July 2024

Shiawassee County Local Hazard Mitigation Plan

Prepared By:
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List of Commonly Used Acronyms

Acronym	Meaning
BRIC	Building Resilient Infrastructure and Communities
CFR	Code of Federal Regulations
CRS	Community Rating System
DFRIM	Digital Flood Insurance Rate Map
DMA	Disaster Mitigation Act
FEMA	Federal Emergency Management Agency
Hazus	FEMA Loss Estimation Software
HMGP	Hazard Mitigation Grant Program
LHMP	Local Hazard Mitigation Planning
MSP/EMHSD	Michigan State Police, Emergency Management and Homeland Security Division
MPC	Mitigation Planning Committee
NCEI	National Centers for Environmental Information
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NRI	National Risk Index
NWS	National Weather Service
RAPT	Resilience Analysis and Planning Tool
SCEMHS	Shiawassee County Emergency Management and Homeland Security Division
SFHA	Special Flood Hazard Area

Section 1 – Introduction, Assurances, and Adoption

1.1 Introduction

Mitigation is commonly defined as sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects. Hazard mitigation planning provides communities with a roadmap to aid in the creation and revision of policies and procedures, and the use of available resources, to provide long-term, tangible benefits to the community. A well-designed hazard mitigation plan provides communities with realistic actions that can be taken to reduce potential vulnerability and exposure to identified hazards.

This multi-jurisdictional natural Local Hazard Mitigation Plan (LHMP) was prepared to provide sustained actions to eliminate or reduce risk to people and property from the effects of natural and man-made hazards. This plan documents Shiawassee County and its participating jurisdictions planning process and identifies applicable hazards, vulnerabilities, and hazard mitigation strategies. This plan will serve to direct available community and regional resources towards creating policies and actions that provide long-term benefits to the community. Local and regional officials can refer to the plan when making decisions regarding regulations and ordinances, granting permits, and in funding capital improvements and other community initiatives.

Specifically, this hazard mitigation plan was developed to:

- Update the 2016 Shiawassee County, Michigan Hazard Mitigation Plan
- Build for a safer future for all citizens
- Foster cooperation for planning and resiliency
- Identify, prioritize and mitigate against hazards
- Assist with sensible and effective planning and budgeting
- Educate citizens about hazards, mitigation and preparedness
- Comply with federal requirements

This plan has been designed to be a living document, a document that will evolve to reflect changes, correct any omissions, and constantly strive to ensure the safety of Shiawassee County's citizens.

1.2 Assurances

In an effort to reduce natural disaster losses, the United States Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) in order to amend the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act). DMA 2000 amended the Stafford Act by repealing the previous Mitigation Planning section (409) and replacing it with a new Mitigation Planning section (322). Section 322 of the DMA makes the development of a hazard mitigation plan a specific eligibility requirement for any local government applying for Federal mitigation grant funds. This LHMP was prepared to meet the requirements of the DMA 2000, as defined in regulations set forth by the Interim Final Rule (44 Code of Federal Regulations (CFR) Part 201.4).

All adopting jurisdictions certify that they will comply with all applicable Federal statutes and regulations during the periods for which they receive grant funding, in compliance with 44 CFR 13.11(c), and will amend this plan whenever necessary to reflect changes in State or Federal laws and statutes as required in 44 CFR 13.11(d).

This hazard mitigation plan was prepared to comply with all relevant requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988, as amended by the Disaster Mitigation Act of 2000. This plan complies with all the relevant requirements of:

- Code of Federal Regulation (44 CFR) pertaining to hazard mitigation planning
- FEMA planning directives and guidelines
- Interim final, and final rules pertaining to hazard mitigation planning and grant funding
- Relevant presidential directives

- Office of Management and Budget circulars
- Any additional and relevant federal government documents, guidelines, and rules.

Additionally, this LHMP has been completed to address all State of Michigan recommendations and requirements concerning hazard mitigation planning and the requirements of FEMA's Local Mitigation Planning Policy Guide that went into effect April 19, 2023.

1.3 Authorities

The LHMP relies on the authorities given to participating jurisdictions by its citizens and encoded in local and state law. This plan is intended to be consistent with all policies and procedures that govern activities related to the mitigation programing and planning. In all cases of primacy, State of Michigan and local laws, statutes, and policies will supersede the provisions of the plan.

1.4 Adopting Jurisdictions

In order to have an approved hazard mitigation plan, DMA 2000 requires that each jurisdiction participate in the planning process. Each jurisdiction choosing to participate in the development of the plan was required to meet detailed participation requirements, which included the following:

- When practical and affordable, participation in planning meetings
- Provision of information to support the plan development
- Identification of relevant mitigation actions
- Review and comment on plan drafts
- Formal adoption of the plan

Based on the above criteria, the following jurisdictions participated in the planning process, and will adopt the approved hazard mitigation plan:

Table 1: Participating Jurisdictions

Jurisdiction	Requirements Met	Name	Title
Shiawassee County	x	Trent Atkins	Director of Emergency Management
City of Durand	x	Robert Brancheau	Police Chief
City of Laingsburg	x	Dan DeKorte	Police Chief
City of Owosso	x	Kevin Lenkart	Public Safety Director
City of Perry	x	Kyle Bawks	Police Chief
Township of Owosso	x	Brian Springdorf	Fire Captain

1.5 Plan Adoption

This plan was submitted to Michigan State Police Emergency Management and Homeland Security Division (MSP/EMHSD) and FEMA Region V prior to adoption (approval pending adoption protocol). This methodology allows for a single plan adoption by participating jurisdictions in the event of plan revisions during the review and approval process. Upon review and approved pending adoption status by FEMA Region V, adoption resolutions will be signed by the participating jurisdictions. FEMA approval documentation and jurisdictional adoption resolutions may be found in Appendix A.

Administration and oversight of the hazard mitigation program is the responsibility of the Shiawassee County Emergency Management Office. The plan will be reviewed annually and will be updated every five years, or as required by changing hazard mitigation regulations or guidelines.

Section 2 – Documentation of the Planning Process

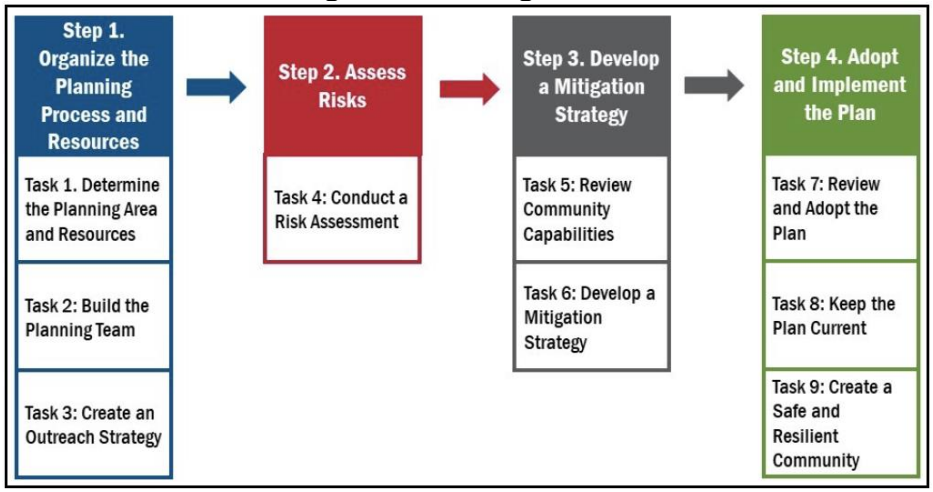
2.1 Planning Process

The process established for this planning effort is based on the Disaster Mitigation Act of 2000 planning and update requirements and the FEMA associated guidance for local hazard mitigation plans (Local Mitigation Planning Policy Guide (FP 206-21-0002), effective April 19, 2023). To accomplish this, the following planning process methodology was followed:

- Inform, invite, and involve other mitigation plan stakeholders throughout the state, including federal agencies, state agencies, regional groups, businesses, non-profits, underserved communities, and local emergency management organizations.
- Creation of a Mitigation Planning Committee (MPC) to codify and guide the planning process.
- Develop the planning and project management process, including methodology, review procedures, details about plan development changes, interagency coordination, planning integration, and the organization and contribution of stakeholders.
- Creation of a multi-pronged outreach strategy to engage stakeholders.
- Conduct a thorough review of all relevant current and historic planning efforts.
- Conduct a review of all related and relevant state and local plans for integration and incorporation.
- Collect data on all related state plans and initiatives, local plans' hazard risk, local plans' mitigation strategies and actions, critical facilities and community lifelines, flood plains, Repetitive Loss/Severe Repetitive Loss properties, hazard events, on-going and completed mitigation actions, and mitigation program changes since the development of the previous plan.
- Complete a risk and vulnerability assessment using data from the FEMA and other federal and state agency resources. Analyses were conducted at the state level, county by county, of state-owned facilities, and county by county drawing on local assessments.
- Develop and update the capability assessment of Shiawassee County and all participating jurisdictions.
- Develop a comprehensive mitigation strategy effectively addressing Shiawassee County's hazards and mitigation program objectives. This included reviewing pre and post disaster policies and programs, identifying objectives and goals, identifying mitigation actions and projects, and assessing mitigation actions and projects.
- Determination and implementation of a plan maintenance cycle, including a timeline for plan upgrades and improvements.

The following figure summarizes these steps:

Figure 1: Planning Process



Source: FEMA

2.2 Project Timeline

The Shiawassee County LHMP review and revision process began in February 2024, with the first public meeting held in March 2024. The following chart indicates the planning stages completed as part of this process:

Chart 1: Project Planning Stages

2.3 2024 Plan Organization

This LHMP is both a reference document and an action plan. It has information and resources to educate readers and decision-makers about hazard events and related issues and a comprehensive strategy that participating jurisdictions, stakeholders, and community members can follow to improve resilience. This LHMP is composed of the following sections:

- **Section 1 - Introduction, Assurances, Incorporation, and Adoption:** Details the regulatory framework for plan development, participating jurisdictions, how the plan will be incorporated into other planning mechanisms, and adoption requirements.
- **Section 2 – Planning Process:** Outlines the steps taken to complete this LHMP, consideration of planning equity, the people involved in its creation, strategies to invite public participation, and technical and planning resources utilized in completing this plan.
- **Section 3 - Regional Profile and Development Trends:** Details demographic information, vulnerable populations, critical facility and community lifeline information, agricultural data, and a discussion of climate change parameters.
- **Section 4 - Hazard Identification and Risk Assessment:** Describes the hazards that can impact the planning area, including extent, previous occurrences, changing conditions, and vulnerabilities.
- **Section 5 – Capability Assessment:** Provides a comprehensive evaluation of existing abilities to effectively mitigate hazards and manage disaster risks. This assessment involves analyzing the community's current resources, policies, programs, and systems to determine how well it can implement mitigation strategies.
- **Section 6 - Mitigation Strategy:** Outlines the specific actions, policies, and projects designed to reduce or eliminate the risks and impacts of hazards on a community. These strategies are developed based on the findings from the hazard identification and risk assessment phases and are tailored to address the unique vulnerabilities and capabilities of the community.
- **Chapter 7 - Plan Maintenance:** Summarizes plan maintenance responsibilities, monitoring and update requirements, and opportunities for continued public involvement.
- **Appendices:** Provides supplementary detailed information and supporting documents. The appendices serve to enhance the main content by offering further clarification, data, and documentation that support the planning process and implementation.

