Programs and Protection Directorate.

Location

Terrorism and Civil Disorder can occur throughout the entire planning area. Cities, schools, and government buildings are more likely to see terroristic activity. Concerns are primarily related to political unrest, activists' groups, and others that may be targeting businesses, police, and federal buildings. In schools, concerns center on political terrorism and are generally perpetrated erratically by loners. School shootings are an increasing threat across the country. In rural areas, concerns are primarily related to agro-terrorism and tampering with water supplies. However, water systems of any size could be vulnerable.

Historical Occurrences

To identify any incidence of civil disorder or terrorism in the planning area, data was gathered from the Global Terrorism Database, maintained by the University of Maryland and the National Consortium for the Study of Terrorism and Responses to Terrorism (START). This database contains information for over 140,000 terrorist attacks. According to this database, there were zero civil disorder or terrorist incidents within the planning area from 1970-2017.[142]

[142] National Consortium for the Study of Terrorism and Responses to Terrorism. 2018. Global Terrorism Database [Data file]. Retrieved from https://www.start.umd.edu/gtd.

Average Annual Damages
According to the START Global Terrorism Database (1970-2017), no civil unrest or terrorist events have occurred in the planning area. As there were no such events within the planning area, there were no average annual damages.

Extent
Incidents of civil disorder and terrorism can vary greatly in scale and magnitude, depending on the location of the attack, number of protesters, and reasoning for unrest.

Climate Change
Climate change will likely have a limited impact on terrorism or cyber-attacks. Climate activism may be a growing motive for civil unrest and lead to Civil Disorder events. Government authorities report that civil disturbances and riots are more likely to occur during heat waves.[143] With an increase in the number of 100°F days,[144] these events may be more likely to occur but are unlikely to reach the level of terrorism.

Economic Impacts
Buildings, water and wastewater system, electrical system, and communications can all be targets of a terroristic event. Typically, these events are meant to cause as much damage or impact as possible. Large events can impact an entire community or county while smaller events can impact a single building. Bridges can also be targets of terrorism, meant to cause damage, and disrupt traffic. Protests and civil disorder often impact roadways. Past events around the country have targeted high traffic roadways and intersections in order to get better publicity. Terrorism and civil disorder are more likely to occur in large population communities like Knoxville, Melcher-Dallas, and Pella because the impacts will be greater. FEMA standard values for traffic delays, electric power loss, IT/communications loss, potable water loss, and wastewater loss can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development
Increased security measures at vulnerable locations such as schools will reduce the likelihood and impacts of a terroristic act. Measures can include bollards to protect from vehicles, fencing, security cameras, advanced locks, etc. Having strong cyber security can keep bad actors from taking control of municipal systems with the intent to cause harm to humans and damage to buildings.

Probability
Given zero incidences over a 48-year period, the annual probability for civil unrest and terrorism in the planning area has a less than one percent chance of occurring during any given year. This does not indicate that an event will never occur within the planning area, only that the likelihood of such an event is incredibly low.

Community Top Hazard Status
The following jurisdictions identified Terrorism and Civil Disorder as a top hazard of concern:

- City of Pella
- Melcher-Dallas School District

[143] Yeeles, Adam. 2015. Weathering unrest: The ecology of urban social disturbances in Africa and Asia". https://journals.sagepub.com/doi/full/10.1177/0022343314557508.

[144] Union of Concerned Scientists. 2022. "Extreme Heat and Climate Change: Interactive Tool". https://www.ucsusa.org/resources/killer-heat-interactive-tool.

Regional Vulnerabilities

The following table provides information related to regional vulnerabilities; for jurisdictional-specific vulnerabilities, refer to *Section Seven: Community Profiles.*

Table 109: Regional Terrorism Vulnerabilities

SECTOR	VULNERABILITY
People	-Police officers and first responders at risk of injury or death -Civilians at risk of injury or death -Students and staff at school facilities at risk of injury or death from school shootings
Economic	-Damaged businesses can cause loss of revenue and loss of income for workers -Agricultural attacks could cause significant economic losses for the region -Risk of violence in an area can reduce income flowing into and out of that area
Built Environment	-Targeted buildings may sustain heavy damage
Infrastructure	-Water supply, power plants, utilities may be damaged
Critical Facilities	-Police stations, government offices, and schools are at a higher risk
Climate	-Climate activism provides increasing motive for disturbances

Tornado and High Winds

The NWS defines a tornado as a violently rotating column of air extending from a thunderstorm to the ground. Typically associated with a supercell thunderstorm, for a rotation to be classified as a tornado three characteristics must be met:

- There must be a microscale rotating area of wind, ranging in size from a few feet to a few miles wide;
- The rotating wind, or vortex, must be attached to a convective cloud base and must be in contact with the ground; and,
- The spinning vortex of air must have caused enough damage to be classified by the Fujita Scale as a tornado.

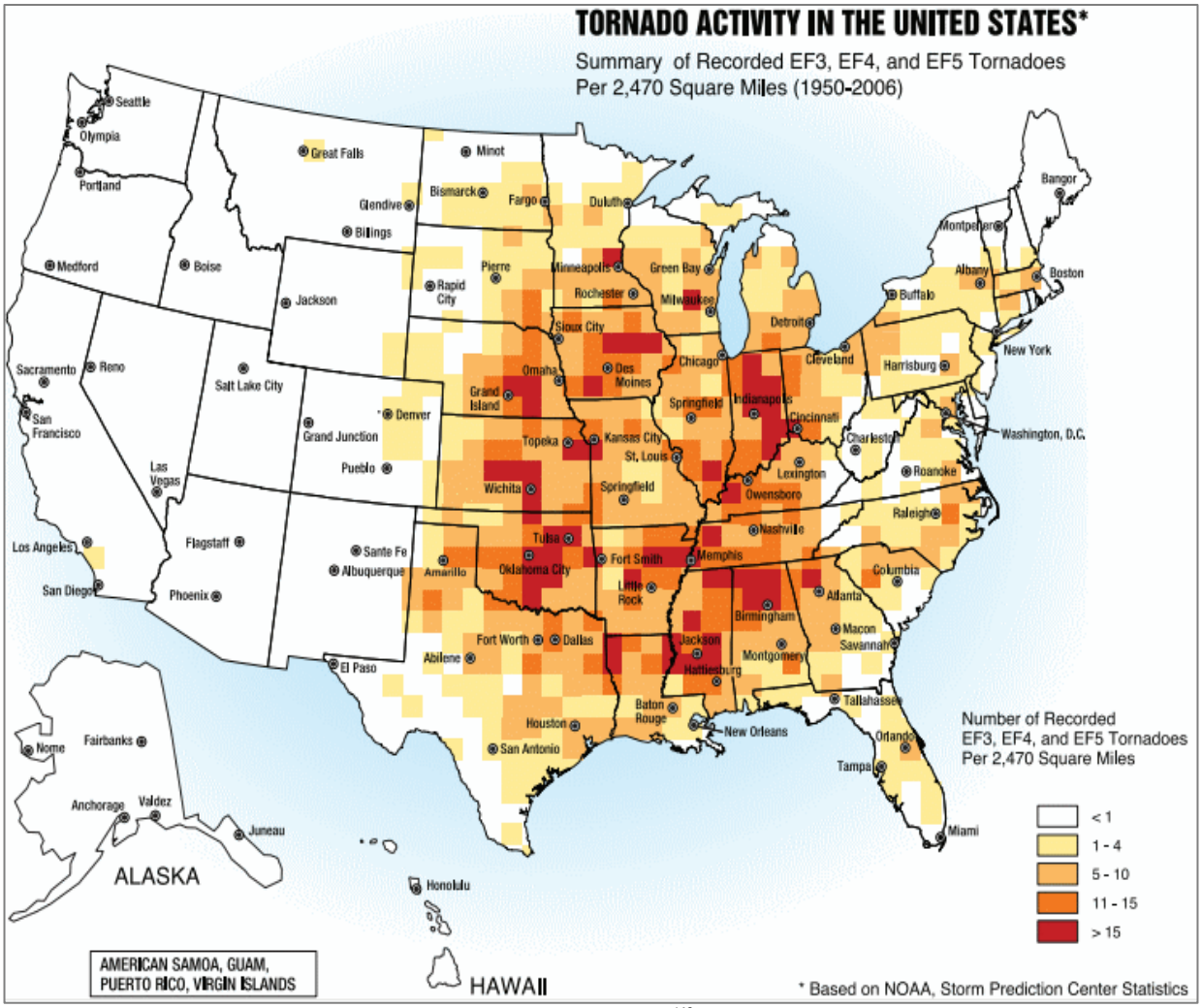
Once tornadoes are formed, they can be extremely violent and destructive. They have been recorded all over the world but are most prevalent in the American Midwest and South, in an area known as "Tornado Alley." Though the description of "tornado alley" varies slightly, Iowa is generally considered to be included in, or on the edge of, the geographic area. Approximately 1,250 tornadoes are reported annually in the contiguous United States. Tornadoes can travel distances over 100 miles and reach over 11 miles above ground. Tornadoes usually stay on the ground for no more than 20 minutes. Nationally, the tornado season typically occurs between April and July. On average, 80% of tornadoes occur between noon and midnight.

There are certain socio-economic factors which may increase the vulnerability of different populations. Citizens living in mobile homes, citizens who are elderly with decreased mobility or have poor hearing are at higher risk for lasting impacts from a tornado event. High winds 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. Campers, construction trailers, mobile homes, barns, and sheds and their occupants are particularly vulnerable as high wind events in Marion County can be sufficient in magnitude to overturn these lighter structures. Additionally, older homes which have not been maintained may be more susceptible to damage during windstorms.

Iowa is ranked sixth in the nation for tornado frequency with an annual average of 47 tornadoes between 1985 and 2014.[145] Roughly 64% of tornadoes in Iowa occur in the months of May, June, and July. Figure 66 shows the tornado activity in the United States as a summary of recorded EF3, EF4, and EF5 tornadoes per 2,470 square miles from 1950 through 2006.

[145] NOAA. "U.S. Annual Averages: Tornadoes by State (1985-2014)". Accessed April 2022. https://www.spc.noaa.gov/wcm/ustormaps/1985-2014-stateavgtornadoes.png

Figure 66: Tornado Activity in the United States



Source: FEMA, 2008[146]

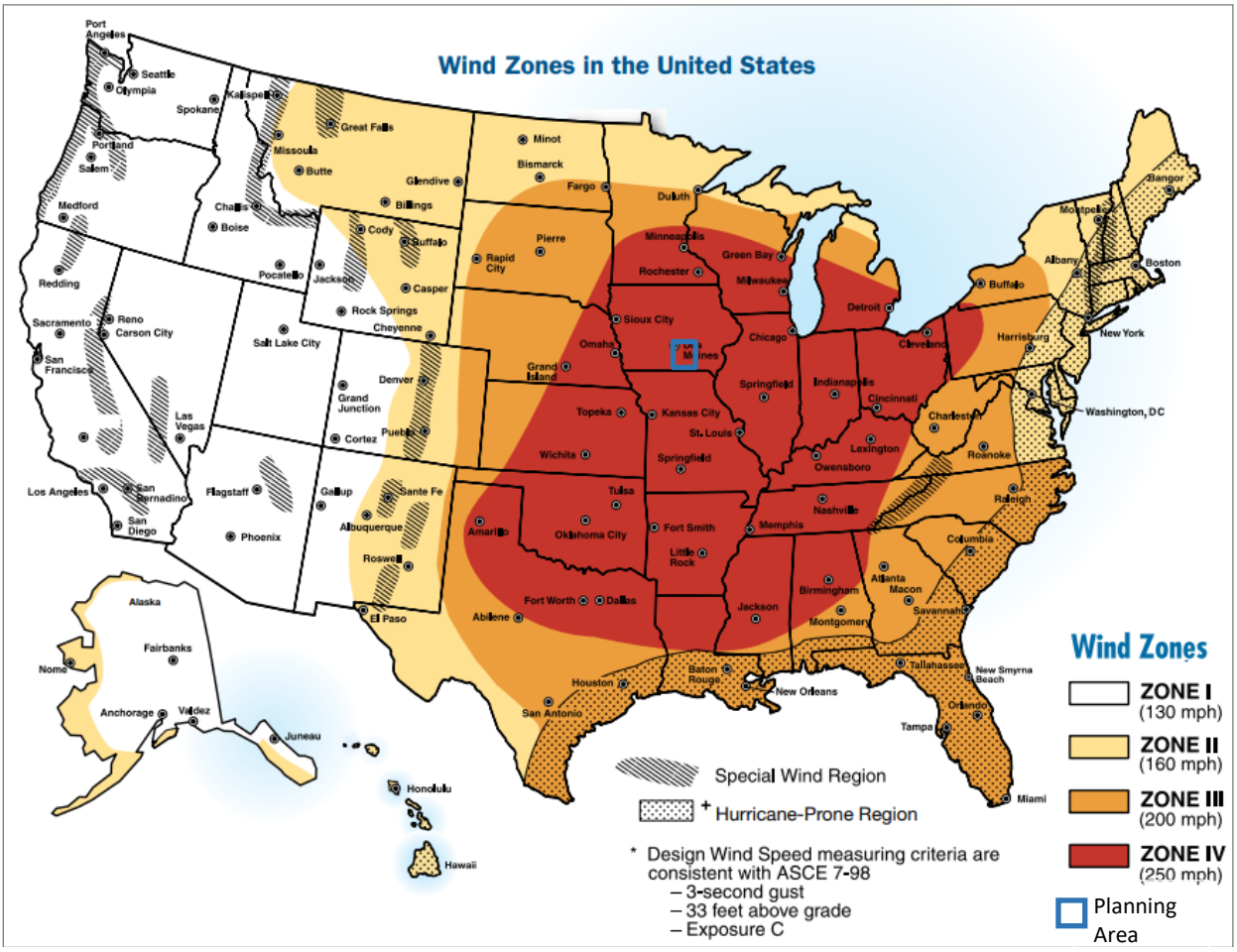
The National Weather Service (NWS) defines high winds as sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration.[147] The NWS issues High Wind Advisories when there are sustained winds of 25 to 39 mph and/or gusts to 57 mph. High winds typically accompany severe thunderstorms, severe winter storms, tornadoes, and other large low-pressure systems, which can cause significant crop damage, downed power lines, loss of electricity, traffic flow obstructions, and significant property damage including to trees and center-pivot irrigation systems.

Figure 67 shows the wind zones in the United States. The wind zones are based on the maximum wind speeds that can occur from a tornado or hurricane event. The planning area is located in Zone IV which has maximum winds of 250 mph, equivalent to an EF5 tornado.

[146] Federal Emergency Management Agency. August 2008. "Taking Shelter From the Storm: Building a Safe Room for Your Home or Small Business, 3rd edition."

[147] National Weather Service. 2017. "Glossary." http://w1.weather.gov/glossary/index.php?letter=h.

Figure 67: Wind Zones in the U.S.

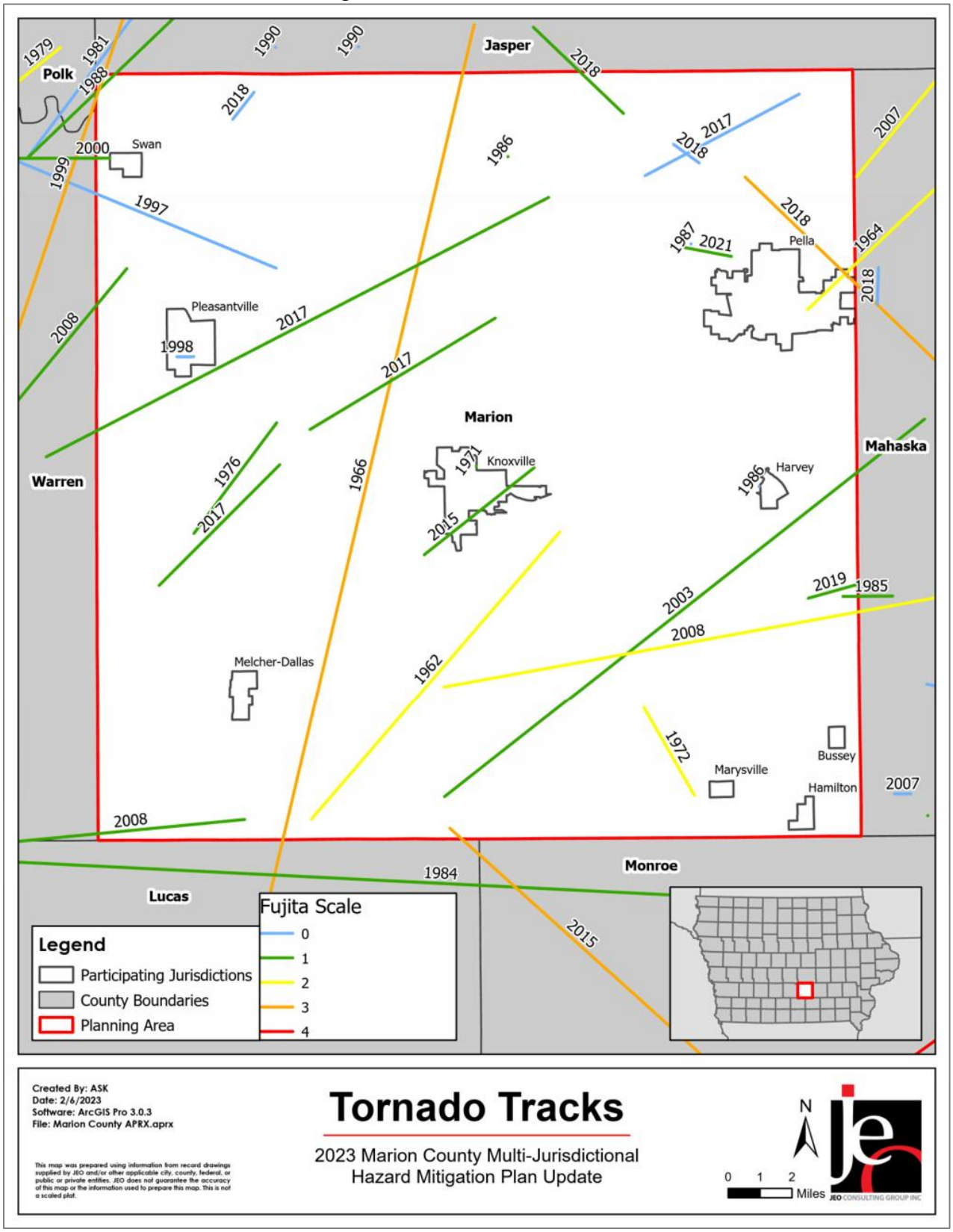


Source: FEMA, 2016

Location

High winds and tornadoes can take place anywhere in the county. Impacts would likely be greater in densely populated areas, such as Knoxville or Pella. Figure 68 shows the historical track locations across the region according to the Midwestern Regional Climate Center. A few tornado events have significantly impacted communities located in the planning area between 1996 and 2022. These include a 2008 EF2, a 2015 EF1 that impacted Knoxville, and an EF3 near Pella in 2018.

Figure 68: Historic Tornado Tracks

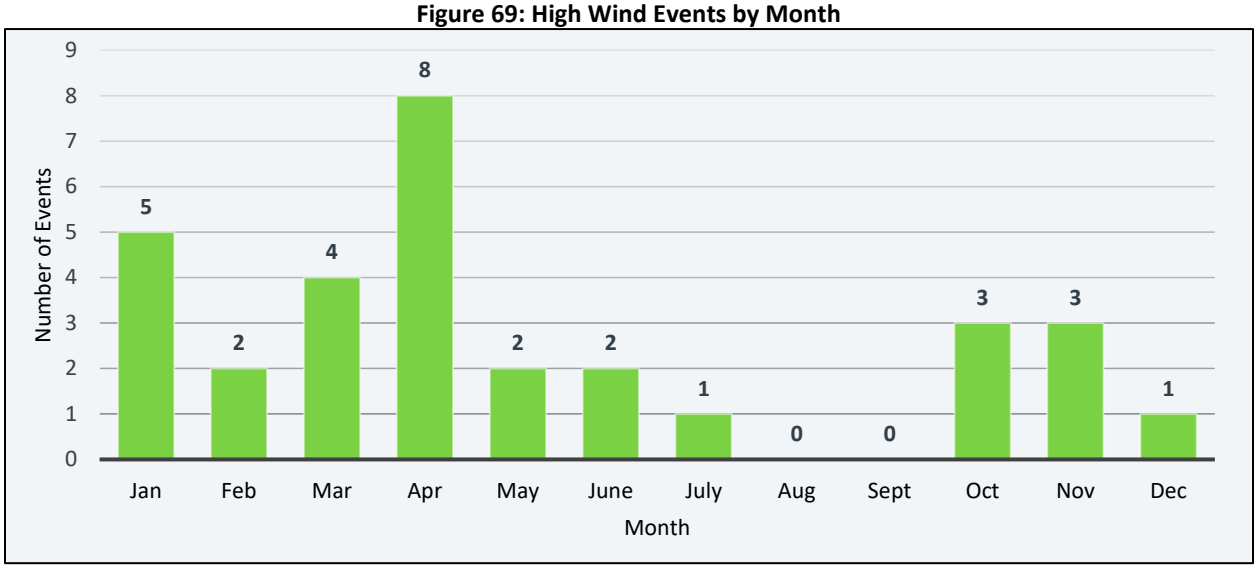


Historical Occurrences

There were 31 high wind events that occurred between 1996 and 2022 and 25 tornadic events ranging from a magnitude of EF0 to EF3. These events were responsible for $122,414,110 in property damages and $682,231 in crop damages. The NCEI reported 24 injuries and no deaths.

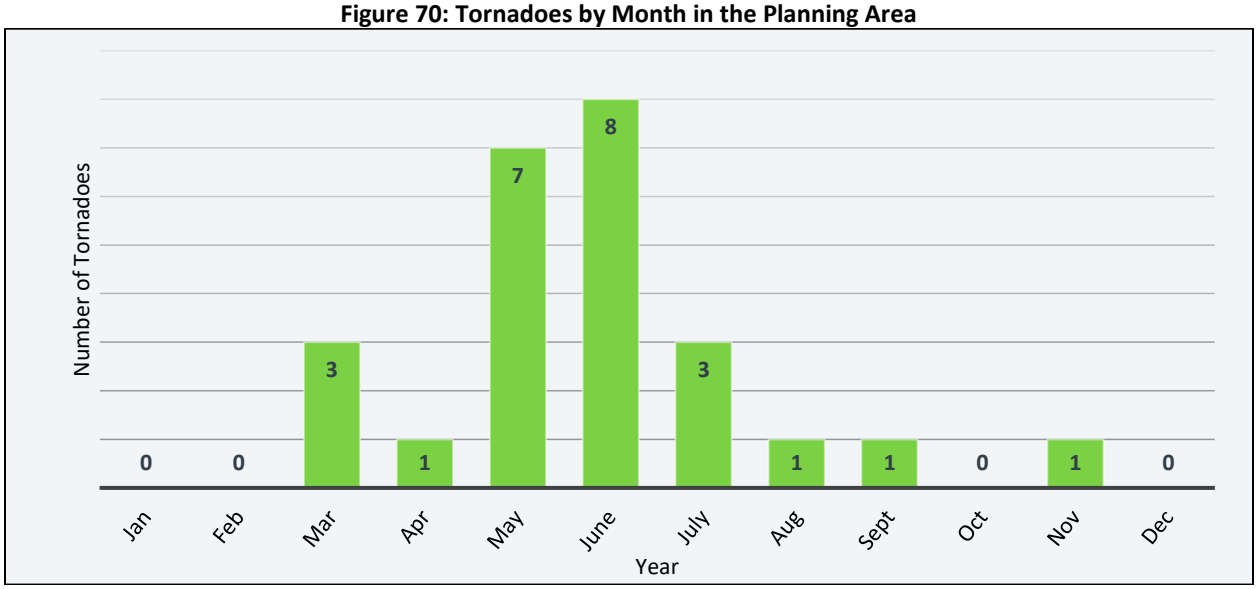
The most damaging tornado occurred in 2018, causing $120,000,000 in damages and 13 injuries. This EF3 tornado started north of Pella and moved southeast along the city limits. The tornado shifted one house off its foundation and destroyed one of the large buildings at the Vermeer facility on the east side of Pella. Thirteen injuries occurred at the Vermeer facility with six requiring transport to the hospital. The second most damaging tornado was an EF2 tornado that hit Marion County and caused $750,000 in property damage. As seen in the following figures, the majority of high winds events occur in the spring and winter months, while most tornado events occur in late spring and early summer.

Figure 69: High Wind Events by Month



Source: NCEI, 1996-2022

Figure 70: Tornadoes by Month in the Planning Area



Source: NCEI, 1996-2022

Event descriptions from NCEI for the most damaging events are provided below.

- **5/30/2008 Tornado –** $750,000 in property damages, $25,000 in crop damages. A very unstable airmass moved into Iowa during the day on the 29th as a warm front lifted north into the state during the afternoon. Low pressure approached from the west, along with a cold front so that the triple point was near the western Iowa, eastern Nebraska area by late afternoon. Thunderstorms erupted quickly during the late afternoon and evening hours in the unstable airmass. By evening, the low-level jet was in the 40 to 60 kt range, feeding moisture into the state and pushing precipitable water values to around 200% of normal, in the 1.5-to-1.8-inch range. ... Thunderstorms erupted over western Iowa stretching into north central Iowa first. It did not take long for the storms to become severe with hail and high winds. Most of the hail reported was in the pea to marble size, with the larger stones in the nickel to quarter size range. The primary mode of severe weather was high winds and several tornadoes. The secondary, but significant threat, was heavy rainfall. ... As the storms moved east, another tornado was on the ground for over 10 miles in Warren and Marion Counties. The most significant tornado occurred in Marion and Mahaska Counties where an EF2 tornado was on the ground for about 18 miles. Several homes were damaged along its path, two mobile homes were destroyed, and considerable damage was done to trees in the area. Up to 10 people were injured by this tornado, mainly in Attica. The official damage count from this tornado included 5 homes destroyed, 15 with major damage, and another 25 with minor damage. Many of the storms produced high winds with several reports of winds in the 65 to 75 MPH range. Considerable tree damage was reported and some structural damage, mainly to outbuildings and shingle damage...

- **7/19/2018 Tornado -** $120,000,000 in property damages. A setup for some rotating storms was in place over much of central and southern Iowa. A low-pressure system situated northwest of the state slid to the northeast throughout the day, eventually moving into western and central Minnesota. Given its mature frontal situation, an occluded front dropped into northwest Iowa with the warm front extending E/SE from central Iowa and the cold front dropping back to the SW. At the surface within the warm sector observations were favorable with temperatures into the mid-80s and dew points in the low to mid-70s. Looking in more detail, lifted condensation levels were quite low with values under 750 meters, MUCAPE values were modest in the 1000-3000 J/kg range, effective bulk shear was more than 40 kts, and effective storm relative helicity was around 200 m2/s2 to name a few. Resulting composite indices correctly highlighted an increased chance for supercells and tornadic potential as seen with supercell composite values above 12 and significant tornado parameter values in the 3 to 5 range in the afternoon. All of which is, considering the general setup, understandably unable to account for storms potentially tapping into additional shear and helicity generated from rooting themselves along outflow boundaries. The result was a sizable tornado outbreak across Iowa, including more than a dozen confirmed tornadoes. The tornadoes of most note occurred in the NE Des Moines Metro (specifically Bondurant), Pella, and Marshalltown…The Pella tornado tacked on the north side of town, directly hitting the Vermeer plant, causing EF3 damage...All in all, while numerous injuries were experienced and millions of dollars of damage, no direct fatalities were reported from the tornadoes.

Average Annual Damages

The average damage per event estimate was determined based upon NCEI Storm Events Database since 1996 and number of historical occurrences. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. Crop damages were determined based on the USDA RMA since 2000. It is important to note that damages from tornadoes vary greatly depending on the severity or magnitude of each event.

Table 110: Tornado and High Wind Loss Estimate

Hazard Type	Number of Events[1]	Average Events Per Year	Total Property Loss[1]	Average Annual Property Loss[1]	Total Crop Loss[2]	Average Annual Crop Loss[2]
Tornado	25	0.9	$121,535,000	$4,501,296	$537,598	$24,436
High Wind	31	1.1	$879,110	$32,560	$144,633	$6,574

Source: 1 Indicates data is from NCEI (1996 to 2022); 2 Indicates data is from USDA RMA (2000 to 2021)

Extent

The Beaufort Wind Scale can be used to classify wind strength, while the magnitude of tornadoes is measured by the Enhanced Fujita Scale. Table 111 outlines the Beaufort scale, provides wind speed ranking, range of wind speeds per ranking, and a brief description of conditions for each ranking.

Table 111: Beaufort Wind Ranking

Ranking	Range of Wind	Conditions
0	<1 mph	Smoke rises vertically
1	1 – 3 mph	Direction shown by smoke but not wind vanes
2	4 – 7 mph	Wind felt on face; leaves rustle; wind vanes move
3	8 – 12 mph	Leaves and small twigs in constant motion
4	13 – 18 mph	Raises dust and loose paper; small branches move
5	19 – 24 mph	Small trees in leaf begin to move
6	25 – 31 mph	Large branches in motion; umbrellas used with difficulty
7	32 – 38 mph	Whole trees in motion; inconvenience felt when walking against the wind
8	39 – 46 mph	Breaks twigs off tree; generally, impedes progress
9	47 – 54 mph	Slight structural damage: chimneypots and slates removed
10	55 – 63 mph	Trees uprooted; considerable structural damages; improperly or mobiles homes with no anchors turned over
11	64 – 72 mph	Widespread damages; very rarely experienced

Source: Storm Prediction Center, 2017[148]

Using the NCEI reported events, the most common high wind event in the planning area is a level 10 on the Beaufort Wind Ranking scale. The reported high wind events ranged from 40 mph to 73 mph, with an average speed of 56 mph.

The Enhanced Fujita Scale replaced the Fujita Scale in 2007. The Enhanced Fujita Scale does not measure tornadoes by their size or width, but rather the amount of damage caused to human-built structures and trees after the event. The official rating category provides a common benchmark that allows comparisons to be made between different tornadoes. The enhanced scale classifies EF0-EF5 damage as determined by engineers and meteorologists across 28 different types of damage indicators, including different types of building and tree damage. To establish a rating, engineers and meteorologists examine the damage, analyze the ground-swirl patterns, review damage imagery, collect media reports, and sometimes utilize photogrammetry and videogrammetry. Based on the most severe damage to any well-built frame house, or any comparable damage as determined by an engineer, an EF-Scale number is assigned to the tornado.

[148] Storm Prediction Center: National Oceanic and Atmospheric Administration. 1805. "Beaufort Wind Scale." http://www.spc.noaa.gov/faq/tornado/beaufort.html.

The following table summarize the Enhanced Fujita Scale and description of common damages. According to a recent report from the National Institute of Science and Technology on the Joplin Tornado, tornadoes rated EF3 or lower account for around 96 percent of all tornado damages.[149]

Table 112: Enhanced Fujita Scale

Storm Category	3 Second Gust (mph)	Damage Level	Damage Description
EF0	65-85 mph	Gale	Some damages to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
EF1	86-110 mph	Weak	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages might be destroyed.
EF2	111-135 mph	Strong	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
EF3	136-165 mph	Severe	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
EF4	166-200 mph	Devastating	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown, and large missiles generated.
EF5	200+ mph	Incredible	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.
EF No rating	--	Inconceivable	Should a tornado with the maximum wind speed in excess of F5 occur, the extent and types of damage may not be conceived. A number of missiles such as iceboxes, water heaters, storage tanks, automobiles, etc. will create serious secondary damage on structures.

Source: NOAA; FEMA

Based on historic record, it is most likely that tornadoes within the planning area will be of EF1 strength. Of the 25 reported tornado events, 10 were EF0, 13 were EF1, one was EF2, and one was EF3.

The extent of damage felt by high wind or tornado events will vary depending on the severity of the event and amount of infrastructure and development within a community or area. Due to the nature of how tornadic events are categorized, significant tornado events will occur in areas with more infrastructure. Communities such as Knoxville and Pella would have greater extent of impacts if a tornado or high wind event were to occur; however, small communities with limited staff and fiscal capability are more likely to have a prolonged recovery period and the extent of damages would be felt more severely.

[149] Kuligowski, E.D., Lombardo, F.T., Phan, L.T., Levitan, M.L., & Jorgensen, D.P. March 2014. "Final Report National Institute of Standards and Technology (NIST) Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri."