2.4 2024 Plan Update

In undertaking this planning effort, Shiawassee County determined that wide variances in planning format and data do not allow for effective continuous planning. To provide planning continuity every effort was made during this plan update to adhere as closely as possible to elements of the previous LHMP. As such, the level of analysis and detail included in this risk assessment is cumulative, allowing participating jurisdictions to have a robust base to further mold and improve their mitigation strategies over the next five years.

As part of this planning effort, each section of the previous mitigation plan was reviewed based on current and available data. The plan was reviewed against the following elements:

- Compliance with the current regulatory environment
- Completeness of data
- Correctness of data
- Capability differentials
- Current regional environment

Based on the above criteria, each section of the previous LHMP was revised as required. In addition to data revisions, the format and sequencing of the previous plan was updated for ease of use and plan clarity. Key updated elements from the previous LHMP include:

- Integration of the all current and relevant county and jurisdictional plans, including general and comprehensive plans.
- Expanded definition and discussion of underserved communities and vulnerable populations.
- Updated critical facilities and community lifelines list.
- Expanded detailing of historic hazard event occurrences.
- Updated mapping using newly available data.
- Updated county and jurisdictional capabilities assessment
- Updated mitigation actions, including progress on previous actions

Additionally, during this process, and after a thorough review and discussion with all stakeholders, it was determined that the priorities of the Shiawassee County in relation to hazard mitigation planning have not changed during the five years of the previous planning cycle.

2.5 Hazard Mitigation Planning Equity

Planning equity refers to the principle of fairness and justice in planning and development processes. It emphasizes the equitable distribution of resources, opportunities, and benefits among all members of a community, particularly those who have historically been marginalized or disadvantaged. The concept of planning equity recognizes that planning decisions can have significant impacts on different groups of people and aims to ensure that these decisions promote social justice and inclusivity. It involves addressing spatial inequalities, such as disparities in access to housing, transportation, public services, green spaces, and employment opportunities.

Planning equity entails involving diverse stakeholders in decision-making processes, including community members, advocacy groups, and underrepresented populations. It seeks to empower marginalized communities by giving them a voice in shaping the development and planning policies that directly affect their lives.

Planning equity and hazard mitigation planning are closely related, as both aim to create more resilient and inclusive communities. As part of this planning effort, the following intersections were considered between planning equity and hazard mitigation planning:

- Vulnerability assessment: Planning equity recognizes that certain communities, particularly marginalized and disadvantaged populations, may be more vulnerable to hazards due to social, economic, and environmental

factors. When conducting a vulnerability assessment as part of hazard mitigation planning, it is important to consider equity issues and identify areas or groups that may experience disproportionate impacts.

- Engaging marginalized communities: Planning equity emphasizes the inclusion and participation of diverse stakeholders, including marginalized communities, in decision-making processes. In hazard mitigation planning it is crucial to engage these communities to understand their unique needs, concerns, and perspectives regarding hazards.
- Addressing social disparities: Hazard mitigation planning can help address social disparities by considering the unequal distribution of resources and opportunities in the context of hazards. This can involve implementing mitigation measures that specifically target vulnerable populations, such as affordable housing in safer areas or improved access to emergency services and transportation for underserved communities.
- Equitable distribution of resources: Planning equity promotes the equitable distribution of resources, and this principle can be applied to hazard mitigation planning. It involves ensuring that mitigation measures and investments are allocated fairly, with consideration given to communities that have historically received less attention or investment. This can help reduce existing disparities and enhance the resilience of marginalized communities.

By integrating planning equity into hazard mitigation planning, it becomes possible to develop strategies and actions that not only reduce the risks associated with hazards but also promote social justice, inclusivity, and resilience for all members of the community.

As part of this planning process, the MPC considered potential inequities within the county and encouraged the participation of potentially vulnerable citizens and communities. This process began with recognizing that disparities exist within the county, including health outcomes and living conditions for people of color, people with disabilities, and historically disadvantaged communities. It was recognized that these populations may be at greater risk to the hazards identified in this plan and may be limited in their ability to adapt, respond, and recover if an event were to occur.

As recommended in FEMA's "Guide to Expanding Mitigation," Shiawassee County took a whole community approach to this planning effort, including:

- Inviting historically underserved populations to participate in the planning and decision-making processes
- Inviting faith based and community organizations, nonprofit groups, schools, and academia to be plan stakeholders

The following identifies our equity partners who actively engaged in the LHMP planning effort:

- Shiawassee Health Department: Provides a wide range of social services, mental health services, alcohol and drug treatment services, public health services, emergency preparedness and income assistance.

2.6 Mitigation Planning Committee

Project initiation began with a selection and meeting of the primary stakeholders to establish the Mitigation Planning Committee (MPC). Leading the MPC was the SCEMHS Emergency Manager, Trent Atkins, who directed the identification of MPC members from each participating jurisdiction. Once determined, members of the MPC established the projects operating procedures, established expectations, solidified the plan development timeline, and created project milestones. Additionally, the team reviewed and discussed how the plan would incorporate FEMA requirement and other emergency management planning efforts.

In general, all MPC members were asked to participate in the following ways:

- Attend and participate in meetings
- Assist with the collection of data

- Assure the accuracy and completeness of data
- Assist with the revision and development of mitigation actions
- Review planning elements and drafts
- Integrate hazard mitigation planning elements with other planning mechanisms

The following table represents members of the MPC:

Table 2: Mitigation Planning Committee

MPC Member	Title	Jurisdiction/Department
Trent Atkins	Emergency Manager	Shiawassee County
Phil Heavilin	Facility Manager	Shiawassee County Health Department
Jodi Defrenn	Emergency Prep Coordinator	Shiawassee County Health Department
Casey Elliott	Environmental Health Director	Shiawassee County Health Department
Cory Carson	Under Sheriff	Shiawassee Sheriff's Department
Angie Norling	Lieutenant	Shiawassee Sheriff's Department
Tony Newman	Drain Commissioner	Shiawassee County Drain Commissioner
Robert Brancheau	Chief of Police	Durand Police Department
Kevin Lenkart	Chief	Owosso Public Safety
Brian D. Springsdorf	Captain	Owosso Charter Township Fire Department
Kyle Bawks	Chief	Perry Police Department
Tim Crane	Chair	Local Emergency Planning Committees
Bob Wolf	Lieutenant	Michigan State Police, Emergency Management and Homeland Security Division

2.7 Stakeholders

Shiawassee County acknowledges that effective hazard mitigation planning should involve a diverse group of stakeholders, including government agencies, private sector entities, private non-profit organizations, quasi-governmental authorities, and special districts. The coordination and cooperation of these stakeholders assists with all aspects of plan development, including:

- Data collection
- Risk analysis
- High and Significant Hazard dam information
- Statewide capability assessment
- Mitigation action review, revision, and development
- Plan implementation

The Shiawassee County MPC provided the opportunity for a wide variety of stakeholders to participate in the planning process, including:

- Local and regional agencies involved in hazard mitigation activities.
- Agencies that have the authority to regulate development.
- National Flood Insurance Program coordinators.
- Neighboring communities.
- Representatives of business, academia, and other private organizations.
- Non-profit and community-based organizations who work to provide support to socially vulnerable and underserved communities.

While not all of these organizations attended meetings, each was actively courted to provide information, data, and feedback as necessary and as related to their areas of expertise. Emphasis was placed on inviting local building departments, who played a critical role in creating and reviewing this LHMP. Their expertise was used to help identify local vulnerabilities and develop building-related mitigation measures (please see section 5.3) Additionally, jurisdictional NFIP coordinators played a key role in mitigation planning at the community level. These coordinators were actively engaged and for their expertise on flood risk, mitigation strategies, and NFIP compliance (please see Section 5.4).

The following provides a listing of all stakeholders involved in the development of this LHMP:

- Jurisdictional Building, Planning, and Zoning Departments
- Jurisdictional NFIP Coordinators
- U.S. Army Corps of Engineers (USACE)
- U.S. Department of Agriculture (USDA)
- U.S. Geological Survey (USGS)
- National Weather Service (NWS)
- United States Census Bureau
- University of Wisconsin SILVIS Labs
- National Oceanic and Atmospheric Administration
- Adjacent Region Emergency Management Departments
- State of Michigan Department of Agriculture and Rural Development
- State of Michigan Department of Environment, Great Lakes, and Energy
- State of Michigan Bureau of Fire Services
- State of Michigan Department of Labor and Economic Activity
- State of Michigan Department of Natural Resources
- Department of Technology, Management, and Budget
- State of Michigan Department of Transportation
- State of Michigan Dam Safety Program
- State of Michigan Bureau of Construction
- State of Michigan State Climatologist

2.8 Community Outreach

As part of the overall planning process, the community was provided with numerous opportunities to contribute and comment on the creation and adoption of the plan. These opportunities included:

- Advertised meeting invitations
- Comment period upon completion of draft plan
- Online survey

Experience has indicated that public meetings, no matter how well advertised, generally do not generate either participation or interest in the planning process. Even so, open meetings were held at easily accessible community locations.

To help generate community interest and participation, a parallel online outreach strategy was undertaken. An online LHMP survey was created, the Shiawassee County Hazard Mitigation Plan Survey. This online survey portal allowed community members to provide feedback and input on the LHMP update using a series of guided questions and open comment fields. Community members commented through this survey, and these comments are both incorporated in this LHMP and are included in Appendix B.

Input from the general public provided the MPC with a clearer understanding of local concerns, helped confirm identified hazards, and helped shape proposed mitigation actions. This public outreach effort was also an opportunity for adjacent jurisdictions and entities to be involved in the planning process. Additionally, as citizens were made more aware of potential hazards and the local process to mitigation against their impacts, it was believed that they would take a stronger role in making their homes, neighborhoods, schools, and businesses safer from the potential effects of natural hazards.

2.9 Planning Meetings

Numerous in-person meetings were conducted for the 2024 LHMP update. All of the meetings were held in a publicly accessible location and advertised as open to the public. These meeting were conducted to discuss the mitigation planning process as well as gain public support and input for the plan update. The following is a brief synopsis of those meetings.

- **LHMP Update Kick-Off and Public Information Meeting – March 12, 2024:** BOLDplanning hosted a kick-off meeting for the Shiawassee County LHMP, stakeholders, and the public. Prior to the meeting, a public announcement was published in the local newspaper and on participating jurisdiction websites. The meeting was used to present the general structure and timeline for the LHMP process, discuss jurisdictional participation requirements, present data concerning changing demographics and development, review and discuss identified hazards that could impact the region, and present next steps. During the meeting, MPC members, plan stakeholders, and the public were invited to voice any concerns, ask questions, and provide input on the mitigation plan update. Additionally, MPC members were tasked with collecting contact information, and advised of future data collection requirements such as hazard history, facility information, and other pertinent information from participating jurisdictions.
- **FEMA Region V Hazard Mitigation Plan Review Meeting – March 20, 2024:** FEMA hosted a meeting to discuss revised hazard mitigation planning components and review mitigation grant procedures.
- **LHMP Plan Review, Capability Review, and Mitigation Strategy Review Meeting – May 15, 2024:** An online meeting was held with Shiawassee County emergency management to review and revise, as necessary, hazard mitigation actions. Attendees reviewed and revised, as necessary, the hazards list and vulnerability assessment. MPC members also reviewed the mitigation strategy to ensure it was in-line with the current planning environment.
- **LHMP Final Review Meeting – TBD:** BOLDplanning hosted a public final plan review meeting for the Shiawassee County LHMP. Prior to the meeting, a public announcement was published in the local paper and on the participating jurisdiction websites. At the meeting, MPC members, plan stakeholders, and the public were invited to voice any concerns, ask questions, and provide input on the mitigation plan update. Additionally, members of the public were invited to review a draft copy of the Shiawassee County LHMP update posted to County's website for two weeks prior to the final meeting, and prior to its submission to Michigan State Police/Emergency Management and Homeland Security Division (MSP/EMHS).