Climate Change

For extreme events like tornadoes and high winds "scientists do now know how the frequency and severity of tornadoes will change". The EPA's climate change snapshot indicates that "rising concentrations of greenhouse gases tend to increase humidity, and thus, atmospheric instability, which would encourage tornadoes. But wind shear is likely to decrease, which would discourage tornadoes."[150]

Economic Impacts

Tornadoes and high winds can cause large scale damage to buildings, communication infrastructure, and electrical infrastructure. Water and wastewater can also be impacted if treatment plants are damaged. Downed tree branches and power poles can result in power outages that range in size from a couple blocks to entire portions of a community. Downed trees, branches, and power lines can also block roadways causing delays until they can be removed. These delays could last for several days as recovery may be focused on other areas. Cellphone or other communication towers can be damaged during tornado causing a loss in service. FEMA standard values for traffic delays, potable water loss, wastewater loss, IT/communication loss, and electric power loss can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development

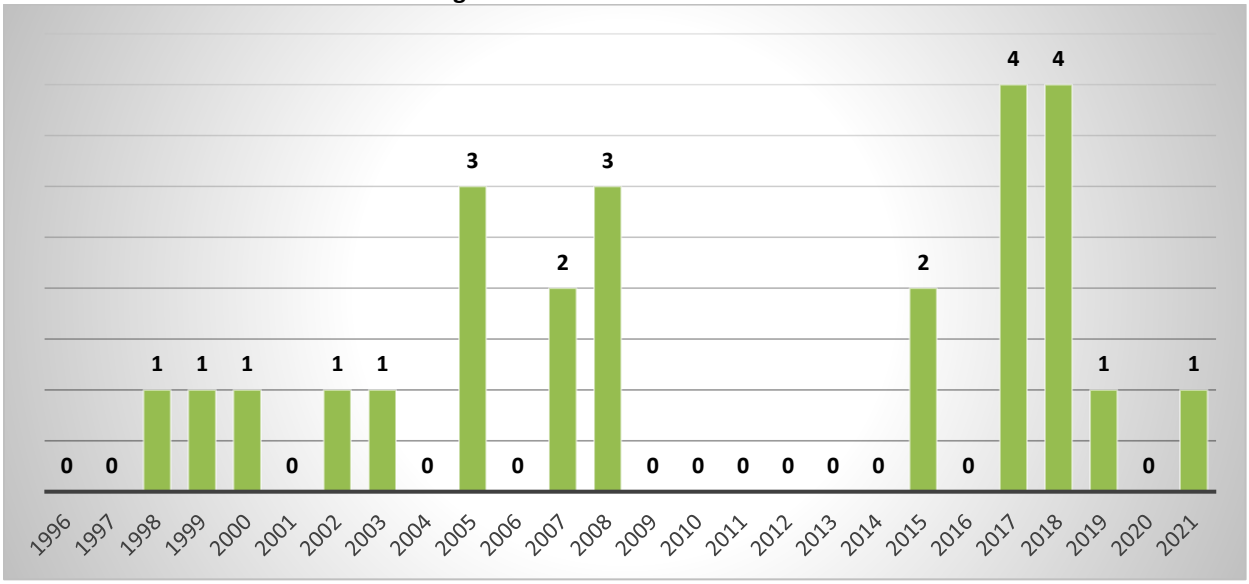
In planning future development, jurisdictions in the planning area should work to ensure that all facilities housing large numbers of people and/or vulnerable populations have access to safe rooms. Additionally, safe rooms can be especially useful in areas with transient populations, such as parks and camp grounds. New development built to modern building codes, and well-maintained older buildings are unlikely to contribute to greater high wind vulnerability. Of course, any structure, regardless of its age or construction, could be damaged by flying debris, fallen trees, or tree limbs.

Probability

Given the historic record of occurrence for high wind (19 out of 27 years with reported events), for the purposes of this plan, the annual probability of high wind occurrence is 70 percent. However, high winds could be more common than presented here but may have simply not been reported in past years. Given the historic record of occurrence for tornado events (13 out of 27 years with reported events), for the purposes of this plan, the annual probability of tornado occurrence is 48 percent.

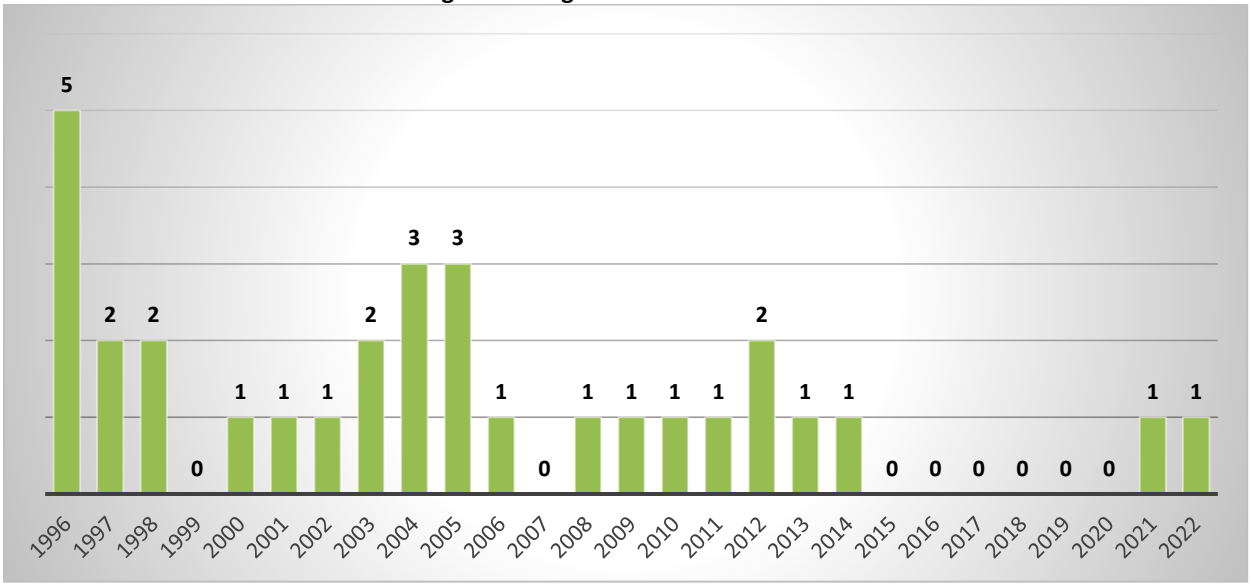
[150] Environmental Protection Agency. 2016. "What Climate Change Means for Iowa". Accessed January 2023. https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ia.pdf

Figure 71: Tornado Events Per Year



Source: NCEI, 1996-2022

Figure 72: High Wind Events Per Year



Source: NCEI, 1996-2022

Community Top Hazard Status

The following jurisdictions identified Tornado and High Winds as a top hazard of concern:

- Marion County
- City of Bussey
- City of Melcher-Dallas
- City of Pella
- City of Pleasantville
- Knoxville School District
- Pella School District

- Twin Cedars School District

Regional Vulnerabilities

The following tables provide information related to regional vulnerabilities and FEMA's National Risk Index values for Tornadoes and High Winds. For jurisdictional specific vulnerabilities, refer to *Section Seven*.

Table 113: Regional Tornado and High Winds Vulnerabilities

SECTOR	VULNERABILITY
People	-Vulnerable populations include those living in mobile homes (especially if they are not anchored properly), nursing homes, and/or schools -People outdoors during events -Citizens without access to shelter below ground or in safe rooms -Elderly with decreased mobility or poor hearing may be higher risk -Lack of multiple ways of receiving weather warnings, especially at night
Economic	-Agricultural losses to both crops and livestock -Damages to businesses and prolonged power outages can cause significant impacts to the local economy, especially with EF3 tornadoes or greater
Built Environment	-All building stock is at risk of significant damages
Infrastructure	-Downed power lines and power outages -All above ground infrastructure at risk to damages -Impassable roads due to debris blocking roadways
Critical Facilities	-All critical facilities are at risk to damages and power outages
Climate	-Changes in seasonal precipitation and temperature normals can increase frequency and magnitude of severe storm events
National Risk Index Values	**Strong Wind** Risk Index – Relatively Low Expected Annual Loss – Relatively Moderate **Tornadoes** Risk Index – Relatively Low Expected Annual Loss – Relatively Moderate

Source: FEMA National Risk Index, 2022

Transportation Incidents

A transportation accident involves an incident between one or more conveyances on land, sea, or air. Transportation accidents can cause property damage, bodily injury, and death. Accidents are influenced by several factors, including the type of driver, road condition, weather conditions, density of traffic, type of roadway, signage, and signaling. Most transportation incidents are of short duration and limited impact.

In the planning area, automobile and rail accidents are likely to be the most common type of incident, though some boating accidents may occur on the Red Rocks Reservoir. Both Knoxville and Pella have municipal airports and hospitals with heliports. Areas surrounding these airports and helicopter landing pads have a slightly higher vulnerability to transportation incidents due to proximity.

Roadways within Marion County consist of state highways and two-lane county roads. The only four lane highway in the county runs as State Highway 5 northeast turning into Highway 92 in Knoxville where it continues running east out of the county. Highway 5 continues as a two-lane road running southeast from Knoxville. Finally, the two-lane Highway 14 allows for north to south transportation.

Location

Transportation incidents are most likely to occur anywhere along major routes in the planning area but are most likely to occur along major highways due to increased speeds and the higher number of vehicles. While any area of the county is vulnerable to an air transportation incident, those living near the Knoxville Municipal Airport (KOXV) and Pella Municipal Airport (PEA) experience a higher level of vulnerability to an air incident. Figure 75 shows the location of the major transportation routes in the planning area.

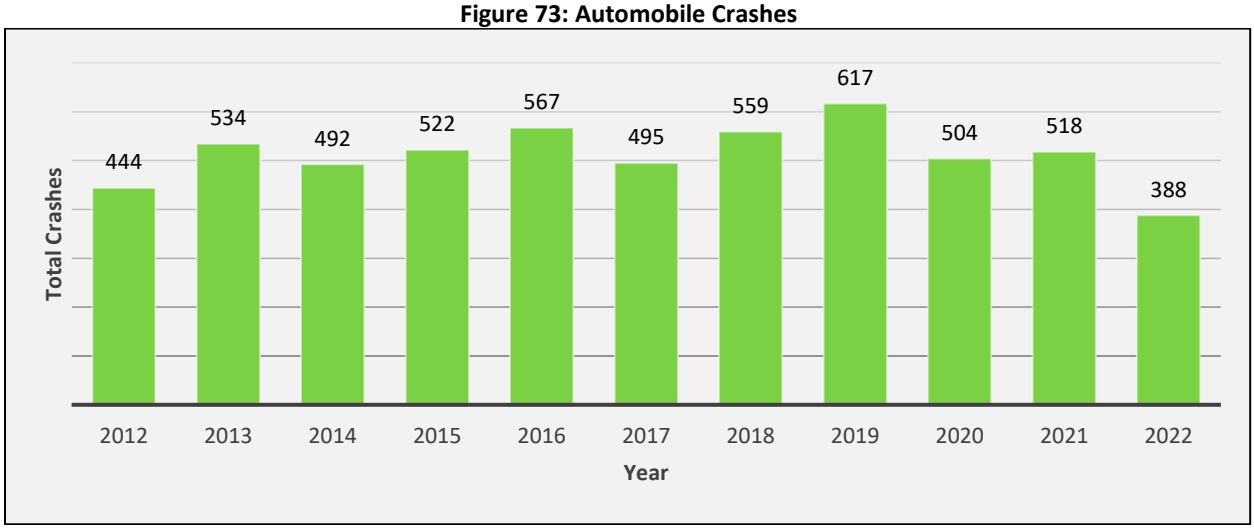
Historical Occurrences

Automobile

The Iowa Department of Transportation (IDOT) maintains records at the county level for certain automobile related accidents. The following figure shows total crashes from 2012 to October 2022[151]. These events resulted in a total of 5,640 crashes, 1,649 injuries, and 38 fatalities. IDOT also reported an estimated $34,979,475 in property damages from these crash events. Of the 5,640 crash events, over 8,000 vehicles and 11,000 occupants were part of an accident. As seen in Figure 74 most automobile crashes between 2015 and 2022 occurred along state highways and county roads with heavy clustering within the cities of Knoxville, Pella, and Pleasantville.

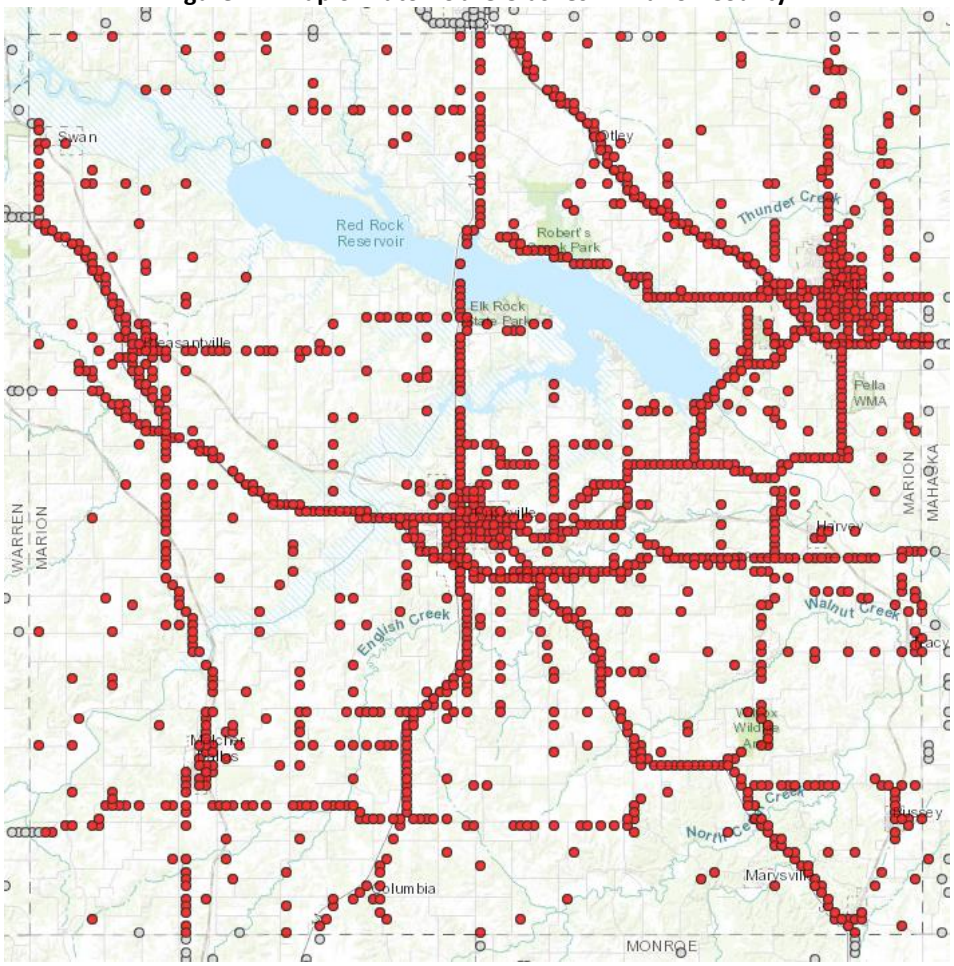
[151] Iowa Department of Transportation. 2022. "ICAT-Iowa Crash Analysis Tool." https://icat.iowadot.gov/

Figure 73: Automobile Crashes



Source: IDOT, 2012-2022

Figure 74: Map of Automobile Crashes in Marion County



Source: IDOT, 2015-2022

Highway Rail

The Federal Railroad Administration (FRA) keeps data on all highway rail accidents since 1975. The FRA reported 46 rail incidents which caused 18 injuries and one death.

Table 114: Historical Highway Rail Incidents

Number of Incidents	Injuries	Fatalities
46	18	1

Source: Federal Railroad Administration, 1975-2022[152]

Aviation

From 1962 through 2022, there were 22 aviation accidents in the planning area, as reported by the National Transportation Safety Board (NTSB) database. The events resulted in 11 injuries and four fatalities.

Table 115: Historical Aviation Incidents

Date	Phase of Flight	Injuries	Fatalities	Nearest Community
11/11/1964	Takeoff - Climb	0	0	Knoxville
2/5/1965	Taxi	0	0	Pella
7/23/1966	Landing	0	0	Knoxville
4/30/1967	Landing	0	0	Pella
5/7/1967	Takeoff – Run	1	0	Pella
5/13/1968	Landing	0	0	Knoxville
9/27/1968	Takeoff - Climb	0	0	Pella
8/28/1969	In flight – Low Pass	0	0	Pella
4/8/1971	Cruise	0	0	Pella
7/7/1971	Landing	1	0	Knoxville
7/31/1971	Landing	0	0	Knoxville
8/25/1971	Landing	0	0	Knoxville
12/29/1976	Cruise	0	0	Pella
9/1/1977	Cruise	0	0	Knoxville
11/29/1980	Takeoff-Run	0	0	Knoxville
6/12/1983	Maneuvering	0	4	Knoxville
7/10/1985	Maneuvering	2	0	Pella
10/1/1989	Landing	0	0	Swan
4/24/1997	Landing	0	0	Pella
5/12/2013	Landing	0	0	Pella
4/17/2017	Takeoff - Climb	0	0	Knoxville
3/26/2019	Landing	0	0	Pella

Source: National Transportation Safety Board, 1962- 2022[153]

[152] Federal Railroad Administration. 2022. "Highway Rail Accidents". https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/on_the_fly_download.aspx.

[153] National Transportation Safety Board. 1962- 2022. "Aviation Accident Database & Synopses". https://www.ntsb.gov/_layouts/ntsb.aviation/index.aspx.

Average Annual Damages

The average damage per event estimate was determined for each incident type based upon records from IDOT, FRA, NTSB, and number of historical occurrences. Only transportation events from FRA included damage totals for specific incidents. This does not include losses from functional downtime, economic loss, injury, or loss of life. Transportation incidents have caused an average of $3,181,324 per year in property damages to the planning area. RMA data is not available for transportation incidents, but crop damage would be expected if an accident occurred in or adjacent to agricultural lands.

Table 116: Transportation Incidents Loss Estimate

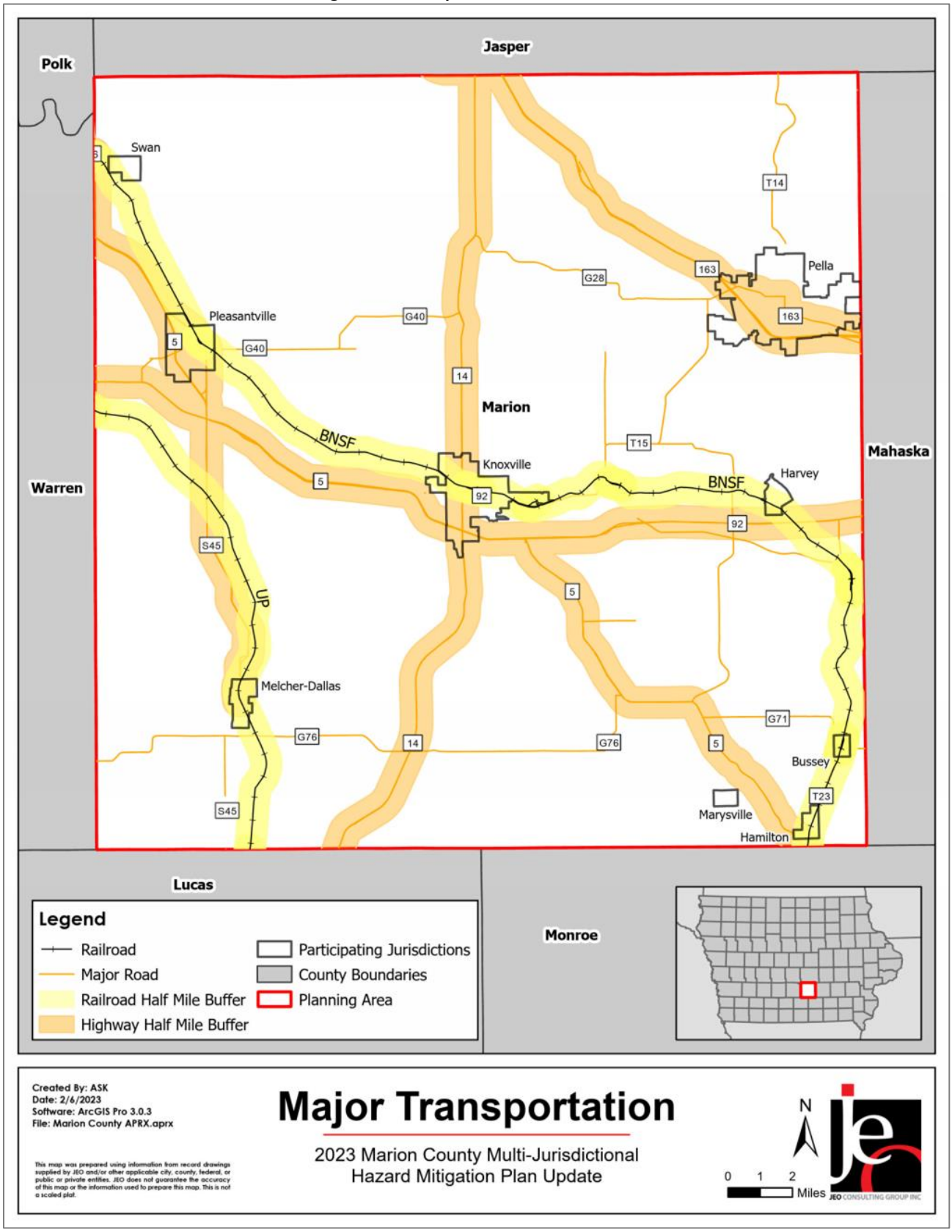
Hazard Type	Number of Events	Average Events per Year	Total Property Loss	Average Annual Property Loss
Auto[1]	5,640	513	$34,979,475	$3,179,952
Aviation[2]	22	0.36	N/A	N/A
Highway Rail[3]	46	0.96	$65,850	$1,372
Total	**5,708**	**514.32**	**$35,045,325**	**$3,181,324**

Source:1 IDOT, 2012- October 2022; 2 NTSB 1962- 2022; 3 FRA 1975- 2022

Extent

The extent of automobile, rail, and air incidents is usually localized, however catastrophic events can occur and may require assistance from outside jurisdictions. Transportation incidents can also cause hazard materials releases, which can further increase damages and risk of injury.

Figure 75: Transportation Corridors



Climate Change

According to the EPA, climate change may affect transportation at local, regional, and national scales with impacts coming from changes in precipitation, extreme weather, and increasing extreme temperatures[154]. These hazards can have serious impacts on the system performance, safety, and reliability of transportation systems. An increase in local flooding may cause roadways to weaken and become unstable. Increasing temperatures can create difficulties for airplanes taking flight or cause damage railway tracks and cracks on roadways.

Economic Impacts

The state highways that run through the county are the most likely location for a transportation incident due to increased speeds and the high number of vehicles. State highways in the county are two-lane with the exception of State Highway 5 being four-lane. Any transportation incident on a two-lane highway will likely cause delays and potential closures until the accident is removed and cleaned up. Transportation incidents can also negatively impact the local economy even when occurring outside the county. Marion County lies adjacent to the intersection of I-35 and I-80. A large incident can cause delays on these vital interstates and other major highways resulting in delays for commuters and shipping. These delays and closures will have a trickle-down effect on local businesses due to shipping delays, reduced customer access, and other impacts. FEMA standard values for traffic delays can be found in *Section 4: Risk Assessment* under *Average Annual Damages and Frequency*.

Future Development

It is recommended that major roadways undergo necessary updates and repairs, such as re-paving, re-grading or drainage improvements. It is also recommended that development continue away from major roads and railways to limit citizens' vulnerability to transportation incidents, as well as potential chemical release/spill.

Probability

The probability of transportation incidents is based on the historic record provided by the IDOT, FRA, and NTSB. Based on the historic record, there is a 100% annual probability of auto incidents, a 26% annual probability (16 out of 61 years with reported events) for aviation incidents, and a 37.5% probability (18 out of 48 years) of highway rail incidents occurring in the planning area each year.

Community Top Hazard Status

The following jurisdictions identified Transportation Incidents as a top hazard of concern:

- City of Pleasantville
- Knoxville School District

Regional Vulnerabilities

The following table provides information related to regional vulnerabilities; for jurisdictional-specific vulnerabilities, refer to *Section Seven: Community Profiles.*

Table 117: Regional Transportation Incidents Vulnerabilities

Sector	Vulnerability
People	-Injuries and fatalities to drivers and passengers

[154] United States Environmental Protection Agency. 2022. "Climate Change Impacts on Transportation" https://www.epa.gov/climateimpacts/climate-change-impacts-transportation

SECTOR	VULNERABILITY
	-Injuries and fatalities to those nearby if hit
Economic	-Prolonged road closures and detours for clean-up
Built Environment	-Potential damage to nearby buildings
Infrastructure	-Damage to roadways, utility poles, and other infrastructure if struck by a vehicle
Critical Facilities	-Roadway closures -Damage to facilities if located near transportation routes
Climate	-Increased risk to damaged roadways from climate change can contribute to accident prevalence

Section Five
Mitigation Strategy

Introduction

The primary focus of the mitigation strategy is to identify action items to reduce the effects of hazards on existing infrastructure and property based on the established goals and objectives. These actions should consider the most cost effective and technically feasible manner to address risk.

The establishment of goals took place during the kick-off meeting with the Hazard Mitigation Planning Team. Meeting participants reviewed the goals from the 2016 HMP and discussed recommended additions and modifications. The intent of each goal is to develop strategies to account for risks associated with hazards and identify ways to reduce or eliminate those risks.

The Hazard Mitigation Planning Team decided to keep the same list of goals from the 2016 HMP, with a couple slight modifications. One of the subobjectives for the second goal was removed as was identified as an actionable objective. The goals were then shared with all local community representatives at the Round 1 public meetings.

Requirement §201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these tools.

Requirement §201.6(c)(3)(i): The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Requirement §201.6(c)(3)(ii): The mitigation strategy shall include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. The jurisdiction's participation in the National Flood Insurance Program and continued compliance with NFIP requirements, as appropriate, must also be addressed.

Requirement: §201.6(c)(3)(iii): The mitigation strategy section shall include an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

Requirement §201.6(c)(3)(iv): For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.

Summary of Changes

The development of the mitigation strategy for this plan update includes the addition of new mitigation and strategic actions, updated status or removal of past actions, and revisions to the mitigation and strategic action selection process or descriptions of actions for consistency across the planning area. A key change included identifying at least one mitigation action to address each hazard of top concern to meet new regulatory guidance by FEMA.

Goals

Below is the final list of goals as determined for this plan update. These goals provide direction to guide participants in reducing future hazard related losses.

- **Goal 1**: Protect the Health and Safety of Residents
  - **Objective 1.1**: Reduce or prevent damage to property or prevent loss of life or serious injury
- **Goal 2**: Reduce Future Losses from Hazard Events
  - **Objective 2.1**: Provide protection for existing structures, future development, critical facilities, services, utilities, vulnerable areas or populations, and trees.
  - **Objective 2.2**: Develop hazard specific plans, conduct studies or assessments, and retrofit buildings and facilities to mitigate hazards and minimize their impact.
  - **Objective 2.3**: Minimize the impact of hazard events through enacting or updating ordinances, permits, laws or regulations.
- **Goal 3**: Increase Public Awareness and Education Regarding Vulnerabilities to Hazards
  - **Objective 3.1**: Develop and provide information to the public and property owners about their risk and vulnerability to hazards.
- **Goal 4**: Improve Emergency Management Capabilities
  - **Objective 4.1**: Develop or update City and/or County Emergency Response Plan(s) and procedures and increase the capability to respond.
  - **Objective 4.2**: Develop or improve Evacuation Plans and procedures.
  - **Objective 4.3**: Improve warning systems and ability to communicate to the public during and following a disaster or emergency.
- **Goal 5**: Pursue Multi-Objective Opportunities (whenever possible)
  - **Objective 5.1**: When possible, use existing resources, agencies, and programs to implement the projects.
  - **Objective 5.2**: When possible, implement projects that achieve several goals.
- **Goal 6**: Enhance Overall Resilience and Promote Sustainability
  - **Objective 6.1**: Incorporate hazard mitigation and adaptation into updating other local planning endeavors (e.g. comprehensive plans, zoning ordinance, subdivision regulation, etc.)

Selected Mitigation and Strategic Actions

Local community representatives evaluated and prioritized mitigation and strategic actions at the local level. These actions included: the mitigation and strategic actions identified per jurisdiction in the previous plan; additional mitigation and strategic actions discussed during the planning process; and recommendations from JEO for additional mitigation and strategic actions based on risk probability and vulnerability at the local level.

The Hazard Mitigation Planning Team provided each participant a link to the FEMA Handbook as a list of mitigation actions to be used as a starting point. Participants were also encouraged to think of actions that may need FEMA grant assistance and to review their hazard prioritization for potential mitigation actions. These suggestions helped participants determine which actions would best assist their respective jurisdiction in alleviating damages in the event of a disaster. The listed priority rating does not indicate which actions will be implemented first but serves as a guide in determining the order in which each action should be implemented. Participants were informed of the STAPLEE (Social, Technical, Administrative,

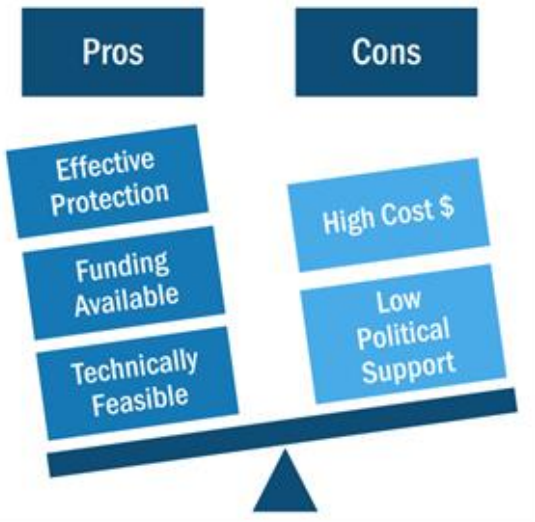
Political, Legal, Economic, Environmental) feasibility review process and were encouraged to use it when determining project priorities.

These prioritized projects are the core of a hazard mitigation plan. The local planning teams were instructed that each action must directly relate to the goals of the plan and the hazards of top concern for their jurisdiction. Actions must be specific activities that are concise and can be implemented individually. Mitigation and strategic actions were evaluated based on referencing the community's risk assessment and capability assessment. Jurisdictions were encouraged to choose mitigation and strategic actions that were realistic and relevant to the concerns identified.

Mitigation actions were prioritized by the local planning team members according to criterion most applicable to their jurisdiction. Note that the listed priority rating does not indicate which actions may be implemented first – as some low priority actions may be easily accomplished while high priority actions may require a more time-consuming implementation process. Not all mitigation actions identified by a community can be a high priority project due to a lack of funds, time, or local capacity. Representatives were tasked with considering the pros and cons of the following amongst the local planning team when determining whether to pursue a mitigation action and its priority level:

- Does the action address a local concern? To what extent does it mitigate local risk? Does the action address multiple hazard concerns or broadly improve resiliency?
- How much might the action cost? Are the costs reasonable compared to probable benefits? Are there local funds to accomplish the project or is outside funding needed?
- Does the lead agency or responsible party have the time, expertise, or capacity to implement the project?
- Does the project or action have local and/or political support?
- Is the project prohibitive in some way? For example: financially prohibitive; lacking legal authority to implement; strong local opposition; etc.

Generally, high priority actions either address a major concern for the jurisdiction, have few to no challenges in implementation, and/or garner large support from the public and administration. Low priority actions either address a minor concern for the jurisdiction, have many challenges in implementation, and/or may not have support from the public or administration at this time. Medium priority actions may only have one or two of the items listed above. A mitigation action's priority may change very quickly as circumstances change. All mitigation action priority levels were established qualitatively by the local planning team members. Future updates to the plan should consider a quantitative approach to feasibility, benefit, and support when prioritizing actions.



It is important to note that not all the mitigation and strategic actions identified by a jurisdiction may ultimately be implemented due to limited capabilities; availability of existing information; prohibitive costs or funding opportunities and limitations; low benefit-cost ratio; administrative capabilities of communities; or other concerns. These factors may not be identified during this planning process. The cost estimates, priority rating, potential funding, and identified agencies are used to give communities an

idea of what actions may be most feasible over the next five years. This information will serve as a guide for the participants to assist in hazard mitigation for the future. Also, some jurisdictions may identify and pursue additional mitigation and strategic actions not identified in this HMP.

Mitigation and strategic actions identified by participants of the Marion County HMP are found in the Mitigation and Strategic Actions Project Matrix below. The information listed in the following tables is a compilation of new and ongoing mitigation and strategic actions identified by jurisdiction. Completed and removed actions can be found in respective community profiles. Each action includes the following information in the respective community profile.

- Action: General title of the action item.
- Description: Brief summary of what the action item(s) will accomplish.
- Hazard(s) Addressed: Which hazard the action aims to address.
- Estimated Cost: General cost estimate for implementing the action for the appropriate jurisdiction.
- Funding: A list of any potential local funding mechanisms to fund the action.
- Timeline: General timeline as established by planning participants.
- Priority: General description of the importance and workability in which an action may be implemented (high/medium/low); priority may vary between each community, mostly dependent on funding capabilities and the size of the local tax base.
- Lead agency: Listing of agencies or departments which may lead or oversee the implementation of the action item.
- Status: A description of what has been done, if anything, to implement the action item.