Other planning events included conference phone calls with participating jurisdiction officials who could not attend scheduled meetings. Additionally, there were regular situation calls provided to Shiawassee County and its participating jurisdictions to provide updates concerning the phases of plan development and to review plan data..

2.10 Planning Document Resources

The hazard mitigation plan is an overarching document that is both comprised of, and contributes to, various other jurisdictional plans. In creating this plan, all the planning documents identified below were consulted and reviewed, often extensively. In turn, when each of these other plans is updated, they will be measured against the contents of the hazard mitigation plan.

Below is a list of the various planning efforts, sole or jointly administered programs, and documents reviewed and included in this hazard mitigation plan. While each plan can stand alone, their review and functional understanding was pivotal in the development of this plan and further strengthens and improves Shiawassee County's resilience to disasters.

- **Shiawassee County 2016 Multi-Jurisdictional Natural Hazard Mitigation Plan**
  The previous LHMP has been reviewed and is incorporated throughout this plan per FEMA requirements.
- **Shiawassee County Master Plan, 2016**
  The plan sets policies that help the county address critical issues facing the community, achieve goals based on priority, and coordinate public and private efforts for mutual success. It also provides the historical context, background, and current data necessary to understand issues and choose solutions as well as seek various forms of funding.
- **Participating Jurisdictions Master and/or Comprehensive Plans:**
  These plans help jurisdictions set policies that help address critical issues facing the community, achieve goals based on priority, and coordinate public and private efforts for mutual success. They also provide the historical context, background, and current data necessary to understand issues and choose solutions as well as seek various forms of funding.
- **Shiawassee County and Participating Jurisdictions Critical Facilities List, 2024**
  The MPC compiled a list of critical facilities and pertinent information on those facilities. This list is used throughout the plan and is the basis for the vulnerability assessments and loss estimates.
- **Shiawassee County Emergency Operations Plan**
  Shiawassee County Emergency Management and Homeland Security (SCEMHS) developed this plan to develop procedures for the protection of personnel, equipment, and critical records to help determine existing established policies that ensure the continuity of government and essential services during and after disasters.
- **State of Michigan Hazard Mitigation Plan, 2019**
  The State of Michigan Hazard Mitigation Plan is intended to provide the framework for hazard mitigation. This plan set a baseline for standards and practices for hazard mitigation planning and was used as a resource for information and data.

- **Shiawassee County and Participating Jurisdiction Planning and Zoning Documents and Ordinances**
  Shiawassee County and participating jurisdictions provided a host of planning, zoning, and development related documents. These documents were reviewed, assessed, and cataloged to compile each participating jurisdiction's capabilities.

Information from each of these plans and programs is utilized within the applicable hazard sections to provide data and fully inform decision making and prioritization.

2.11 Technical Resources

The Shiawassee County MPC employed a variety of technical resources in its plan development. These technical resources were instrumental in completing an accurate vulnerability and risk assessment.

- **FEMA Digital Flood Insurance Rate Maps**: FEMA's National Flood Hazard Layer data was instrumental in mapping floodplain locations and estimating potential flood impacts and loss estimates.
- **FEMA National Risk Index (NRI):** An online mapping application that identifies communities most at risk to natural hazards. The mapping service visualizes natural hazard risk metrics and includes data about expected annual losses from natural hazards, social vulnerability, and community resilience. The NRI's interactive web maps are at the county and Census tract level and made available via GIS services for custom analyses.

- **FEMA Resilience Analysis and Planning Tool (RAPT):** FEMA and Argonne National Laboratory created RAPT to support state, local, tribal, territorial analysis in identifying focus areas for building resilience, response, and recovery capabilities. RAPT is a geographic information system web map tool with clickable layers of community resilience indicators, infrastructure locations, and hazard data.
- **Homeland Infrastructure Foundation-Level Data (HIFLD)**
  A program managed by the U.S. Department of Homeland Security (DHS) that provides authoritative geospatial data for use by government agencies, emergency responders, and other authorized users involved in homeland security, emergency management, and critical infrastructure protection. The primary goal of HIFLD is to support homeland defense, security, and emergency preparedness missions by offering high-quality, reliable geospatial information.
- **National Oceanic and Atmospheric Administration (NOAA)/National Centers for Environmental Information (NCEI):** Provided weather data and historical events occurrence data.
- **U.S. Army Corps of Engineers (USACE):** Provided dam and flood control data.
- **U.S. Department of Agriculture (USDA):** Provided drought and agricultural data.
- **U.S. Geological Survey:** Provided geologic hazard occurrence and probability data.
- **National Weather Service (NWS):** Provided meteorological and storm event occurrence and probability data.
- **U.S. Drought Monitor:** Provided drought occurrence and intensity data.
- **Michigan Geological Society:** Provided data about Shiawassee County's geology.
- **FEMA Map Service Center:** The official public source for flood hazard information produced in support of the National Flood Insurance Program (NFIP).
- **United States Census Bureau:** Data concerning populations, socially vulnerable populations, and housing.
- **MSP/EMHSD:** LHMP planning guidance and technical support.

Section 3 – Regional Profile and Development Trends

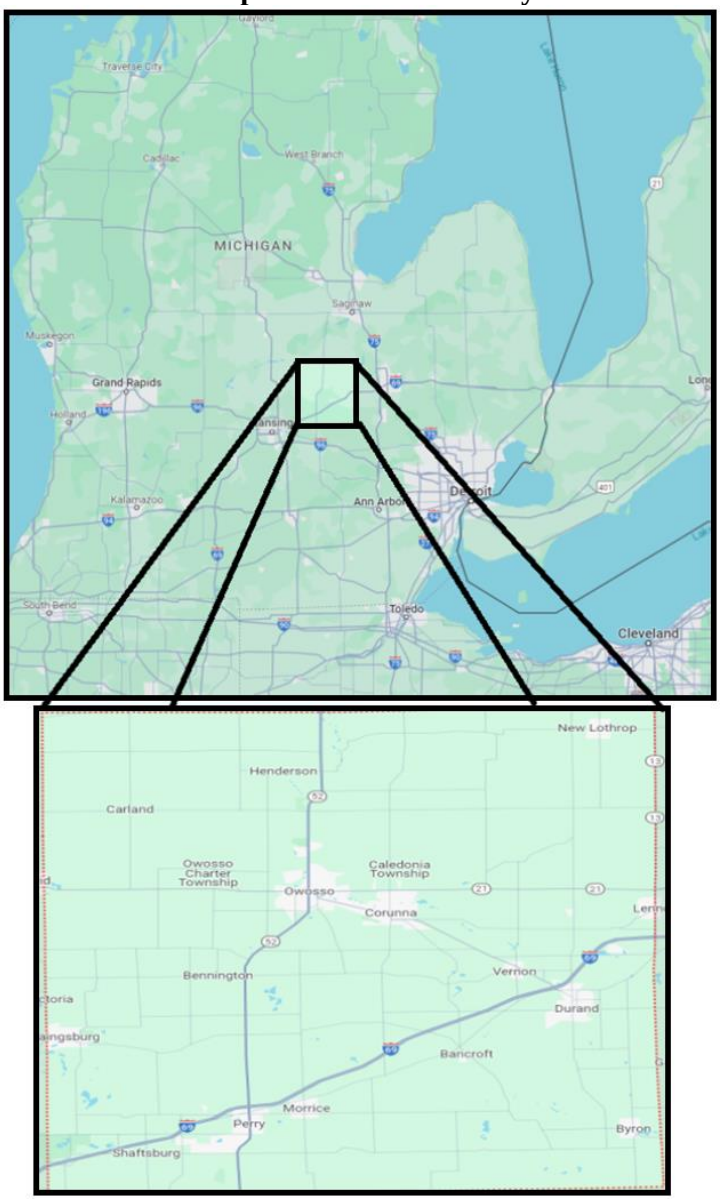
3.1 Introduction

Data concerning development trends and conditions is of great importance in determining regional and local risk and vulnerability to identified hazards, especially in locations which are susceptible to identified hazards. In general, any increase in population or development in hazard susceptible areas tends to increase both the risk and the vulnerability to that hazard. As such, the information presented in this chapter details relevant population and building statistics for the region on a local level basis. This data will then be used to determine and refine potential hazard vulnerability in succeeding sections.

3.2 Regional Maps

The following map details the locations of Shiawassee County relative to the State of Michigan:

Map 1: Shiawassee County



Source: Google Maps

3.3 Population Data

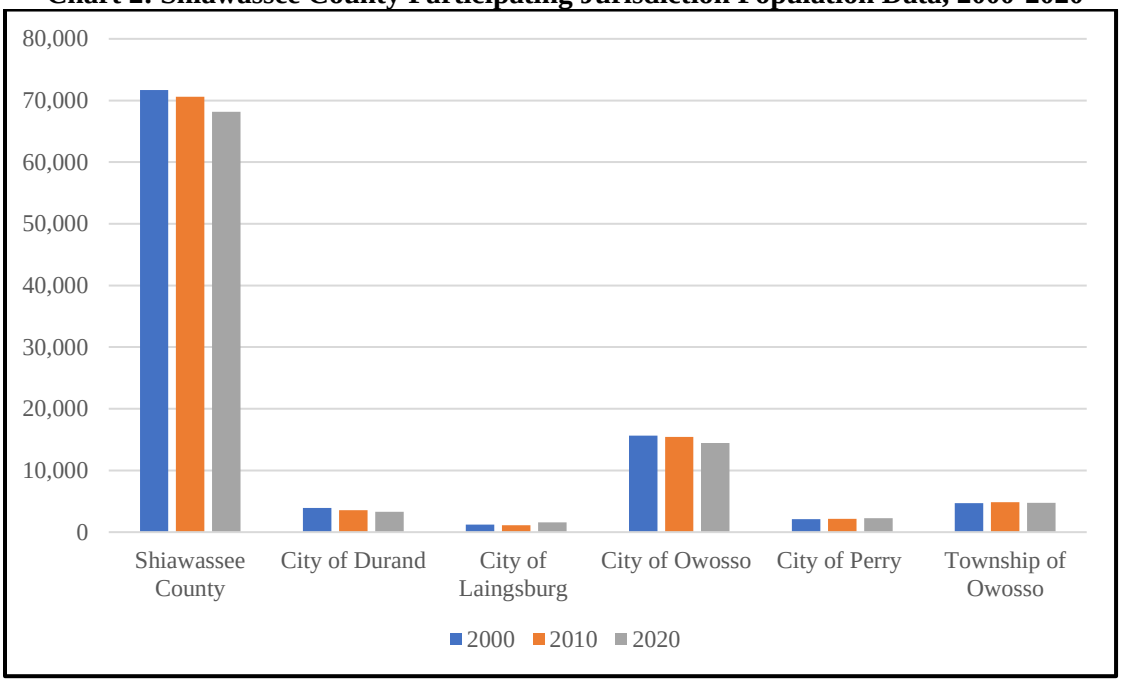
In general, Shiawassee County is a rural area with smaller to medium sized urban centers. Data from the United States Census Bureau from the 2000, 2010 and 2020 Decennial Census in the table below details the participating jurisdictions' demographic information.