Table 118: Mitigation and Strategic Actions Selected by Each Jurisdiction (1 of 2)

Actions	Goal	Marion County	City of Bussey	City of Harvey	City of Knoxville	City of Melcher-Dallas	City of Pella	City of Pleasantville
Abandoned Properties	Goal 2	X						X
Backup Generators	Goal 1, 2	X	X	X	X			X
Backup Files	Goal 6			X		X		
Backflow Devices	Goal 2						X	
Building Codes	Goal 6					X		
Bury Utility Lines	Goal 2						X	
Chemical Container Removal	Goal 1					X		
Civil Service Improvements	Goal 3				X			
Emergency Communications	Goal 4	X						
Emergency Preparedness Drills	Goal 4	X			X	X		X
Emergency Vehicle Tracking	Goal 4	X					X	
Flood-Prone Structures	Goal 1				X			
GIS Mapping	Goal 3, 5	X			X			
Grade Control Structure	Goal 1							X
Hazard Signs	Goal 3	X						
Highway 5 Traffic Changes	Goal 3							X
Improve Hazardous Incident Response	Goal 4, 5, 6				X			
Impervious Manhole Covers	Goal 2						X	
Jurisdictional Plans	Goal 6							X
Lagoon Improvements	Goal 2							X
Multi-Family Fire Extinguishers	Goal 1						X	
New Fire Truck and Ambulance	Goal 4						X	
New or Upgrade Fire Station	Goal 4				X			
Public Awareness and Education	Goal 3		X	X			X	X
Redundant Utilities	Goal 2							X
Road Bypass Projects	Goal 2						X	
Road Closure Barricades	Goal 2	X						
Security Upgrades	Goal 1						X	
Sewer and Water Upgrades	Goal 2							X
Shelters or Safe Rooms	Goal 1			X	X	X	X	X
Soil Erosion Stabilization Projects	Goal 2	X						
Standby Pumps	Goal 2				X			

Actions	Goal	Marion County	City of Bussey	City of Harvey	City of Knoxville	City of Melcher-	City of Pella	City of Pleasantville
Stormwater Controls	Goal 2				X			
Stormwater Detention Pond	Goal 2							X
Stormwater Drainage	Goal 2			X		X	X	X
Stream Modifications	Goal 2						X	
Study Illegal Sump Pump	Goal 2					X	X	X
Tree Planting Program	Goal 2	X						
Upgrade Equipment	Goal 4	X					X	
Upgrade Radios	Goal 4					X	X	
Warning Sirens	Goal 4							X
Watershed Studies	Goal 6	X						

Table 119: Mitigation and Strategic Actions Selected by Each Jurisdiction (2 of 2)

Actions	Goal	Knoxville Community School District	Melcher-Dallas School District	Pella Community School District	Pella Christian Schools	Twin Cedars School District
Alternate Bus Routes	Goal 1	X				
Backup Generators	Goal 1, 2		X	X	X	X
Handicap Accessibility	Goal 1					X
Jurisdictional Plans	Goal 4		X	X		
Shelters or Safe Rooms	Goal 1	X	X	X		X
Security Upgrades	Goal 1		X			

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Section Six
Plan Implementation and Maintenance

Monitoring, Evaluating, and Updating the Plan

Each participating jurisdiction in the Marion County HMP is responsible for monitoring (annually at a minimum), evaluating, and updating the plan during its five-year lifespan. Hazard mitigation and strategic projects will be prioritized by each participant's governing body with support and suggestions from the public and business owners. Unless otherwise specified by each participant's local planning team, the governing body will be responsible for implementing the recommended projects. The responsible party for the various implementation actions will report on the status of all projects and include which implementation processes worked well, any difficulties encountered, how coordination efforts are proceeding, and which strategies could be revised.

As projects or mitigation and strategic actions are implemented, a detailed timeline of how that project was completed should be written and attached to the plan in a format selected by the governing body. Information that will be included will address project timelines, agencies involved, area(s) benefited, total cost (if complete), etc. At the discretion of each governing body, local planning team members, and other identified relevant stakeholders should review the original draft of the mitigation plan and recommend applicable changes.

Plan review and updates will occur annually, with a complete update occurring every five years at a minimum. At the discretion of each governing body, updates may be incorporated more frequently, especially in the event of a major hazard or as additional mitigation needs are identified. Local planning team members should engage with the public, other elected officials, and multiple departments as they review and update the plan. The persons overseeing the evaluation process will review the goals and objectives of the previous plan and evaluate them to determine whether they are still pertinent and current. Among other questions, they may want to consider the following:

Requirement §201.6(c)(4)(i): The plan maintenance process shall include a section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

Requirement §201.6(c)(4)(ii): The plan shall include a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

Requirement §201.6(c)(4)(iii): The plan maintenance process shall include a discussion on how the community will continue public participation in the plan maintenance process.

Requirement §201.6(d)(3): A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within five years to continue to be eligible for mitigation project grant funding.

- Do the goals and objectives address current and expected conditions?
- If any of the recommended projects have been completed, did they have the desired impact on the goal for which they were identified? If not, what was the reason it was not successful (lack of

funds/resources, lack of political/popular support, underestimation of the amount of time needed, etc.)?
- Have either the nature, magnitude, and/or type of risks changed?
- Are there implementation problems?
- Are current resources appropriate to implement the plan?
- Were the outcomes as expected?
- Did the plan partners participate as originally planned?
- Are there other agencies which should be included in the revision process?

Worksheets in *Appendix C* may also be used to assist with plan review and updates.

Plan Amendments

If new, innovative mitigation strategies arise that could impact the planning area or elements of this plan, which are determined to be of importance, a plan amendment may be proposed and considered separate from the annual review and other proposed plan amendments. The applicable Hazard Mitigation Planning Team will compile a list of proposed amendments received annually and prepare a report for state officials, who will file it with FEMA. Re-adoption of the plan would not be needed until the normal five-year update. Such amendments should include all applicable information for each proposed action, including description of changes, identified funding, responsible agencies, etc. For an amendment template, see Appendix C.

In addition, the governing body will be responsible for ensuring that the HMP's goals are incorporated into applicable revisions of other planning mechanisms per jurisdiction. These plans may include: Comprehensive Plans, Capital Improvement Plans, Zoning Ordinances, Floodplain Ordinances, Building Codes, and/or Watershed Management Plans. Future updates of this HMP will review and update discussions of plan integration per community as appropriate.

Continued Public Involvement

To ensure continued plan support and input from the public and business owners, public involvement should remain a top priority for each participating jurisdiction. Notices for public meetings involving discussion of an action on mitigation updates should be published and posted in the following locations:

- Public spaces around the jurisdiction
- City/Village Hall
- Websites
- Social media
- Local radio stations
- Local newspapers
- Regionally distributed newsletters

Any amendments to the HMP as determined through public involvement or community actions must be submitted to HSEMD for inclusion in the final HMP.

Integrating Other Capabilities

There are a number of state and federal agencies with capabilities that can be leveraged during HMP updates or mitigation and strategic action implementation. A description of some regional resources is provided below.

Iowa Department of Homeland Security and Emergency Management

HSEMD is the coordinating body for homeland security and emergency management activities across the state of Iowa. HSEMD is responsible for emergency management, which is usually divided into five phases: preparedness, response, recovery, prevention, and mitigation.

The governor appoints the Iowa homeland security advisor and the director of the Iowa Department of Homeland Security and Emergency Management. The HSEMD director serves as the state administrative agent for grants administered by the federal government: such as HMGP, FMA and BRIC. HSEMD is responsible for developing the state hazard mitigation plan, which serves as a comprehensive set of guidelines for hazard mitigation across the state. The state hazard mitigation officer (SHMO) is responsible for the coordination of plan updates and maintenance. The SHMO also serves as the lead coordinator for the State Hazard Mitigation Team (SHMT), which provides input on the state hazard mitigation planning process.

For more information regarding HSEMD responsibilities as well as their ongoing projects and programs, please go to https://homelandsecurity.iowa.gov/.

Iowa Department of Natural Resources

The IDNR is committed to providing Iowa's citizens and leaders with the data and analyses they need to make appropriate natural resource decisions for the benefit of all Iowan's both now and in the future. This state agency is responsible in the areas of forest and prairie management, fish and wildlife programs, fire prevention, surface water and groundwater, floodplain management, dam safety, natural resource planning, animal feeding operations, permitting, solid waste management, household hazardous materials and many other programs and services. IDNR also coordinates with the US Forest Service, State and private forest agencies, the Big Rivers Forest Fire Management Compact to support natural resource managers and fire departments in fire prevention efforts.

For more information regarding IDNR's responsibilities as well as their ongoing projects, please go to https://www.iowadnr.gov/.

Silver Jackets Program

The Silver Jackets program is also worth mentioning for their extensive role in providing a formal and consistent strategy for an interagency approach to planning and implementing measures to reduce the risks associated with flooding and other natural hazards. It brings together multiple state, federal, and sometimes tribal and local agencies to learn from one another and apply their knowledge to reduce risk. The State Hazard Mitigation Team and the Iowa Flood Risk Management Team, also known as the Silver Jackets, coordinate efforts related to the review and update of the Iowa Hazard Mitigation Plan. The State Hazard Mitigation Team has largely delegated flood mitigation interagency coordination to the Silver Jackets.

At this time the Silver Jackets do not have any projects taking place in the Marion County planning area.

Unforeseen Opportunities

If new, innovative mitigation strategies arise that could impact the planning area or elements of this plan, which are determined to be of importance, a plan amendment may be proposed. If a new mitigation action is identified in between the five-year updates, it is recommended to share this amendment with Marion County Emergency Management, as the plan sponsor, and with HSEMD, who will file it with FEMA. Re-adoption of the plan would not be needed until the normal five-year update. Such amendments should include all applicable information for each proposed action, including description of changes, identified funding, responsible agencies, etc. For an amendment template, see Appendix C.

Incorporation into Existing Planning Mechanisms

The Hazard Mitigation Planning Team utilized a variety of plan integration tools to help communities determine how their existing planning mechanisms were related to the Hazard Mitigation Plan. Utilizing FEMA's *Integrating Hazard Mitigation Into the Local Comprehensive Plan*[155] guidance, as well as FEMA's *2015 Plan Integration*[156] guide, each jurisdiction engaged in a plan integration discussion. This discussion was facilitated by a Plan Integration Worksheet, created by the Hazard Mitigation Planning Team. This document offered an easy way for participants to notify the Hazard Mitigation Planning Team of existing planning mechanisms, and if they interface with the HMP.

Each jurisdiction referenced all relevant existing planning mechanisms and provided information on how these did or did not address hazards and vulnerability. Summaries of plan integration are found in each participant's *Community Profile*. For jurisdictions that lack existing planning mechanisms, especially smaller communities, the HMP may be used as a guide for future activity and development in the jurisdiction.

[155] Federal Emergency Management Agency. July 2020. "FEMA Region X Integrating the Local Natural Hazard Mitigation Plan into a Community's Comprehensive Plan." https://www.fema.gov/sites/default/files/2020-07/integrating-hazard-mitigation-local-plan.pdf

[156] Federal Emergency Management Agency. July 2015. "Plan Integration: Linking Local Planning Efforts." https://www.fema.gov/sites/default/files/2020-06/fema-plan-integration_7-1-2015.pdf

Section Seven
Community Profiles

Purpose of Community Profiles

Community Profiles contain information specific to jurisdictions participating in the Marion County planning effort. Community Profiles were developed with the intention of highlighting each jurisdiction's unique characteristics that affect its risk to hazards. Community Profiles may serve as a reference of identified vulnerabilities and mitigation and strategic actions for a jurisdiction as they implement the mitigation plan. Information from individual jurisdictions was collected at public and one-on-one meetings and used to establish the plan. Community Profiles include the following elements:

- Local Planning Team
- Location and Geography
- Demographics
- Employment and Economics
- Housing
- Governance
- Capability Assessment
- Plans and Studies
- Future Development Trends
- Community Lifelines
- Parcel Improvements and Valuation
- Hazard Prioritization
- Mitigation Strategy
- Plan Maintenance

In addition, maps specific to each jurisdiction are included, such as jurisdiction identified critical facilities, flood-prone areas, and a future land use map (when available).

The hazard prioritization information, as provided by individual participants, varies due in large part to the extent of the geographical area, the jurisdiction's designated representatives (who were responsible for completing meeting worksheets), identification of hazards, and occurrence and risk of each hazard type.

The overall risk assessment for the identified hazard types represents the presence and vulnerability to each hazard type throughout the entire planning area. A discussion of certain hazards selected for each Community Profile was prioritized by the local planning team based on the identification of hazards of greatest concern, hazard history, and the jurisdiction's capabilities. The hazards not examined in depth for each community profile can be found in *Section Four: Risk Assessment*.

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Section Eight
Funding Guidebook

Overview

The following *Hazard Mitigation Project Funding Guidebook* is intended to provide initial guidance on hazard mitigation project funding opportunities and where to find more information on grants. The information included is consistent with established processes for hazard mitigation planning. However, it is important to note the following in terms of the context for this guidebook relative to the overall planning process.

Project identification includes identifying all possible options (or alternatives) to address planning objectives; at this stage, all options are viable. At times, the best option may be to work with other stakeholders in the community to design solutions that are in line with community values while reducing risk (e.g., a bike path or ball field that can double as a retention area, or the preservation of an animal habitat that also serves as a natural buffer). These types of solutions can often be funded in very innovative ways, including solutions which increase local industry and revenue (e.g., tapping into the entrepreneurial community). For information on the broad range of mitigation project types and how projects have been implemented in communities across the country, please refer to FEMA's Mitigation Best Practices webpage at https://www.fema.gov/mitigation-best-practices-portfolio.

It should be noted that the grant programs listed in this guidebook are not the only ones that could support hazard mitigation project implementation. Additionally, many of these programs are dependent on yearly funding allocations, resulting in fluctuations in their fund availability. However, at this point, it is more important to be aware of the potential for various avenues of support for a broad array of project types. As needs and potential hazard mitigation project options are identified, more information can begin to be gathered on the range of programs which might be utilized. It will be more efficient to start with project options and then follow up with the identification of potential matches, working with the full range of available programs and agencies as part of a comprehensive project evaluation process.

When the current FEMA hazard mitigation planning program was formulated in the late 1990s as part of the Disaster Mitigation Act of 2000, there was an assumption that federal funding would be provided on a substantial, on-going basis for implementing hazard mitigation projects. However, the level of funding has varied from year to year and future prospects are unclear. Additionally, some communities have not been successful in their pursuit of these grants and have not seen the value of their investment in mitigation planning. While participation in a hazard mitigation plan is required for a jurisdiction to be eligible for FEMA funds, those are not the only funding source available for mitigation actions. Depending on the type of mitigation project being pursued, FEMA funding is not always the best option either, so it is increasingly important to look for other opportunities.

Opportunities for funding and technical assistance exist in various federal, state, and local agencies. Non-governmental funding opportunities are available at the regional or local level with private sector businesses, private foundations, and other non-governmental organizations (NGOs). In order to fully map out the range of local and state options, it is necessary to undertake a detailed stakeholder analysis – something which has not been done at this time. The following contains an overview of key federal and

state programs that may include opportunities for hazard mitigation project funding, as well as additional information on suggested alternative funding routes.

Federal Funding Resources

Information about federal hazard mitigation project funding opportunities is organized by agency. Under each agency heading, applicable grant programs are listed with a description of the grant and, when available, information on typical funds available, eligibility, examples of past projects funded, and any additional relevant information. Agencies covered in this guidebook include:

- FEMA
- US Forest Service
- US Army Corps of Engineers
- US Bureau of Reclamation – WaterSMART
- US Department of Agriculture
- US Department of Agriculture Rural Development Funding
- US Department of Energy
- US Department of Housing and Urban Development
- US Economic Development Administration
- US Environmental Protection Agency
- US Fish and Wildlife Service

Note: This is not a complete list of all federal funding opportunities. These grant programs have been chosen for their applicability to popular mitigation actions. The websites and reference materials used to provide this information are as current as possible; however, it is important to note that funding programs are dynamic and subject to frequent changes. While it is helpful to be familiar with the current information, it is equally as important to engage candidate federal and state agencies in a dialog as soon as possible.