Table 3: Population Data

Jurisdiction	Population			Change
	2000	2010	2020	2000-2020
Shiawassee County	71,687	70,606	68,176	-3,511
City of Corunna	3,371	3,515	3,363	-8
City of Durand	3,917	3,572	3,308	-609
City of Laingsburg	1,233	1,140	1,586	353
City of Owosso	15,664	15,452	14,476	-1,188
City of Perry	2,111	2,165	2,248	137
Township of Antrim	2,066	2,609	2,159	93
Township of Bennington	2,978	3,169	3,074	96
Township of Burns	3,480	3,501	3,325	-155
Township of Caledonia	4,444	4,508	4,292	-152
Township of Fairfield	764	702	628	-136
Township of Hazelton	2,221	2,256	2,310	89
Township of Middlebury	1,485	1,478	1,650	165
Township of New Haven	1,289	1,305	1,184	-105
Township of Owosso	4,710	4,846	4,750	40
Township of Perry	4,392	4,386	4,218	-174
Township of Rush	1,396	1,219	1,069	-327
Township of Sciota	1,832	1,701	1,345	-487
Township of Shiawassee	2,911	2,894	2,744	-167
Township of Venice	2,577	2,601	2,285	-292
Township of Vernon	4,996	4,735	4,461	-535
Township of Woodhull	3,850	3,867	3,701	-149

Source: US Census Bureau

Chart 2: Shiawassee County Participating Jurisdiction Population Data, 2000-2020



Source: US Census Bureau

3.4 Social Vulnerability

Each participating jurisdiction has socially vulnerable and at-risk populations, populations that may have difficulty with medical issues, poverty, extremes in age, and communications due to language barriers. Several principles 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
- The hazard event will, in many cases, affect at risk population in differing 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." The following tables present information on potentially at-risk populations within Shiawassee County.

Table 4: Shiawassee County Vulnerable Population Data

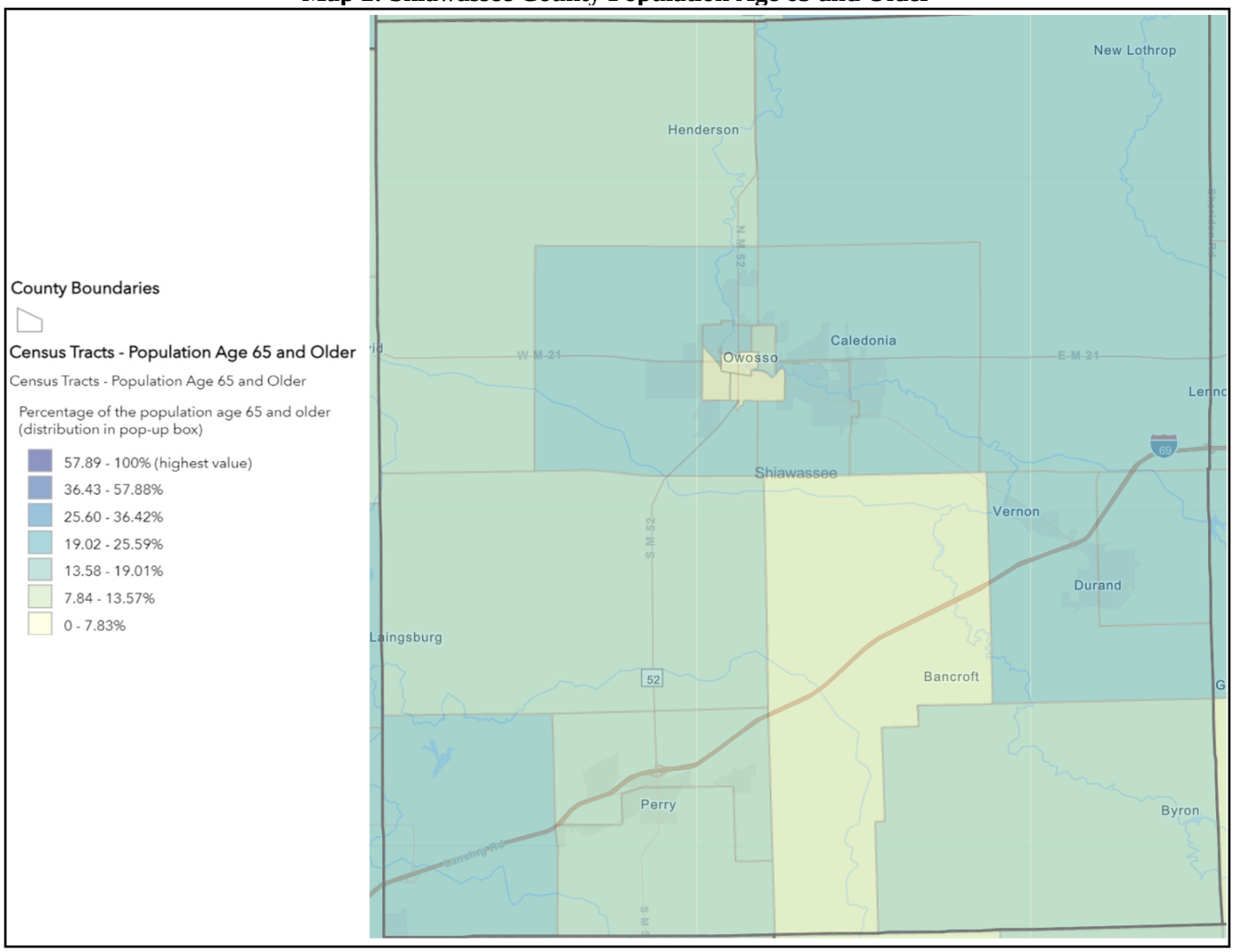
Jurisdiction	Population 5 and Under 2020	Population Over 75 2020	Speak a Language Other Than English 2018-2022	Estimated People in Poverty 2018-2022
Shiawassee County	3,545	5,059	1,802	8,539
City of Corunna	63	65	27	159
City of Durand	105	326	39	65
City of Laingsburg	173	186	31	173
City of Owosso	233	322	63	421
City of Perry	32	35	4	89
Township of Antrim	194	178	10	186
Township of Bennington	64	74	41	98
Township of Burns	27	161	7	100
Township of Caledonia	285	622	81	640
Township of Fairfield	245	270	138	496

Jurisdiction	Population 5 and Under 2020	Population Over 75 2020	Speak a Language Other Than English 2018-2022	Estimated People in Poverty 2018-2022
Township of Hazelton	28	71	27	113
Township of Middlebury	46	78	39	123
Township of New Haven	102	99	71	277
Township of Owosso	85	194	30	301
Township of Perry	76	343	58	269
Township of Rush	163	152	67	375
Township of Sciota	767	999	526	1,891
Township of Shiawassee	256	346	42	379
Township of Venice	202	334	20	461
Township of Vernon	182	128	75	384
Township of Woodhull	270	59	27	408

Source: US Census Bureau

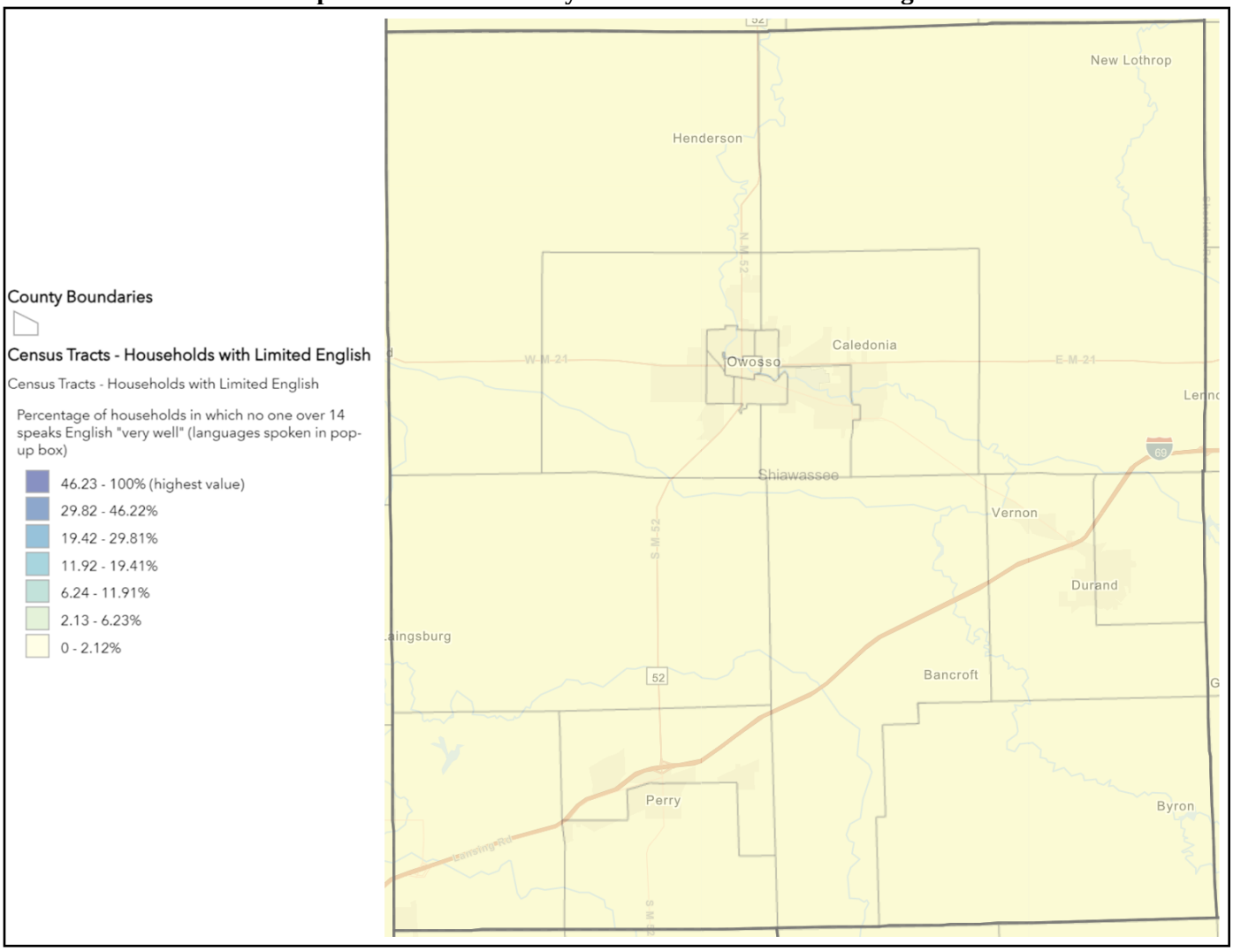
The following maps, from FEMA RAPT, present information on potentially at-risk populations within Shiawassee County.

Map 2: Shiawassee County Population Age 65 and Older



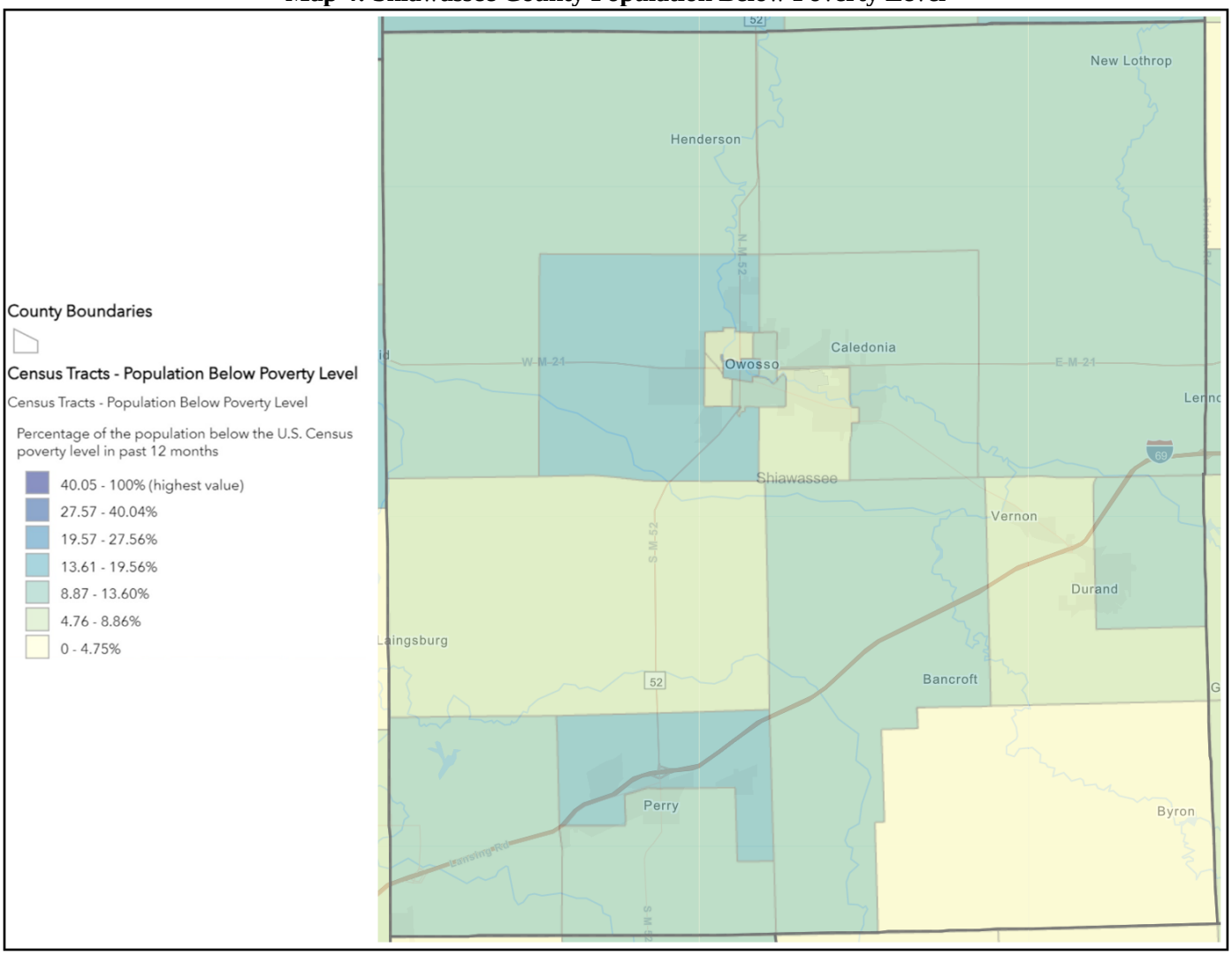
Source: FEMA RAPT

Map 3: Shiawassee County Households with Limited English



Source: FEMA RAPT

Map 4: Shiawassee County Population Below Poverty Level

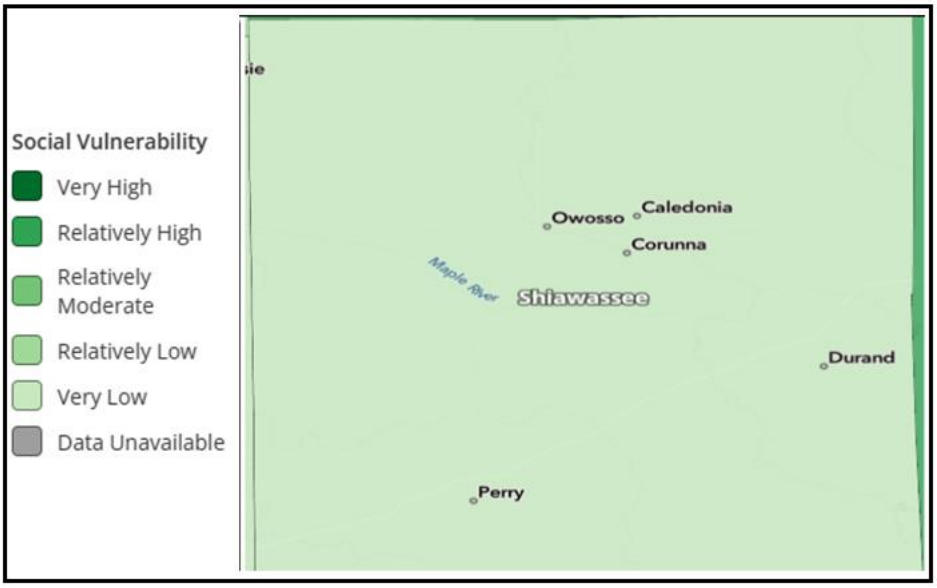


Source: FEMA RAPT

Using data from the Centers for Disease Control and Prevention (CDC)/Agency for Toxic Substances and Disease Registry Social Vulnerability Index FEMA's NRI creates and maps a Social Vulnerability score. In this context, social vulnerability is the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. This score represents the relative level of a community's social vulnerability compared to all other communities at the same level. A qualitative rating that describes the community in comparison to all other communities at the same level, ranging from "Very Low" to "Very High" is used quantify Social Vulnerability. Census tracts with the social vulnerability score highest qualify for designation as a community disaster resilience zone. Census tracts designated as a community disaster resilience zone may receive special technical assistance, planning assistance, and a 90% federal funding match (as opposed to the standard 75% federal match) for mitigation projects. Currently there are no designated community disaster resilience zones in Shiawassee County.

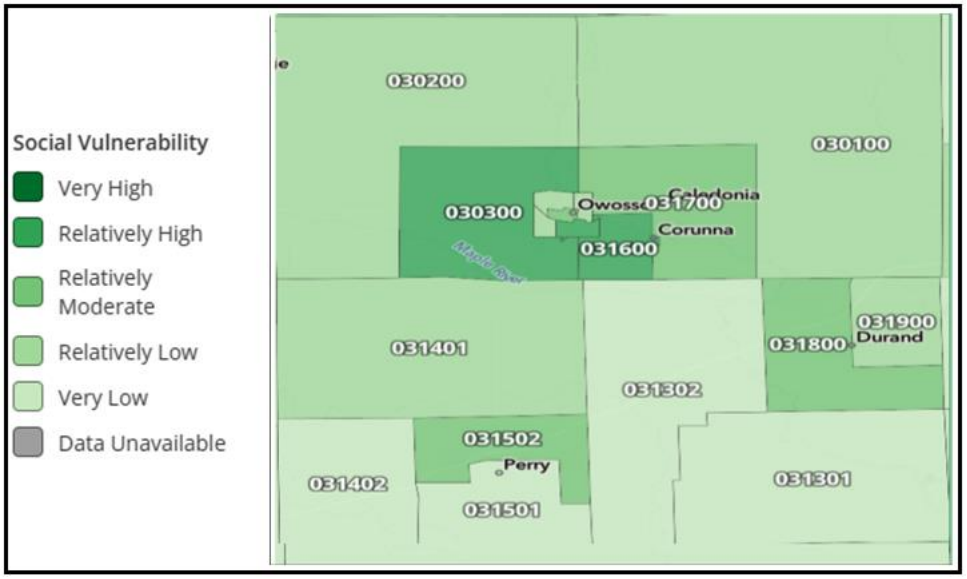
Data concerning social vulnerability is reported by county and by census tract, which can be analogous with jurisdictions. The following maps details the social vulnerability both county and census tract for Shiawassee County:

Map 5: FEMA NRI Shiawassee County Social Vulnerability



Source: FEMA NRI

Map 6: FEMA NRI Shiawassee County Jurisdictional Social Vulnerability

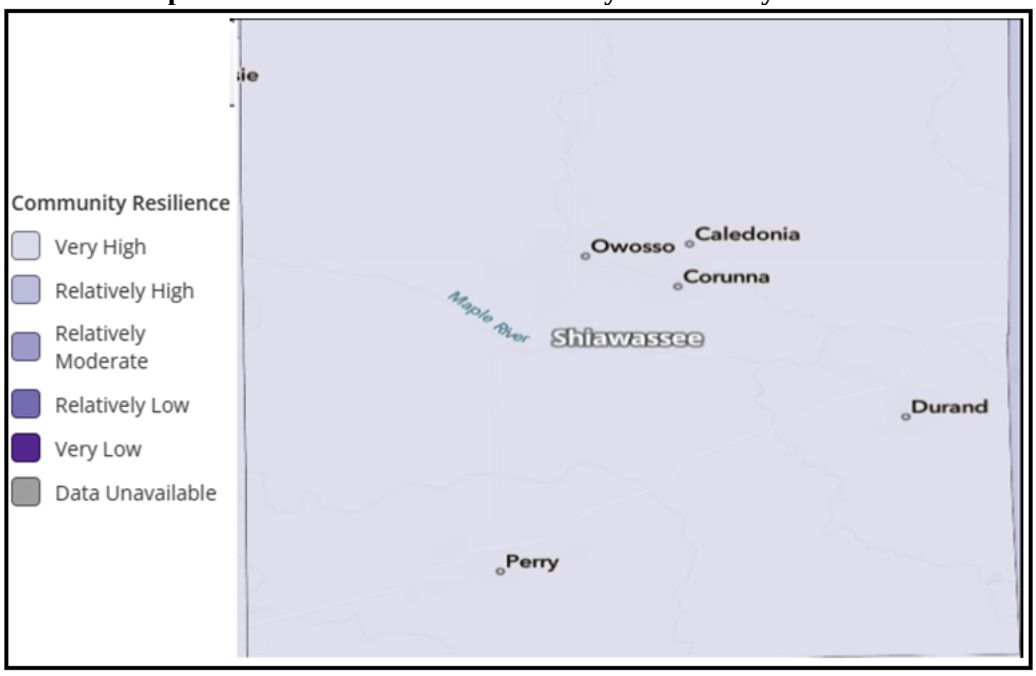


Source: FEMA NRI

Community resilience is the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. Factors that are considered when calculating community resilience include governance, infrastructure, education, and other capabilities that help communities deal with hazards on their own. As a consequence reduction risk component of the NRI, a community resilience score and rating represent the relative level of a community's resilience compared to all other communities at the same level. A community resilience score is inversely proportional to a community's risk. The following map indicates the community resilience scores for Shiawassee County counties:

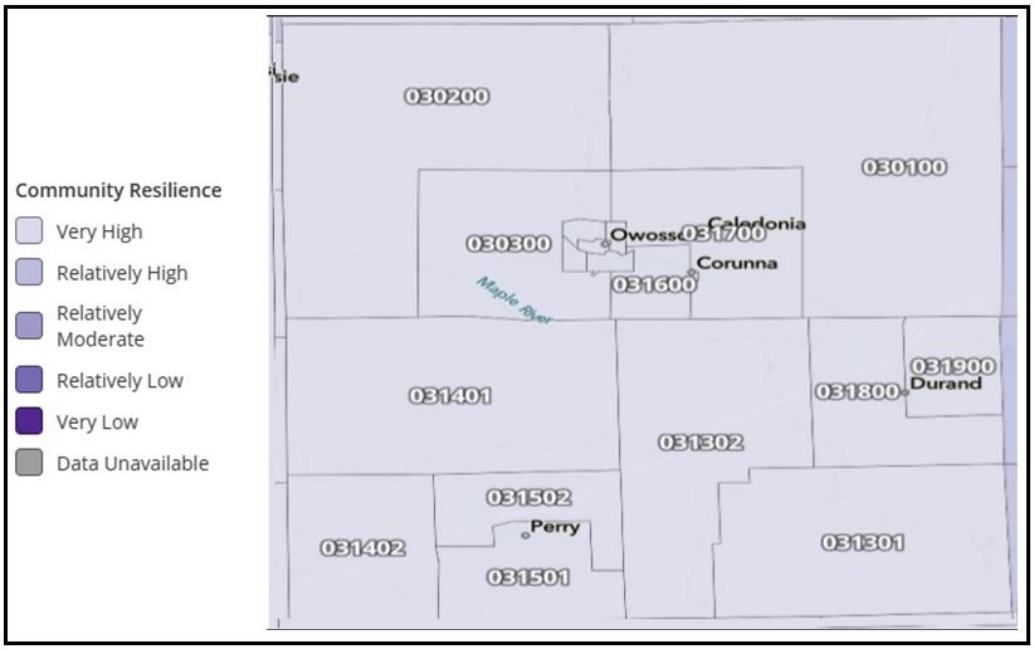
Data concerning community resilience is reported on the county level and by census tract, which can be analogous with jurisdictions. The following maps detail community resilience by both county and census tract for Shiawassee County:

Map 7: FEMA NRI Shiawassee County Community Resilience



Source: FEMA NRI

Map 8: FEMA NRI Shiawassee County Jurisdictional Community Resilience



Source: FEMA NRI

Augmenting these maps, a United States Census Bureau tract map is available in Appendix C detailing the jurisdiction in each census tract.

3.5 Regional Population Migration and Population Changes

Shiawassee County is experiencing a significant population movement as people increasingly migrate from rural areas to urban centers. This transformation reflects broader demographic trends witnessed across the United States. Demographic research indicates that this migration is occurring due to the following factors:

- Economic Opportunity: A primary driver of the population movement from rural to urban areas is the quest for better economic prospects. Urban centers such as Wichita, the largest city in the region, offer a diverse range of employment opportunities in sectors like manufacturing, healthcare, finance, and technology. These opportunities often come with higher wages and better access to educational and healthcare facilities compared to rural locales.
- Technological Advancements in Agriculture: The modernization of agriculture has led to increased mechanization and efficiency, reducing the demand for manual labor on farms. As a result, rural residents whose livelihoods were traditionally tied to farming are increasingly seeking employment in urban areas.
- Access to Education and Training: Urban centers are often home to educational institutions, including colleges, universities, and vocational schools. Young people from rural areas often migrate to these urban settings to pursue higher education and vocational training. This educational mobility is a key factor in the rural-to-urban population shift.

The rural-to-urban population movement has significant implications for both rural and urban areas in Shiawassee County, and Michigan as a whole. Rural communities may experience declining populations, school closures, and reduced economic activity. Meanwhile, urban centers may undergo growth, requiring increased investment in housing, infrastructure, and public services to accommodate the influx of new residents.

Information from Michigan Center for Data and Analytics' Michigan Statewide Population Projections through 2050 Report indicate that:

- Michigan's population is expected to experience slow growth and then decline, even with projected net positive migration to the state. Michigan's population is projected to increase by approximately 231,000 people from 2022 through 2034, and then decline to 9,906,000 people by 2050. This represents an overall decline of approximately 128,000 people from 2022 to 2050.
- Michigan has shifted from a young, higher fertility population to an older, low fertility population. This is a challenging age structure for sustained population growth. Decreasing births and increasing deaths are substantial contributors to the state's projected slow growth and population decline. These birth and death trends are projected even if the state has net positive migration of working- and family-age migrants.
- As the baby boomers age into high mortality years, Michigan is projected to transition to sustained and steepening natural decrease (more deaths than births) through 2050. This is a notable shift since most of Michigan's growth from the 1970s onward was from natural increase (more births than deaths).
- Since the 1970s, Michigan has typically had net negative migration. However, future population growth in the state will be increasingly dependent on net positive migration. As natural decrease becomes more severe, Michigan's future population growth will be reliant on continually higher levels of net positive migration.
- Michigan is projected to have a slower growth rate and earlier onset of population decline than the United States. The U.S. Census Bureau has projected that the national population will increase by approximately 8 percent from 2022 to 2050 and begin declining in the 2080s.

3.6 Housing Data

Closely tracking population data, but tending to lag population changes, housing data is a good indicator of changing demographics and growth. The following table and associated chart, using data from the U.S. Census, present occupied housing unit information for Shiawassee County.

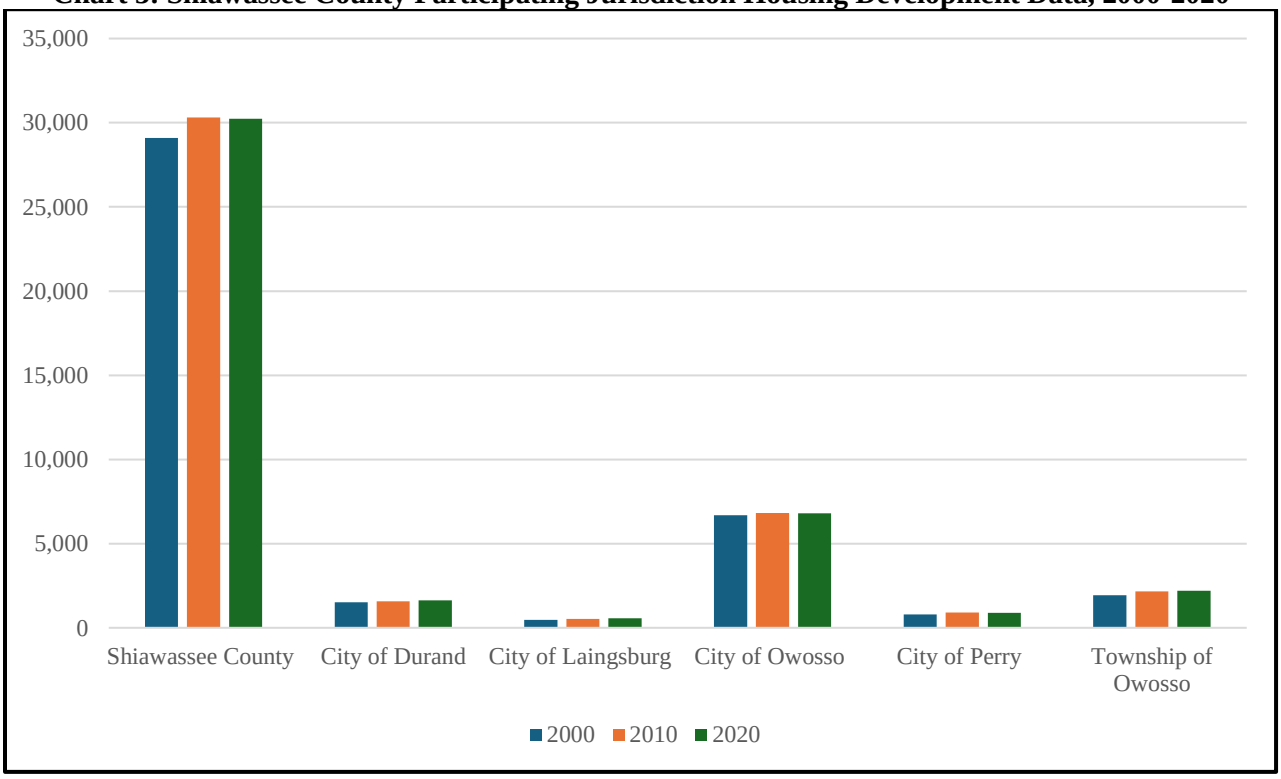
Table 5: Shiawassee County Housing Data

Jurisdiction	2000	2010	2020	Change 2000-2020
Shiawassee County	29,087	30,319	30,231	-1,144
City of Corunna	1,376	1,519	1,469	93
City of Durand	1,521	1,575	1,636	115
City of Laingsburg	476	536	571	95

Table 5: Shiawassee County Housing Data

Jurisdiction	2000	2010	2020	Change 2000-2020
City of Owosso	6,684	6,823	6,796	112
City of Perry	787	902	894	107
Township of Antrim	737	861	846	109
Township of Bennington	1,100	1,252	1,254	154
Township of Burns	1,226	1,356	1,347	121
Township of Caledonia	1,826	1,917	1,868	42
Township of Fairfield	292	300	292	0
Township of Hazelton	860	879	886	26
Township of Middlebury	600	646	646	46
Township of New Haven	507	529	521	14
Township of Owosso	1,933	2,163	2,199	266
Township of Perry	1,661	1,675	1,642	-19
Township of Rush	537	554	554	17
Township of Sciota	637	707	713	76
Township of Shiawassee	1,055	1,142	1,140	85
Township of Venice	1,009	1,046	1,027	18
Township of Vernon	2,822	2,379	2,379	-443
Township of Woodhull	1,441	1,558	1,551	110

Chart 3: Shiawassee County Participating Jurisdiction Housing Development Data, 2000-2020



Source: US Census Bureau

FEMA's Hazus is a nationally standardized risk modeling methodology that uses GIS-based data to identify areas with high risk for natural hazards. Hazus also details the number of buildings and the replacement value of those buildings within the defined area. The following data, from Hazus, indicates the replacement valuation (excluding contents of buildings) for participating jurisdictions in Shiawassee County:

Table 6: Shiawassee County Hazus Structure Valuation Information

Jurisdiction	Replacement Value
Shiawassee County	$11,130,400,000
City of Durand	$1,305,519,753
City of Laingsburg	$895,535,389
City of Owosso	$1,836,227,706
City of Perry	$565,309,987
Township of Owosso	$1,049,457,705

Source: FEMA

Hazus estimates that in Shiawassee County there are 21,566 buildings in total, with 64.7% of the buildings being residential, 20.3% commercial, and 5.5% industrial.