Federal Emergency Management Agency

BUILDING RESILIENT INFRASTRUCTURE AND COMMUNITIES PROGRAM	
Description	This FEMA program aims to focus on research-supported, proactive investment in community resilience. Through BRIC, FEMA invests in a variety of mitigation activities with an added focus on infrastructure projects benefitting disadvantaged communities, nature-based solutions, climate resilience and adaption, and adopting hazard resistant building codes.
Funds Available	For Fiscal Year 2022, FEMA will distribute up to $2.295 billion through the BRIC program in the following manner.
Eligibility	Eligible states, territories and federally recognized tribal governments can submit applications on behalf of subapplicants for BRIC funding. Applicants may have their own priorities or requirements when screening their subapplications. Subapplicants cannot submit these directly to FEMA. Subapplicants must submit them to their applicant for review and submission. Subapplicants are local governments, including cities, townships, counties, special district governments, state agencies and federally recognized tribal governments and must submit subapplication to their state, territory, or tribal applicant agency.
Examples	The top five type of projects funded in Fiscal Year 2021 included Flood Control, Utility/Infrastructure Protection, Stabilization and Restoration, Mitigation Reconstruction, and Retrofits.
Additional Information	A cost share is required for all subapplications funded under BRIC. The non-federal cost share funding may consist of cash; donated or third-party in-kind services and materials; or any combination thereof. Generally, the cost share for this program is 75% federal cost share funding/25% non-federal cost share funding. Additional information can be found at https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities/before-apply#funding

FIRE MANAGEMENT ASSISTANCE GRANT (FMAG) PROGRAM	
Description	FMAG is available to states, local and tribal governments, for the mitigation, management, and control of fires on publicly or privately-owned forests or grasslands, which threaten such destruction as would constitute a major disaster.
Funds Available	The individual fire cost threshold is based on total eligible costs for the declared fire. The individual fire cost threshold for a state is the greater of $100,000 or 5 percent times the statewide per capita indicator, multiplied by the state population (the statewide per capita indicator is adjusted annually for inflation [e.g., the FY21 indicator is $1.55]).
Eligibility	Eligible applicants are entities legally responsible for the firefighting activities that reimbursement is being requested for, this includes states, local governments, and tribal governments.
Examples	Eligible firefighting costs may include expenses for field camps, repair and replacement tools, mobilization and demobilization activities, equipment use, materials and supplies.
Additional Information	https://www.fema.gov/assistance/public/fire-management-assistance

FLOOD MITIGATION ASSISTANCE PROGRAM	
Description	FMA is a competitive program that provides funding for projects that reduce or eliminate the risk of repetitive flood damages to buildings insured by the National Flood Insurance Program. Projects must be cost effective, located in a participating NFIP community in good standing, align with the current hazard mitigation plan, and meet all environmental and historical preservation requirements.
Funds Available	Fiscal Year 2022 had $800 million available for distribution which was more than five times the amount available for Fiscal Year 2021.
Eligibility	States, territories, and federally recognized tribes are eligible. Local governments are considered sub-applicants and must apply to the State, territory, or tribe.
Examples	Projects include: project scoping, technical assistance, community flood mitigation projects, individual structure/property-level flood mitigation projects, and management costs.
Additional Information	Cost share is required for all subapplications funded by the Flood Mitigation Assistance program. Generally, the cost share for this program is 75% federal / 25% non-federal. Contributions of cash, third-party in-kind services, materials, or any combination thereof, may be accepted as part of the non-federal cost share. More information can be found at https://www.fema.gov/grants/mitigation/floods

HAZARD MITIGATION GRANT PROGRAM (HMGP)	
Description	FEMA's Hazard Mitigation Grant Program provides funding to state, local, tribal and territorial governments so they can develop hazard mitigation plans and rebuild in a way that reduces, or mitigates, future disaster losses in their communities. Funding is available when authorized under a Presidential major disaster declaration and in areas of the state requested by the Governor. Federally recognized tribes may also submit a request for a Presidential major disaster declaration within their impacted areas. All state, local, tribal and territorial governments must develop and adopt hazard mitigation plans to receive funding for their hazard mitigation projects.
Funds Available	Amount of funding is based on the estimated total or aggregate cost of disaster assistance: Up to 15% of the first $2 billion; Up to 10% for amounts between $2 billion and $10 billion; Up to 7.5% for amounts between $10 billion and $35.333 billion; States with enhanced mitigation plans: Up to 20%, not to exceed $35.333 billion.
Eligibility	Project eligibility under HMGP can be limited by the State as part of the HMGP Administrative Plan developed post-disaster. For example, funding may only be made available for projects that are related to the type of disaster, i.e., HMGP related to a significant flood disaster declaration may only be designated for flood mitigation projects like acquisitions of repetitively flooded properties.
Examples	Retrofitting existing buildings to make them less susceptible to damage from a variety of natural hazards. Purchasing hazard prone property to remove people and structures from harm's way. Drainage improvement projects to reduce potential for flood damage. Eligible project types do not have to coincide with the type of disaster declaration, as the state decides funding prioritization accordingly.

HAZARD MITIGATION GRANT PROGRAM (HMGP)	
Additional Information	In this program, private homeowners and businesses cannot apply for a grant. However, a local community or other public entity may apply for funding on their behalf. Generally, the cost share is 75% federal and 25% non-federal funding. The 25% can come from any non-federal source, such as the state or local government, an individual, private contributions, Increased Cost of Compliance (ICC) funds from a flood insurance policy, or Small Business Administration loans. Additional information can be found at: https://www.fema.gov/grants/mitigation/hazard-mitigation/before-you-apply

HMGP-POST FIRE	
Description	This program provides funding to help communities implement hazard mitigation measures focused on reducing the risk of harm from wildfire. Provides hazard mitigation grant funding to state, local, tribal, and territorial governments in areas receiving a Fire Management Assistance Grant (FMAG) declaration. The FMAG is the Disaster Declaration required and funding amounts are determined by FEMA based on an annual national aggregate calculation of the past 10 year's FMAG declarations.
Funds Available	Funds available each year are based on an average of historical Fire Management Assistance Grant declarations from the past 10 years. Total funding available for each FMAG declaration in Fiscal Year 2022 is $786,552 for applicants with a standard hazard mitigation plans and $1,048,736 for those with an enhanced hazard mitigation plan. Multiple event funding will be aggregated into one grant under the first declaration.
Eligibility	Eligible projects include defensible space initiatives, ignition-resistant construction, hazardous fuels reduction, erosion control measures, slope failure prevention measures and flash flooding prevention measures.
Examples	Defensible space, reducing hazardous fuels, removing standing burned trees, ignition-resistant construction, installing warning signs, strengthen or harden water systems that were burned and caused contamination, reseeding ground cover, planting grass to prevent noxious weeds, erosion barriers on slopes, modify/remove culverts, drainage dips and emergency spillways.
Additional Information	The application period opens with the state or territory's first FMAG declaration of the fiscal year and closes six months after the end of that fiscal year. Application extensions may be requested. https://www.fema.gov/grants/mitigation/post-fire

PRE-DISASTER MITIGATION (PDM)	
Description	The Pre-Disaster Mitigation grant program makes federal funds available to state, local, tribal, and territorial governments to plan for and implement sustainable cost-effective measures. These mitigation efforts are designed to reduce the risk to individuals and property from future natural hazards, while also reducing reliance on federal funding from future disasters.
Funds Available	On March 1, 2023, FEMA published a Notice of Funding Opportunity (NOFO) for FY23 Pre-Disaster Mitigation grant program. The total amount of funds that are being made available to 100 congressionally directed projects will be

PRE-DISASTER MITIGATION (PDM)	
	$233,043,782. Applicants may request up to an additional 5% of project costs for management and administration of the program from a separate pool of funds.
Eligibility	Only states, territories, or federally recognized tribal governments identified by Congress in the Consolidated Appropriations Act and enumerated in the accompanying Joint Explanatory Statement for Division F are identified in this Notice of Funding Opportunity (NOFO) and are eligible to apply. All applicants and subapplicants must have a FEMA-approved Hazard Mitigation Plan by the application deadline
Examples	Storm Shelters, Wildfire Prevention Project, Bridge Rehabilitation, Drainage Improvements, Water Storage Tanks, Flood Mitigation Planning Projects, Evacuation Center, and more.
Additional Information	https://www.fema.gov/grants/mitigation/pre-disaster

RECOVERY AND RESILIENCE RESOURCE LIBRARY	
Description	FEMA developed library to navigate the numerous programs available to the United States and its territories to help recover from a disaster. Tool helps users to find and research federal disaster recovery resources that would be beneficial to pre-disaster recovery planning or in the wake of a disaster.
Funds Available	Varies
Eligibility	Resources are intended for state, local, territorial, and tribal governments as well as non-profits, businesses, healthcare institutions, schools, individuals, and households.
Examples	Evidence-based or evidence-informed interventions to strengthen rural and urban communities.
Additional Information	https://www.fema.gov/emergency-managers/practitioners/recovery-resilience-resource-library

STATE AND LOCAL CYBERSECURITY GRANT PROGRAM	
Description	Funding to help states, local governments, rural areas, and territories address cybersecurity risks and cybersecurity threats to information systems.
Funds Available	$183.5 million is available under the SLCGP, with varying funding amounts allocated over four years from the Infrastructure Investment and Jobs Act. The recipient contribution can be cash (hard match) or third-party in-kind (soft match).
Eligibility	All U.S. states and territories are eligible to apply. The designated State Administrative Agency (SAA) for each state and territory is the only entity eligible to apply for SLCGP funding.
Examples	Planning, equipment, exercises, management & administration, organization, and training.
Additional Information	This year, each state and territory will receive a funding allocation as determined by the statutory formula:

STATE AND LOCAL CYBERSECURITY GRANT PROGRAM	
	• Allocations for states and territories include a base funding level as defined for each entity: 1% for each state, the District of Columbia, and Puerto Rico; and 0.25% for American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, and the U.S. Virgin Islands. • State allocations include additional funds based on a combination of state population and rural population totals. • 80% of total state allocations must support local entities, while 25% of the total state allocations must support rural entities; these amounts may overlap.

SAFEGUARDING TOMORROW THROUGH ONGOING RISK MITIGATION REVOLVING LOAN FUND (STORM-RLF)	
Description	FEMA is making $50 million available to fund capitalization grants that enable eligible entities to administer revolving loan funds and provide direct loans to local governments for projects and activities that mitigate the impacts of drought, intense heat, severe storms (including hurricanes, tornados, windstorms, cyclones, and severe winter storms), wildfires, floods, earthquakes, and other natural hazards. FEMA will work closely with participating entities and gather best practices on topics such as entity administrative burden and capacity, achieving resilience and equity goals, and common project and activity types for loans under this program. FEMA's goal is to increase entity participation with higher funding levels in future grant cycles.
Funds Available	FEMA intends to award $472 million of the funds available under the new program to address climate change and create a more equitable and resilient nation.
Eligibility	Eligible entities are States, Federally recognized tribes that received a major disaster declaration, Territories, and the District of Columbia. State entities must enroll in this program for it to be an option to local public entities.
Examples	This is an opportunity to prioritize low-impact development, wildland-urban interface management, conservation areas, reconnection of floodplain and open space projects. Funding can be utilized for building code adoption and enforcement. Allowable uses include: Mitigation Activities, Non-Federal Cost-Share, Local Government Technical Assistance, and Entity Administrative Costs.
Additional Information	Application period will be open starting February 1 - April 28, 2023. https://www.fema.gov/grants/mitigation/storm-rlf

U.S. Army Corps of Engineers

PLANNING ASSISTANCE TO STATES	
Description	Provides assistance in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources. Typical studies are only planning level of detail, not design for project construction. Program can encompass many types of studies dealing with water resource issues. PAS program has two types of efforts-comprehensive plans and technical assistance: Comprehensive Plans and Technical Assistance. Comprehensive Plan

PLANNING ASSISTANCE TO STATES	
	Assistance includes planning for the development, utilization, and conservation of the water and related resources of drainage basins, watersheds, or ecosystems located within the boundaries of that State, including plans to comprehensively address water resources challenges such as the state water plan. Comprehensive plans can extend across state boundaries provided both States agree. Technical Assistance provided through the PAS program includes support of planning efforts related to the management of state water resources, including the provision and integration of hydrologic, economic, or environmental data and analysis in support of the State's water resources management and related land resources development plans identified in the state water plan or other water resources management related state planning documents, such as state hazard mitigation, preparedness, response, and recovery plans and plans associated with changing hydrologic conditions, climate change, long-term sustainability, and resilience.
Funds Available	Comprehensive planning activities through the PAS program are cost shared (50 per cent) with the study partner, and voluntarily contributed funds in excess of cost share may be provided by the non-Federal partner. The non-Federal cost share for preparation of a state comprehensive water resources plan may be provided by funds or through the provision of services, materials, supplies, or other in-kind services. Technical assistance activities through the PAS program are cost shared (50 per cent) with the study partner, and voluntarily contributed funds in excess of cost share may be provided by the non-Federal partner. The cost-share for technical assistance must be provided by funds (not in-kind).
Eligibility	States, local governments, other non-Federal entities, and eligible Native American Indian tribes.
Examples	Types of studies in recent years include water supply/demand, water conservation, water quality, environmental/conservation, wetlands evaluation/restoration, dam safety/failure, flood damage reduction, coastal zone protection, and harbor planning.
Additional Information	https://www.nae.usace.army.mil/missions/public-services/planning-assistance-to-states/

U.S. Bureau of Reclamation

SMALL SCALE WATER EFFICIENCY PROJECTS	
Description	Funding for small-scale on-the-ground water management projects that conserve, better manage, or otherwise increase efficient use of water supplies. Projects supported by an existing water management and conservation plan, System Optimization Review, or other planning effort led by the applicant are prioritized.
Funds Available	Applicants may request up to $100,000 in federal funding, with a non-federal cost-share of 50% or more of total project costs for projects with total project costs no more than $225,000.
Eligibility	Eligible applicants for all WaterSMART Grants funding opportunities include states; tribes; irrigation districts; water districts; state, regional, or local authorities, whose members include one or more organization with water or power delivery authority; other organizations with water or power delivery authority; and nonprofit conservation organizations

Small Scale Water Efficiency Projects	
	that are acting in partnership with and with the agreement of an entity previously described. To be eligible, applicants must be located in the Western United States or U.S. Territories. Entities located in Alaska and Hawaii are also eligible to apply.
Examples	Example projects include Canal lining/piping, municipal metering, irrigation flow measurement, SCADA and automation, landscape irrigation measures, high-efficiency indoor appliances and fixtures, commercial cooling systems.
Additional Information	https://www.usbr.gov/watersmart/swep/index.html

Water Marketing Strategy Grants	
Description	Financial assistance for the development of water marketing strategies to facilitate water markets as a tool for helping willing buyers and sellers meet water demands efficiently in times of shortage and prevent water conflicts.
Funds Available	Program funding is allocated through a competitive process. Applicants may request federal funding up to $400,000 for projects to be completed within three years with a non-Federal cost share of 50% or more of the total project cost.
Eligibility	Eligible applicants for all WaterSMART Grants funding opportunities include states; tribes; irrigation districts; water districts; state, regional, or local authorities, whose members include one or more organization with water or power delivery authority; other organizations with water or power delivery authority; and nonprofit conservation organizations that are acting in partnership with and with the agreement of an entity previously described. To be eligible, applicants must be located in the Western United States or U.S. Territories. Entities located in Alaska and Hawaii are also eligible to apply.
Examples	Funding awarded under Water Marketing Strategy Grants can be used for outreach and partnership building, planning activities (e.g., hydrologic, economic, legal and other types of analysis), pilot activities, and the development of a "water marketing strategy" document.
Additional Information	https://www.usbr.gov/watersmart/watermarketing/index.html

Water and Energy Efficiency Grants	
Description	Focuses on projects that result in quantifiable and sustained water savings, including canal lining and piping projects, municipal metering projects, and Supervisory Control and Data Acquisition (SCADA) and automation projects.
Funds Available	Applicants may request federal funding: (I) up to $500,000 for projects to be completed within two years, (II) up to $2 million for projects to be completed within three years; and (III) up to $5 million for projects to be completed within three years, with a non-Federal cost share of 50% or more of the total project cost. No more than $5,000,000 in total WaterSMART Water and Energy Efficiency Grants funds will be awarded to any single applicant under this Funding Opportunity per fiscal year (i.e., an applicant may receive up to $5.0M in FY 2023 funds.

WATER AND ENERGY EFFICIENCY GRANTS	
Eligibility	Eligible applicants for all WaterSMART Grants funding opportunities include states; tribes; irrigation districts; water districts; state, regional, or local authorities, whose members include one or more organization with water or power delivery authority; other organizations with water or power delivery authority; and nonprofit conservation organizations that are acting in partnership with and with the agreement of an entity previously described. To be eligible, applicants must be located in the Western United States or U.S. Territories. Entities located in Alaska and Hawaii are also eligible to apply.
Examples	Projects conserve and use water more efficiently; increase the production of hydropower; mitigate conflict risk in areas at a high risk of future water conflict; and accomplish other benefits that contribute to water supply reliability in the western United States.
Additional Information	https://www.usbr.gov/watersmart/weeg/faq.html

U.S. Department of Agriculture

CONSERVATION INNOVATION GRANTS (CIG)	
Description	Competitive program that supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands. Through creative problem solving and innovation, CIG partners work to address our nation's water quality, air quality, soil health and wildlife habitat challenges, all while improving agricultural operations. Public and private grantees develop the tools, technologies, and strategies to support next-generation conservation efforts on working lands and develop market-based solutions to resource challenges.
Funds Available	Applications made a CIG funding notice is announced each year. Funds for single- or multi-year projects, not to exceed three years, are awarded through a nationwide competitive grants process. Grantees must match the CIG investment at least one to one.
Eligibility	The natural resource concerns eligible for funding through CIG are identified in the funding announcement and may change annually to focus on new and emerging, high-priority natural resource concerns. National and State CIG – all non-Federal entities and individuals are eligible to apply. All CIG projects must involve EQIP-eligible producers.
Examples	Projects may be watershed-based, regional, multi-state or nationwide in scope.
Additional Information	https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/

EMERGENCY WATERSHED PROTECTION PROGRAM	
Description	The EWP Program offers technical and financial assistance to help local communities relieve imminent threats to life and property caused by floods, fires, windstorms, and other natural disasters that impair a watershed. EWP does not require a disaster declaration by federal or state government officials for program assistance to begin.

EMERGENCY WATERSHED PROTECTION PROGRAM	
Funds Available	NRCS may provide technical assistance as services and/or funds to plan, design, and contract the emergency measures, subject to an agreement between NRCS and the Sponsor. Installation/Construction costs are not to exceed 75% or 90% for limited resource areas. Engineering/Technical Assistance is not to exceed 100%. No funds are available for real property rights.
Eligibility	Project criteria requires the project to provide protection from flooding or soil erosion; reduce threats to life and property; restore the hydraulic capacity to the natural environment; and economically and environmentally defensible. Eligible local sponsors for recovery projects include cities, counties, towns, conservation districts, or any federally-recognized Native American tribe or tribal organization.
Examples	Removal of debris from stream channels, road culverts, and bridges; reshaping and protection of eroded streambanks; correction of damaged or destroyed drainage facilities; establishing vegetative cover on critically eroding lands; repair of levees and structures; repair of certain conservation practices; and purchase of floodplain easements.
Additional Information	https://www.nrcs.usda.gov/programs-initiatives/ewp-emergency-watershed-protection

SMALL BUSINESS INNOVATION RESEARCH	
Description	The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs at the U.S. Department of Agriculture (USDA) offer competitively awarded grants to qualified small businesses to support high quality research related to important scientific problems and opportunities in agriculture that could lead to significant public benefits. This program as two phases, Phase I is open to any small business concern that meets the SBIR/STTR eligibility requirements and Phase II is open only to previous Phase I awardees.
Funds Available	Funds are offered across 10 topic areas including: Forests and Related Resources, Plant Production and Protection-Biology, Animal Production and Protection, Conservation of Natural Resources, Food Science and Nutrition, Rural and Community Development, Aquaculture, Biofuels and Biobased Products, Small and Mid-size Farms, and Plant Production and Protection-Engineering
Eligibility	The SBIR/STTR programs do not make loans and do not award grants for the purpose of helping a business get established. The program seeks to stimulate technological innovation in the private sector, strengthen the role of small businesses in meeting federal research and development needs, increase private sector commercialization of innovations derived from USDA-supported research and development efforts, and foster and encourage participation by women-owned and socially and economically disadvantaged small business firms in technological innovations
Examples	Salary and wages for company employees, associated fringe benefits, materials and supplies, and a number of other direct costs needed to conduct the proposed R&D
Additional Information	https://www.nifa.usda.gov/grants/programs/small-business-innovation-research-technology-transfer-programs-sbirsttr

WATERSHED REHABILITATION PROGRAM	
Description	The Watershed Rehabilitation Program helps project sponsors rehabilitate aging dams that are reaching the end of their design life and/or no longer meet federal or state standards. NRCS provides technical and financial assistance to local project sponsors to rehabilitate aging dams that protect lives and property, and infrastructure.
Funds Available	Across the Nation, watershed REHAB projects provide over $2.2 billion in reduced flooding and erosion damage while improving wildlife habitat, recreation, water quality and supply for an estimated 47 million people. Costs associated with additional or new water supply storage purposes added to the rehabilitation project may be cost-shared with watershed rehabilitation funds. Eligible project costs are covered 65% Federal/35% Local of total eligible project cost, not to exceed 100% of actual construction cost. No more than 100% of the engineering/Technical Assistance will be covered.
Eligibility	Eligible projects are dams that were originally constructed through a NRCS Watershed Program, no longer meet current safety and performance standards, including dams past their evaluated life, and has current operation and maintenance.
Examples	*Information not available*
Additional Information	https://www.nrcs.usda.gov/programs-initiatives/watershed-rehabilitation

WATERSHED AND FLOOD PREVENTION OPERATIONS PROGRAM	
Description	The WFPO program provides technical and financial assistance to help plan and implement authorized watershed projects for the purpose of flood prevention, watershed protection, public recreation, public fish and wildlife, agricultural water management, municipal and industrial water supply, water quality management, and watershed structure rehabilitation. The WFPO Program helps units of federal, state, local and tribal of government (project sponsors) protect and restore watersheds up to 250,000 acres.
Funds Available	The percentage of a project that will be covered by the federal cost-sharing varies by project purpose. Engineering and Technical Assistance is covered 100% for most project, except for Municipal and Industrial Water Supply projects. The percentage of installation/construction costs that are covered are as follows: Flood prevention-100%, Watershed Protection - Variable, Public Fish and Wildlife or Public Recreational Development - No more than 50%, Agricultural Water Management - Up to 75%, Municipal and Industrial Water Supply - no more than 50%, Water Quality Management - To be determined, Rehabilitation - No more than 100%.
Eligibility	Project criteria requires public sponsorship, be a watershed project of 250,000 acres or less, and have agricultural benefits that, including rural communities, must be 20% or more of the total benefits for the project. Eligible project sponsors include States, local governments, and tribal organizations.
Examples	Watershed Plans, flood prevention projects, drainage, irrigation, reservoir structure, dams.

Watershed and Flood Prevention Operations Program	
Additional Information	https://www.nrcs.usda.gov/conservation-basics/conservation-by-state/iowa

U.S. Department of Agriculture Rural Development Funding

Community Facilities Loans and Grants	
Description	This program provides affordable funding to develop essential community facilities in rural areas, an essential community facility is defined as a facility that provides an essential service to the local community for the orderly development of the community in a primarily rural area, and does not include private, commercial, or business undertakings.
Funds Available	*Information not available*
Eligibility	Eligible for areas 20,000 or less in population. Applicants are municipalities, non-profits, special purpose districts, and federally recognized Indian tribes. Eligible borrowers include public bodies, community based non-profit corporations, and federally recognized tribes.
Examples	Funds can be used to purchase, construct, and/or improve essential community facilities, purchase equipment, and pay related project expenses
Additional Information	https://www.rd.usda.gov/programs-services/community-facilities/community-facilities-direct-loan-grant-program/ne

Community Facility Rural Community Development Initiative Grants	
Description	RCDI grants are awarded to help non-profit housing and community development organizations, low-income rural communities and federally recognized tribes support housing, community facilities, and community and economic development projects in rural areas. Funds may be used to improve housing, community facilities, and community and economic development projects in rural areas.
Funds Available	Grants are awarded with a minimum amount of $50,000 and maximum of $250,000. Funds are limited and are awarded through a competitive process. Matching fund requirement equal to amount of grant but in-kind contributions cannot be used as matching funds. Partnerships with other federal, state, local, private, and nonprofit entities are encouraged.
Eligibility	Open to public bodies, non-profit organizations, and qualified private organizations. Rural and rural areas other than a city or town with a population of greater than 50,000 people and the urbanized area contiguous and adjacent to such city or town.
Examples	RCDI grants may be used for but are not limited to training sub-grantees and providing technical assistance to sub-grantees on strategic plan developments, accessing alternative funding sources, board training, developing successful child care facilities, creating training tools, and effective fundraising techniques.
Additional Information	https://www.rd.usda.gov/programs-services/community-facilities/rural-community-development-initiative-grants#overview

COMMUNITY FACILITY TECHNICAL ASSISTANCE AND TRAINING GRANT	
Description	Provide associations Technical Assistance and/or training with respect to essential community facilities programs. The Technical Assistance and/or training will help identify and plan for community facility needs that exist in the area. Once those needs have been identified, the Grantee can assist in identifying public and private resources to finance those identified community facility needs.
Funds Available	Maximum grant award of $150,000. Grant funds are limited and are awarded through a competitive process. Matching funds are not required, in-kind contributions cannot be used as matching funds, partnerships with other entities are encouraged.
Eligibility	Open to public bodies, non-profit organizations, and federally recognized tribes. Rural areas including cities, villages, townships, towns, and Federally Recognized Tribal Lands outside the boundaries of a city of 20,000 or more.
Examples	Webster County purchased a new ambulance and equipment with Rural Development funds (and other sources) and South Sioux City was able to build a new fire station with funding from USDA Rural Development (and other sources).
Additional Information	https://www.rd.usda.gov/programs-services/community-facilities/community-facilities-technical-assistance-and-training-grant#overview

EMERGENCY COMMUNITY WATER ASSISTANCE GRANTS (ECWAG)	
Description	This program helps eligible communities prepare for, or recover from, an emergency that threatens the availability of safe, reliable drinking water. A federal disaster declaration is not required, and this grant covers events such as drought or flood, earthquake, tornado or hurricane, disease outbreak, chemical spill, leak, or seepage, or other disasters.
Funds Available	Up to $150,000 for water transmission line projects. Water Source grants up to $1,000,000.
Eligibility	Primarily for residential purposes and are eligible for 10,000 or less population areas. Applicants are municipalities, special purpose districts (RWS), non-profits, and Recognized Indian Tribes. Applications are accepted year-round online through the RD Apply or through local RD office
Examples	Construction of waterline extensions, repair breaks or leaks in existing water distribution lines, and address related maintenance necessary to replenish the water supply. Water Source Grants are to construct a water source, intake, or treatment facility.
Additional Information	https://www.rd.usda.gov/programs-services/water-environmental-programs/emergency-community-water-assistance-grants/ne

U.S. Department of Energy

GRID INNOVATION PROGRAM	
Description	This program provides support for projects that use innovative approaches to transmission, storage, and distribution infrastructure to enhance grid resilience and reliability. Projects selected under this program will include interregional

GRID INNOVATION PROGRAM	
	transmission projects, investments that accelerate interconnection of clean energy generation, and utilization of distribution grid assets to provide backup power and reduce transmission requirements. Innovative approaches can range from use of advanced technologies to innovative partnerships to the deployment of projects identified by innovative planning processes.
Funds Available	The Grid Innovation Program will invest up to $5 billion ($1 billion/year for Fiscal Years 2022-2026) in innovation and new approaches to transmission, distribution, storage, and regional resilience. The first funding cycle will include both FY22 and FY23, up to $2 billion. Projects are subject to a 50% cost share minimum.
Eligibility	Eligible entities include a state, a combination of 2 or more states, an Indian Tribe, a unit of local government, or a public utility commission.
Examples	Transmission, storage, and distribution infrastructure to enhance grid resilience and reliability.
Additional Information	

GRID RESILIENCE UTILITY AND INDUSTRY GRANTS	
Description	Grants provide funding to support activities that will modernize the electric grid to reduce impacts from extreme weather and natural disasters. This grant program will fund comprehensive transformational transmission and distribution technology solutions that will mitigate weather hazards across a region or within a community that can cause a disruption to the power system. Grants awarded under the program will fund transmission and distribution technology projects that seek to address hazards within a region or a community that can disrupt the power system, such as wildfires, floods or hurricanes.
Funds Available	Funding of $2.5 Billion over five years from FY 22-26 with $500 million available per year. Funding is capped at the amount the eligible entity has spent in the previous three years on hardening efforts. There is a 100% cost match for this program. The program includes a small utility set aside for those entities selling no more than 4 million MWh of electricity per year.
Eligibility	This funding opportunity is available to electric grid operators, electricity storage operators, electricity generators, transmission owners or operators, distribution providers, and fuel suppliers.
Examples	Infrastructure upgrades to strengthen and modernize the power grid against natural disasters that are exacerbated by the climate crisis.
Additional Information	https://www.energy.gov/gdo/grid-resilience-utility-and-industry-grants

SMART GRID GRANTS	
Description	Smart Grid Grants is designed to increase the flexibility, efficiency, and reliability of the electric power system, with particular focus on: increasing capacity of the transmission system, preventing faults that may lead to wildfires or other system disturbances, integrating renewable energy at the transmission and distribution levels, and facilitating the

SMART GRID GRANTS	
	integration of increasing electrified vehicles, buildings, and other grid-edge devices. Smart grid technologies funded and deployed at scale through this program must demonstrate a pathway to wider market adoption.
Funds Available	The Smart Grid Grant program will invest up to $3 billion ($600 million/year for Fiscal Years 2022-2026) in grid resilience technologies and solutions. The first funding cycle will include both FY22 and FY23, up to $1.2 billion. Recipients must provide a cost-share of at least 50% of the grant.
Eligibility	This program is open to domestic entities including institutions of higher education; for-profit entities; non-profit entities; and state and local governmental entities, and tribal nations.
Examples	Grid enhancing technologies such as dynamic line rating, flow control devices, advanced conductors, and network topology optimization, to improve system efficiency and reliability. Investments in optical ground wire, dark fiber, operational fiber, and wireless broadband communications networks.
Additional Information	https://www.energy.gov/gdo/grid-innovation-program

U.S. Department of Housing and Urban Development

COMMUNITY DEVELOPMENT BLOCK GRANTS	
Description	Provides annual grants on a formula basis to states, cities, and counties to develop viable urban communities by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for low- and moderate-income persons.
Funds Available	HUD determines the amount of each entitlement grantee's annual funding allocation by a statutory dual formula which uses several objective measures of community needs, including the extent of poverty, population.
Eligibility	Eligible grantees include principal cities of Metropolitan Statistical Areas, Other metropolitan cities with populations of at least 50,000, qualified urban counties with populations of at least 200,000 (excluding the population of entitled cities), States and insular areas. Eligibility for participation as an entitlement community is based on population data provided by Census. Each activity must meet one of the following national objectives for the program: benefit low- and moderate-income persons, prevention or elimination of slums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community for which other funding is not available.
Examples	CDBG funds may be used for activities which include, but are not limited to: Acquisition of real property; Relocation and demolition; Rehabilitation of residential and non-residential structures; Construction of public facilities and improvements, such as water and sewer facilities, streets, neighborhood centers, and the conversion of school buildings for eligible purposes; Public services, within certain limits; Activities relating to energy conservation and renewable energy resources; Provision of assistance to profit-motivated businesses to carry out economic development and job creation/retention activities

COMMUNITY DEVELOPMENT BLOCK GRANTS	
Additional Information	HUD does not provide CDBG assistance directly to individuals, businesses, nonprofit or organizations or other non-governmental entities. https://www.hud.gov/program_offices/comm_planning/cdbg

CDBG DISASTER RECOVERY ASSISTANCE	
Description	The Community Development Block Grant (CDBG) Program has Disaster Recovery grants to rebuild the affected areas and provide crucial seed money to start the recovery process. These flexible grants help cities, counties, and States recover from Presidentially declared disasters, especially in low-income areas, subject to availability of supplemental appropriations. Since CDBG Disaster Recovery (CDBG-DR) assistance may fund a broad range of recovery activities, HUD can help communities and neighborhoods that otherwise might not recover due to limited resources.
Funds Available	Varies according to the state plan outlined by the state department of economic development.
Eligibility	CDBG-DR funds are provided to the most impacted and distressed areas for Disaster Relief, Long-Term Recovery, Restoration of Infrastructure, Housing, and Economic Revitalization. HUD will notify eligible States, cities and counties if they are eligible to receive CDBG-DR grants. Those who receive grant money include state agencies, non-profit organizations, economic development agencies, citizens and businesses
Examples	Funding can be provided to cover unmet needs such as local cost share funding from public assistance projects or hazard mitigation grant projects.
Additional Information	https://www.hud.gov/program_offices/comm_planning/cdbg-dr

NEIGHBORHOOD STABILIZATION PROGRAM	
Description	The Neighborhood Stabilization Program (NSP) was established for the purpose of providing emergency assistance to stabilize communities with high rates of abandoned and foreclosed homes, and to assist households whose annual incomes are up to 120 percent of the area median income (AMI). NSP funds were used for activities which included: Establish financing mechanisms for purchase and redevelopment of foreclosed homes and residential properties; Purchase and rehabilitate homes and residential properties abandoned or foreclosed; Establish land banks for foreclosed homes; Demolish blighted structures; Redevelop demolished or vacant properties.
Funds Available	$4 billion nationwide. Iowa receives $21.6 million in NSP funding
Eligibility	States, certain local governments, and other organizations.
Examples	The NSP provides grants to every state, certain local communities, and other organizations to purchase foreclosed or abandoned homes and to rehabilitate, resell, or redevelop these homes in order to stabilize neighborhoods and stem the decline of house values of neighboring homes.
Additional Information	https://www.hud.gov/program_offices/comm_planning/nsp

U.S. Economic Development Administration

PUBLIC WORKS AND ECONOMIC ADJUSTMENT ASSISTANCE (EAA)	
Description	The EAA provides funding to help plan, build, innovate, and put people into quality jobs in hundreds of communities across the nation. The Economic Adjustment Assistance program is EDA's most flexible program, and grants made under this program will help hundreds of communities across the nation plan, build, innovate, and put people back to work through construction or non-construction projects designed to meet local needs.
Funds Available	Total Program Funding of $500 Million with an award ceiling of $10 Million and a floor of $100,000.
Eligibility	A wide range of technical, planning, workforce development, entrepreneurship, and public works and infrastructure projects are eligible for funding under this program. Eligible applicants for EDA's Economic Adjustment Assistance program include a(n): District Organization of an EDA-designated Economic Development District; Indian Tribe or a consortium of Indian Tribes; State, county, city, or other political subdivision of a State, including a special purpose unit of a State or local government engaged in economic or infrastructure development activities, or a consortium of political subdivisions; Institution of higher education or a consortium of institutions of higher education; Public or private non-profit organization or association acting in cooperation with officials of a political subdivision of a State. Individuals or for-profit entities are not eligible.
Examples	Public infrastructure related to economic development.
Additional Information	As part of the $300 million Coal Communities Commitment, EDA will allocate at least $200 million of the Economic Adjustment Assistance funding to support coal communities.

U.S. Environmental Protection Agency

CLEAN WATERS ACT SECTION 319 GRANTS	
Description	Clean Water Act Section 319(h) funds are provided only to designated state and tribal agencies to implement their approved nonpoint source management programs. State and tribal nonpoint source programs include a variety of components, including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and regulatory programs.
Funds Available	Each year EPA awards Section 319(h) funds to states in accordance with a state-by-state allocation formula that EPA has developed in consultation with the states. Grant totals over the past 5 years have increased from $155.9 million in 2013 and $178 million in 2022.
Eligibility	*Information not available*
Examples	*Information not available*
Additional Information	https://www.epa.gov/sites/default/files/2015-09/documents/319-guidelines-fy14.pdf

ENVIRONMENTAL JUSTICE COLLABORATIVE PROBLEM-SOLVING	
Description	This cooperative agreement program provides financial assistance to eligible organizations working on or planning to work on projects to address local environmental and/or public health issues in their communities. The program assists recipients in building collaborative partnerships with other stakeholders to develop solutions that will significantly address environmental and/or public health issue(s) at the local level. Selected applicants, or recipients, are required to use the EPA's Environmental Justice Collaborative Problem Solving Model as part of their projects.
Funds Available	The EJCPS Program anticipates awarding approximately $30,000,000 of Inflation Reduction Act funding through 83 cooperative agreements, organized in two tracks of funding. $25,000,000 for CBOs proposing projects for up to $500,000 each. Approximately 50 awards for up $500,000 each are anticipated under this track. $5,000,000 for qualifying small CBOs with 5 or fewer full-time employees proposing projects for up to $150,000 each. For more details about this opportunity, please review closely the "Small Community-based Nonprofit Set Aside". Approximately 33 awards for up to $150,000 each are anticipated under this track. Cooperative agreements will be funded for a three-year performance period.
Eligibility	Eligible entities include incorporated non-profit organizations, US Territories, Tribal government, either federally or state recognized, tribal organizations, and freely associated states.
Examples	In 2003 the Pacific Basin Development Council received this grant to build community resiliency.
Additional Information	https://www.epa.gov/environmentaljustice/environmental-justice-collaborative-problem-solving-cooperative-agreement-5

URBAN WATERS SMALL GRANTS	
Description	The mission of this program is to help local residents and their organizations, particularly those in underserved communities, restore their urban waters in ways that also benefit community and economic revitalization. The program recognizes that healthy and accessible urban waters can help grow local businesses and enhance educational, recreational, social, and employment opportunities in nearby communities. Projects should meet the following four objectives: address local water quality issues related to urban runoff pollution; provide additional community benefits; actively engage underserved communities; and foster partnership.
Funds Available	Urban Waters Small Grants are competed and awarded every two years with individual award amounts of up to $60,000.
Eligibility	Eligible applicants include States, local governments, Indian Tribes, public and private universities and colleges, public or private nonprofit institutions/organizations, intertribal consortia, and interstate agencies.
Examples	An example of a past grant awarded was to the University of Nebraska-Lincoln in 2015-2016 to provide technical assistance and training on stormwater and green infrastructure to small businesses and residents of under-served communities.
Additional Information	https://www.epa.gov/urbanwaterspartners/urban-waters-small-grants

WATER INFRASTRUCTURE FINANCE AND INNOVATION ACT OF 2014 (WIFIA)	
Description	The WIFIA program provides long-term, low-cost supplemental loans for regionally and nationally significant water and wastewater infrastructure projects. Borrowers benefit from a single fixed interest rate that is equal to the US Treasury rate of a similar maturity, an interest rate that is not impacted by the borrower's credit or loan structure, custom long-term repayment schedules with options to defer payment for up to 5 years.
Funds Available	$20 million minimum project size for large communities, $5 million minimum for small communities of 25,000 or less. WIFIA can fund a maximum of 49% of eligible project costs.
Eligibility	Eligible borrowers are 1) local, state, tribal, and federal government entities; 2) Partnerships and joint ventures; 3) Corporations and trusts; 4) Clean Water and Drinking Water State Revolving Fund (SRF) programs.
Examples	Wastewater conveyance and treatment projects. Drinking water treatment and distribution projects. Enhanced energy efficiency projects at drinking water and wastewater facilities.
Additional Information	Total federal assistance may not exceed 80% of a project's eligible costs. https://www.epa.gov/wifia/what-wifia

U.S. Fish and Wildlife Services

NORTH AMERICAN WETLANDS CONSERVATION STANDARD AND SMALL GRANT	
Description	A competitive matching grants program that supports public-private partnerships carrying out projects in the United Stated that further the goals of the North American Wetlands Conservation Act. These projects must involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitat for the benefit of all wetlands-associated migratory birds.
Funds Available	US Small Grants may not exceed $100,000 and require a 1-to-1 ratio match for awarded grant amount. The US Standard Grant is for grants larger than $100,000 and requires a 1-to-1 match ratio.
Eligibility	US Small Grants proposals are due in October or else will be considered an early submission for the next Fiscal Year. The US Standard Grant has a two deadline for proposals, one in February and one in July. Proposal submitted after July are considered ineligible unless clearly marked as an early submission for the next Fiscal Year.
Examples	Acquisition of land for the purposes of wetlands conservation, wetland restoration projects, wetland enhancement projects, wetland establishment, or other direct long-term wetland conservation work.
Additional Information	https://www.fws.gov/sites/default/files/documents/north-american-wetlands-conservation-act-us-eligibility-criteria_0.pdf

U.S. Forest Service

FORESTRY LEGACY PROGRAM	
Description	Focuses on private forest land that is faced by threats of conversion to non-forest land by urbanization, residential development. Providing economic incentives to landowners to keep forests as forest encourages sustainable forest

FORESTRY LEGACY PROGRAM	
	management and supports strong markets for forest products. Landowners participate in the FLP by either selling property outright or by retaining ownership and selling only a portion of the property's development rights; both are held by state agencies or another unit of government. Use of a conservation easement allows land to remain in private ownership while ensuring that its environmental values are retained. Program funded by Land and Water Conservation Fund, which invests a small percentage of federal offshore drilling fees towards the conservation of important land, water, and recreation areas for all Americans.
Funds Available	Previous year funds for Fiscal Year 2022 totaled $88,878,955 across 14 projects.
Eligibility	Private Lands
Examples	Funded projects from 2022 include the Montana Great Outdoors Conservation Project, Oregon's Spence Mountain Forest, Wyoming's Munger Mountain Corridor Initiative, and others.
Additional Information	https://www.fs.usda.gov/managing-land/private-land/forest-legacy/program

State of Iowa Funding Resources

In addition to federal grants, there are a number of state agencies and programs with potential applicability to supporting funding and implementation of mitigation projects. Many federal hazard mitigation grant programs are administered at the state level by HSEMD and IDNR, as noted above. These agencies will also likely be important in earlier stages of the hazard mitigation planning process by providing current hazard and risk assessment data.

While this section of the funding guidebook attempts to list as many funding options as possible, it is by no means a complete list of programs in Iowa that could have the potential to support hazard mitigation project implementation. Similar to federal grant programs, many of these programs are dependent on yearly funding allocations, which results in fluctuations in their availability. The websites and reference materials used to provide this information are as current as possible; however, it is important to note that funding programs are dynamic and subject to frequent changes. While it is helpful to be familiar with the current information, it is equally as important to engage candidate federal and state agencies as soon as possible.

WELLMARK FOUNDATION GRANTS	
Description	Must be classified as a Section 501(c)(3) tax-exempt organization under Internal Revenue Code or a governmental entity. If you have any questions related to eligibility, please contact Foundation staff by email at WellmarkFoundation@Wellmark.com or 515-376-6420. Must be an organization within the states of either 3 Iowa or South Dakota or seeking funding support for grant funding restricted for use in Iowa or South Dakota.
Funds Available	Built Environment MATCH Grant REQUESTS UP TO $100,000 MATCH REQUIREMENT: Dollar-for-dollar, at least one-half of that amount must be cash.
Eligibility	
Examples	
Additional Information	TIMELINE: Applications must be submitted by late February. All applicants will be notified of funding decisions by May.

IOWA DEPARTMENT OF NATURAL RESOURCES CLEAN WATER STATE REVOLVING FUND	
Description	Iowa's Clean Water State Revolving Fund (CWSRF) is the best choice to finance publicly owned wastewater treatment, sewer rehabilitation, replacement, and construction, and storm water quality improvements.
Funds Available	Since 1989, the CWSRF has provided more than $1.4 billion in financing assistance for water pollution control.
Eligibility	
Examples	
Additional Information	http://www.iowasrf.com/program/clean_water_loan_program/clean-water-srf-intended-use-plan-information/

DERELICT BUILDING PROGRAM	
Description	The Derelict Building Program is available for Iowa towns of 5,000 or fewer residents' to address neglected commercial or public structures that have sat vacant for at least 6 months.
Funds Available	
Eligibility	To be eligible, the building must not reside on the National Historic Register. Only a City government may be an applicant and they must own or be in the process of owning the building. Applicants may partner with non-profits on projects, but building must be owned by applicant. The building must be a former commercial or public building that's been abandoned for at least six months.
Examples	
Additional Information	https://www.iowadnr.gov/Environmental-Protection/Land-Quality/Waste-Planning-Recycling/Derelict-Building-Program

IOWA SILVER JACKETS	
Description	The Iowa Silver Jackets Program provides a formal and consistent strategy for an interagency approach to planning and implementing measures to reduce the risks associated with flooding and other natural hazards in the State of Iowa. Federal and state agencies are working together to enhance intergovernmental partnerships resulting in comprehensive and sustainable solutions to Iowa state flood risk hazards.
Funds Available	Varies
Eligibility	
Examples	
Additional Information	https://www.floodrisk.iowa.gov/

Alternative Funding Resources

In recent years, states and communities across the country have sought and developed innovative funding sources as alternatives to traditional government grant programs. These funding sources fall into three main categories: Local Funding Options, Public-Private Partnerships, and Private Foundations. These funding sources will be important for current and future hazard mitigation planning efforts for several reasons including:

- Decreases in funding for pre-disaster mitigation grant and assistance programs at the federal level and for state agencies - While technical assistance and other related support functions are still actively supported across federal and state agencies, and in some cases are increasing, allocations for "bricks and mortar" pre-disaster hazard mitigation projects will be competing with a broad range of government funding needs. These funds may not completely disappear, but the need will continue to outstrip the supply in the foreseeable future.

- Opportunities to fund projects that might not qualify or align with traditional grant and assistance programs. Funding programs seek solutions that reduce risk for a particular threshold (i.e., 1-percent flood) and meet absolute cost-benefit criteria that the agencies themselves must adhere to. Therefore, these programs, by their basic nature, are not able to support efforts that may help most of the time but don't meet these thresholds, e.g., a homeowner installed flood wall in a repetitive loss area that prevents annual floods, but not larger magnitude events that come along every few years. There is a related concept that can be referred to as "cumulative risk reduction". For example, a homeowner with limited resources (and no real access to grant funds) might be willing to spend a little time and money each year getting just a little bit safer.

Local Funding Options

Local funding options are just what they sound like, using local funds for local mitigation projects. Local funds are also needed as the non-federal share or "matching funds" for federal grant programs but can also be used independently to fund a range of project types. Local funding options include the following:

Capital Improvement Programs – Ongoing civic improvements can include prioritized hazard mitigation projects or mitigation can be included as one aspect of a larger project. For example, improving the hydraulic capacity of a culvert or bridge to prevent upstream flooding while undertaking periodic replacements for end of service considerations is one example. Replacing windows in a school with shatter resistant glass as part of an overall renovation is another example. Capital improvement programs are generally funded with local tax revenues and municipal bonds.

Permits, Fees, and Developer Contributions- Communities can establish fees, earmark a portion of existing permit and fee structures, and/or establish requirements for developer contributions for new developments in hazard prone areas that can then be used to fund local mitigation projects. The proceeds can be accumulated in what is often referred to as a Mitigation Trust Fund and the uses are typically tied to specific project types and/or relationships with projects already identified in specific plans or documents such as an HMP. These types of funds can also be used to create vouchers or other incentives for individual action.

Force Account / In-Kind Services – Although there is a cost associated with activities of public employees, there are a wide range of activities that can be undertaken by local government staff and officials as well as interested parties on their behalf that would yield significant benefits. Some of the obvious examples

are public outreach and education for individual property owners, businesses, and institutions to reduce their risk through correspondingly inexpensive or essential activities. This would include tapping into available educations resources, promoting individual action, etc.

Property Owners – For a project that directly benefits one or more specific properties, the property owner can be asked to contribute. Through the HIRA process, property owners can become better aware of their risks and options. Owners that recognize they have a real flood problem may be willing to pay a portion of the cost. In recent years, property owners have voluntarily agreed to pay the non-federal share (up to 25 percent of the total project cost) for FEMA HMA grants in some states. In some cases, the owners have paid even higher percentages of the cost. In addition, after a flood, owners may have cash from insurance claims or disaster assistance that they will be using to repair their homes and properties. By including the right floodproofing and mitigation project components into the repairs, the resilience of the property to future flooding may be improved. Having property owners contribute to the project can help stretch available local funds and gives the property owner an enhanced stake in the outcome of the project and incentive to make sure the property is properly maintained.

Individual Participation – Although mitigation is ultimately intended to benefit individuals, HMPs often neglect to integrate participation of potential beneficiaries into the process. The participation by individuals, including small business owners, is important for making sure the resulting HMP reflects community needs and priorities, but it also allows for the planning team to identify measures and options that individuals can take to reduce their own risk at a cost they can afford.

Public-Private Partnerships

Developing a public-private partnership is a phrase used frequently in a wide range of government programs and for good reason, especially in the content of hazard mitigation. Participation of private sector organizations in solving their own hazard risk situations can be a low-cost and effective method. The phrase also encompasses finding opportunities for public and private sector partners to share costs equitably for larger projects that require substantial funds to implement. Private sector businesses and organizations have their own cost-benefit calculations to perform but joint efforts may make the balance sheets work for both sides.

Private Foundations

Cultivating relationships with local, regional, or even national foundations with interests or missions consistent with hazard mitigation, community sustainability, climate change adaptation, and other related topics can yield successful results in terms of funding and other means of support.

There are many local foundations around the State of Iowa, many of which fund programs that can be utilized for components of hazard mitigation projects. Many of these foundations only support non-profit organizations, so the applicability of these funds to projects depends upon the partners involved.