Of particular concern when considering housing data is mobile home residences. Data from the NOAA National Severe Storms Laboratory reports that people living in mobile homes are especially at risk for injury and death, as even anchored mobile homes can be seriously damaged when winds gust over 80 miles per hour. Additionally, study data from Michigan State University reported that the two biggest factors related to wind event fatalities were housing quality (measured by mobile homes as a proportion of housing units) and income level. When a tornadic wind strikes, a county with double the number of mobile homes as a proportion of all homes will experience 62% more fatalities than a county with fewer mobile homes, according to the study data. The following indicates the change between 2010-2020 of mobile homes for Shiawassee County:

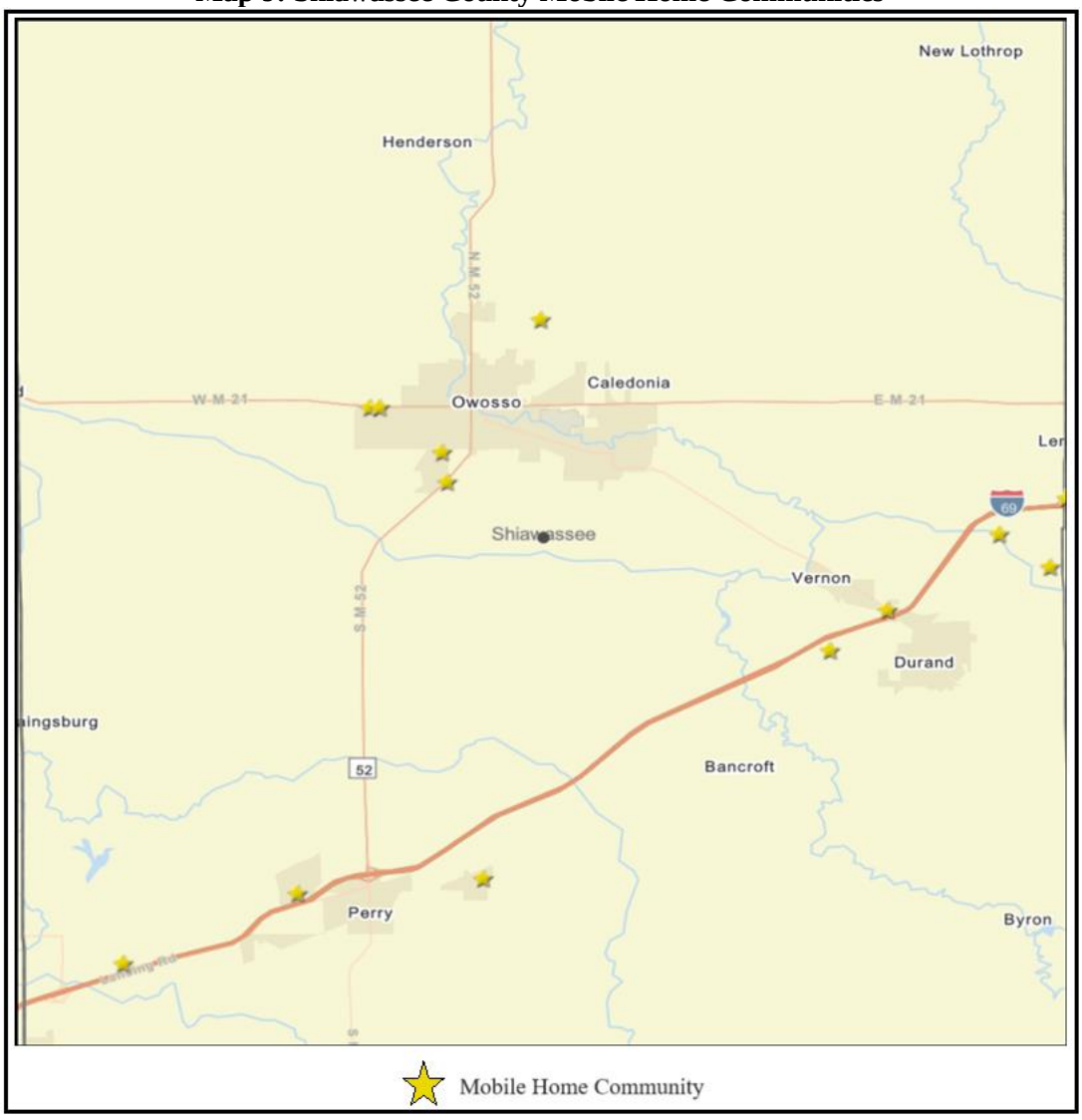
Table 7: Shiawassee County Mobile Home Data

Mobile Homes	2010	2020	Change
Shiawassee County	1,302	1,471	169
City of Corunna	11	0	-11
City of Durand	5	0	-5
City of Laingsburg	5	11	6
City of Owosso	237	149	-88
City of Perry	0	0	0
Township of Antrim	16	21	5
Township of Bennington	7	5	-2
Township of Burns	48	12	-36
Township of Caledonia	57	11	-46
Township of Fairfield	2	5	3
Township of Hazelton	12	5	-7
Township of Middlebury	50	50	0
Township of New Haven	5	11	6
Township of Owosso	314	296	-18
Township of Perry	413	233	-180
Township of Rush	8	3	-5
Township of Sciota	25	6	-19
Township of Shiawassee	55	6	-49
Township of Venice	140	160	20
Township of Vernon	593	324	-269
Township of Woodhull	110	93	-17

Source: United States Census Bureau

The following map details the location of Shiawassee County mobile home communities:

Map 9: Shiawassee County Mobile Home Communities



Source: FEMA RAPT

3.7 School District Data

The following table presents 2024 enrolment information for public schools within Shiawassee County:

Table 8: USD Enrollment Information

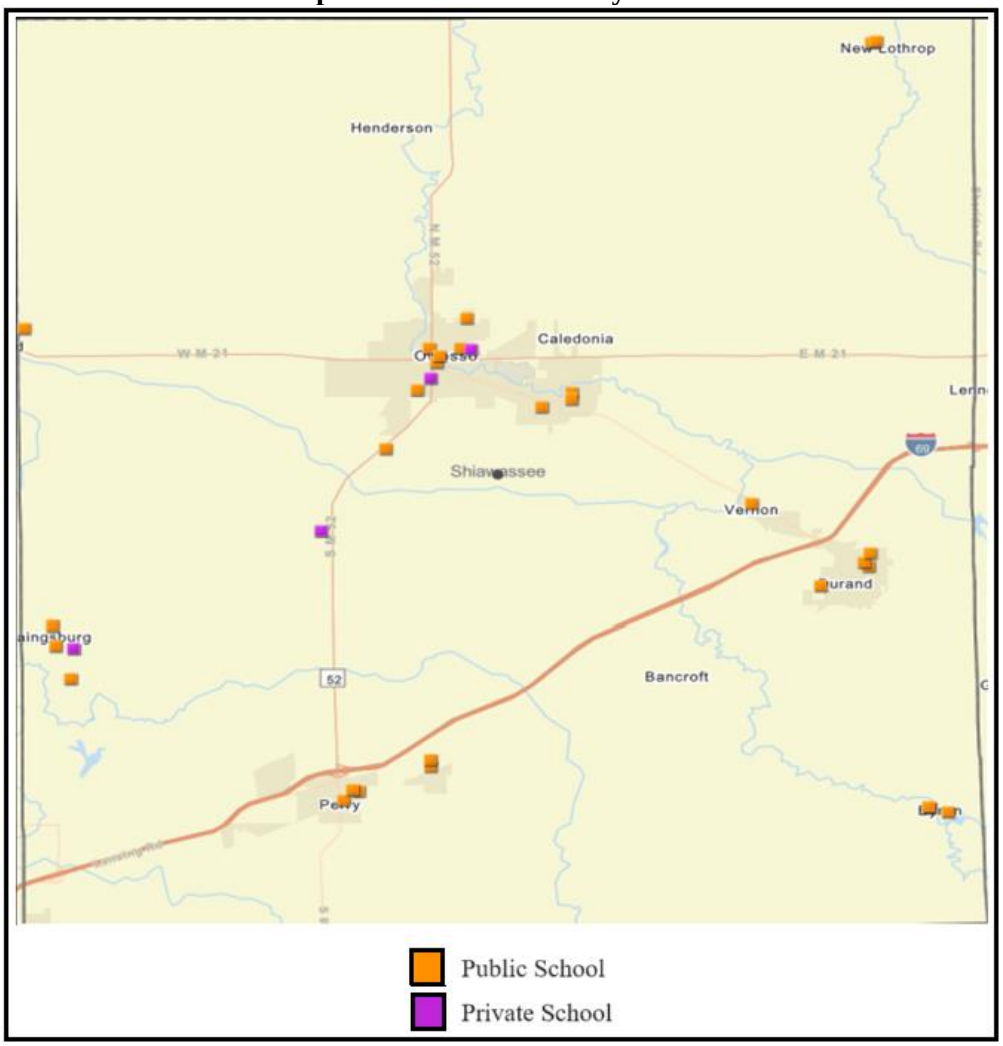
School	District	2024 Enrollment	Grades
Bertha Neal School	Durand Area Schools	185	PK-1
Bryant School	Owosso Public Schools	449	PK-5
Byron Area Elementary School	Byron Area Schools	314	PK-5
Byron Area High School	Byron Area Schools	236	9-12
Byron Area High School	Byron Area Schools	236	9-12
Byron Area Middle School	Byron Area Schools	124	6-8
Central School	Owosso Public Schools	423	KG-5
Corunna High School	Corunna Public School District	666	8-12
Corunna Middle School	Corunna Public School District	452	4-7
Durand Area High School	Durand Area Schools	425	9-12

Table 8: USD Enrollment Information

School	District	2024 Enrollment	Grades
Durand Middle School	Durand Area Schools	276	6-8
Elsa Meyer Elementary School	Corunna Public School District	337	1-3
Emerson School	Owosso Public Schools	452	KG-5
Laingsburg Christian School	Laingsburg Community School District	68	PK-12
Laingsburg Elementary School	Laingsburg Community School District	511	KG-5
Laingsburg Elementary School	Laingsburg Community School District	363	9-12
Laingsburg Middle School	Laingsburg Community School District	265	6-8
Morrice Area Elementary School	Morrice Area Schools	242	PK-5
Morrice Area High School	Morrice Area Schools	239	6-12
Nellie Reed Elementary	Corunna Public School District	164	KG-1
New Lothrop Elementary School	New Lothrop Area Public Schools	476	PK-6
New Lothrop High School	New Lothrop Area Public Schools	401	7-12
Owosso Christian School	Owosso Public Schools	16	K-12
Owosso High School	Owosso Public Schools	843	9-12
Owosso Middle School	Owosso Public Schools	643	6-8
Owosso SDA School	Owosso Public Schools	18	4-8
Perry Elementary School	Perry Public School District	356	PK-4
Perry Elementary School	Perry Public School District	356	PK-4
Perry High School	Perry Public School District	317	9-12
Perry High School	Perry Public School District	317	9-12
Perry Middle School	Perry Public School District	286	5-8
Perry Middle School	Perry Public School District	286	5-8
Robert Kerr School	Durand Area Schools	348	2-5
Salem Lutheran School	Owosso Public Schools	74	PK-8
Shiawassee Alternative High School	Owosso Public Schools	101	9-12
Spring Vale Christian School	Owosso Public Schools	44	7-12
St. Paul School	Owosso Public Schools	132	K-8

Source: Michigan Department of Education and Individual Schools

Map 10: Shiawassee County Schools



Source: FEMA RAPT

3.8 Critical Facilities and Community Lifelines

Certain facilities and community lifelines have a net positive value on the community as they contribute to the public good by facilitating the basic functions of society. These locations help maintain order, public health, education, and help the economy function. Additionally, components are integral to disaster response and recovery operations. For Shiawassee County and its participating jurisdictions, the table below lists the identified locations:

Table 9: Shiawassee County Critical Facilities and Community Lifelines

Location	Function	City
Shiawassee County EOC	Emergency Operations Center	Corunna
Burns Township Fire Department	Fire Station	Byron
Corunna-Caledonia Fire Department	Fire Station	Corunna
Durand Fire Department	Fire Station	Durand
Hazelton - New Lothrop Township Fire Department	Fire Station	New Lothrop
Owosso Twp Fire Department Station	Fire Station	Owosso
Owosso Charter Township Fire Department Station	Fire Station	Owosso
Owosso City Fire Department	Fire Station	Owosso

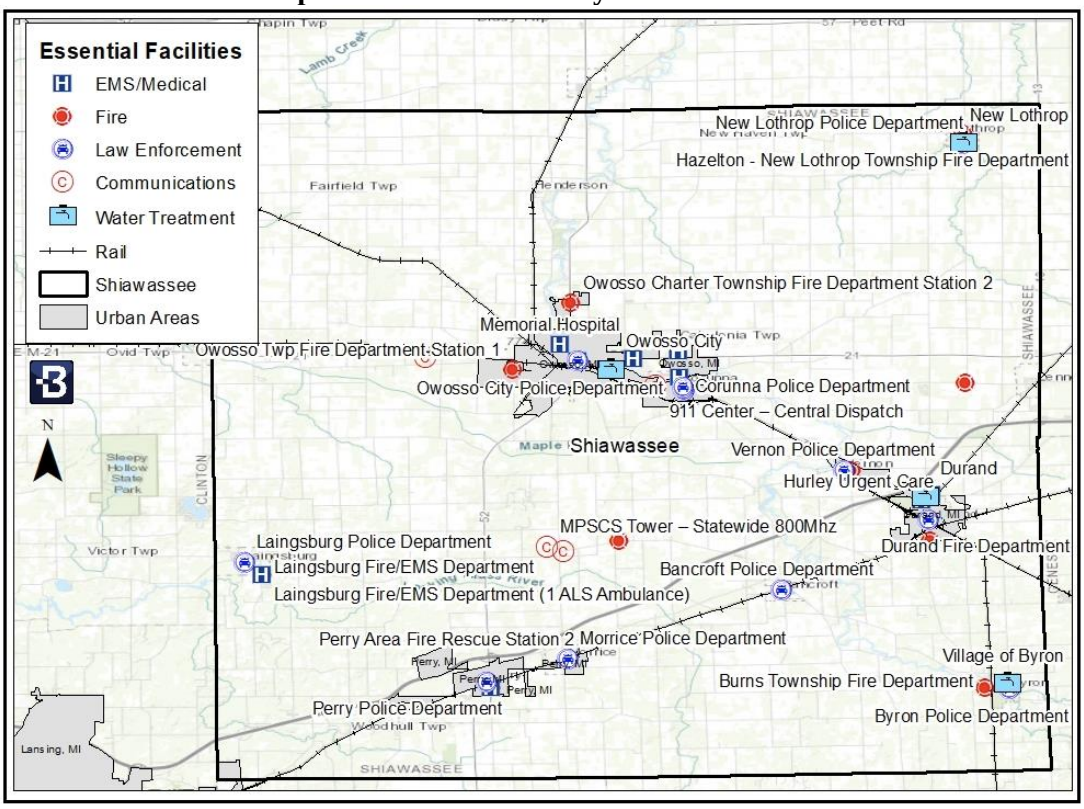
Table 9: Shiawassee County Critical Facilities and Community Lifelines

Location	Function	City
Shiawassee Township Fire Department	Fire Station	Bancroft
Perry Area Fire Rescue Station	Fire Station	Perry
Perry Area Fire Rescue Station 2	Fire Station	Morrice
Venice Township Fire Department	Fire Station	Lennon
Vernon Township Fire Department - South	Fire Station	Durand
Vernon Township Fire Department - North	Fire Station	Vernon
Perry Area Fire Rescue Station	EMS/Medical	Perry
Laingsburg Fire/EMS Department	EMS/Medical	Laingsburg
Owosso City Fire Department	EMS/Medical	Owosso
Corunna Ambulance	EMS/Medical	Corunna
Memorial Hospital	EMS/Medical	Owosso
Convenient Urgent Care	EMS/Medical	Owosso
Memorial Healthcare Urgent Care	EMS/Medical	Owosso
Hurley Urgent Care	EMS/Medical	Durand
Memorial Healthcare Family Medicine	EMS/Medical	Durand
Shiawassee County Sheriffs Office	Law Enforcement	Corunna
Bancroft Police Department	Law Enforcement	Bancroft
Byron Police Department	Law Enforcement	Byron
Corunna Police Department	Law Enforcement	Corunna
Durand Police Department	Law Enforcement	Durand
Laingsburg Police Department	Law Enforcement	Laingsburg
Lennon Police Department	Law Enforcement	Lennon
Morrice Police Department	Law Enforcement	Morrice
New Lothrop Police Department	Law Enforcement	New Lothrop
Owosso City Police Department	Law Enforcement	Owosso
Perry Police Department	Law Enforcement	Perry
Vernon Police Department	Law Enforcement	Vernon
911 Center- Central Dispatch	Communications	Corunna
Shiawassee County	Communications	Owosso
MPSCS Tower	Communications	Owosso
MPSCS Tower- Statewide	Communications	Future Site
Village of Byron	Water Treatment Facilities	Byron
Durand	Water Treatment Facilities	Durand
New Lothrop	Water Treatment Facilities	New Lothrop
Owosso City	Water Treatment Facilities	Owosso

Source: Shiawassee County and participating jurisdictions

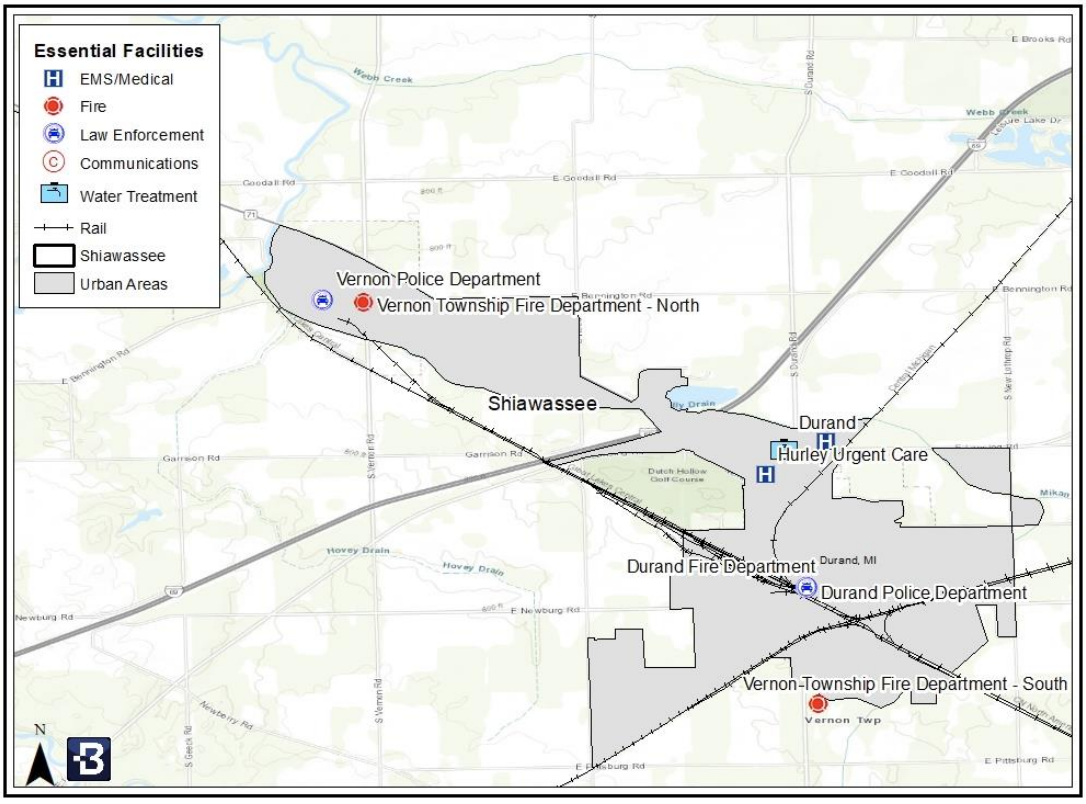
The following maps detail these locations:

Map 11: Shiawassee County Critical Facilities



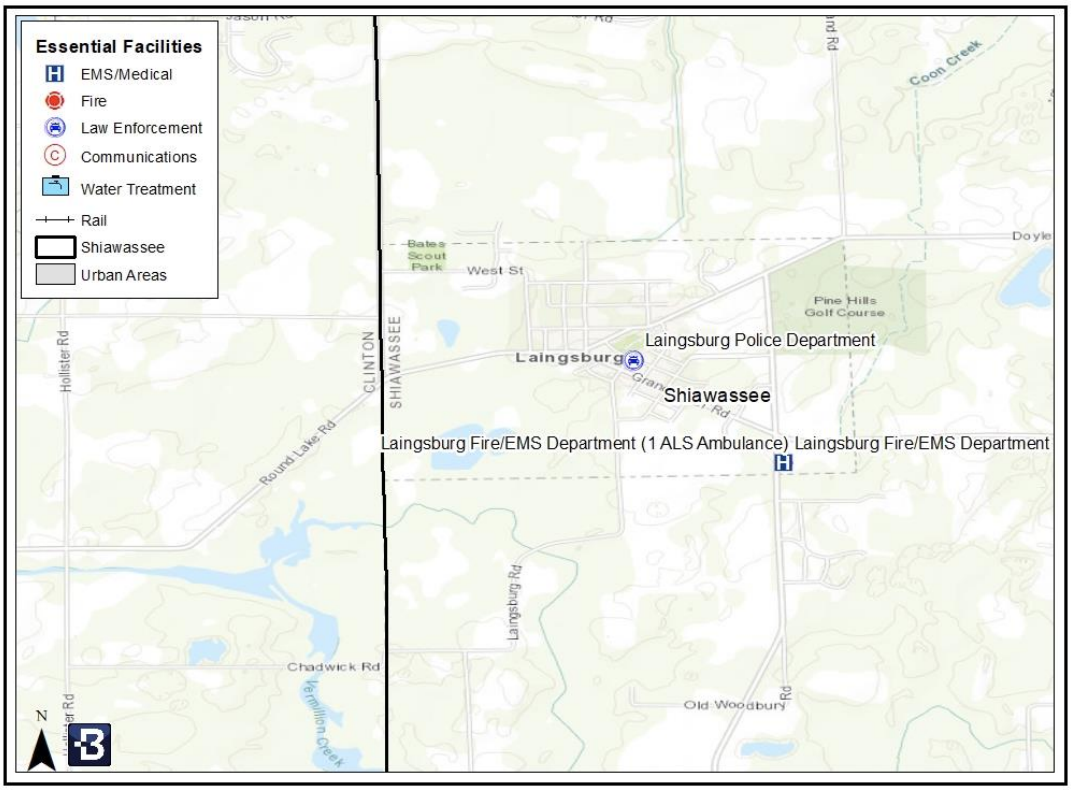
Source: Shiawassee County

Map 12: Durand Critical Facilities



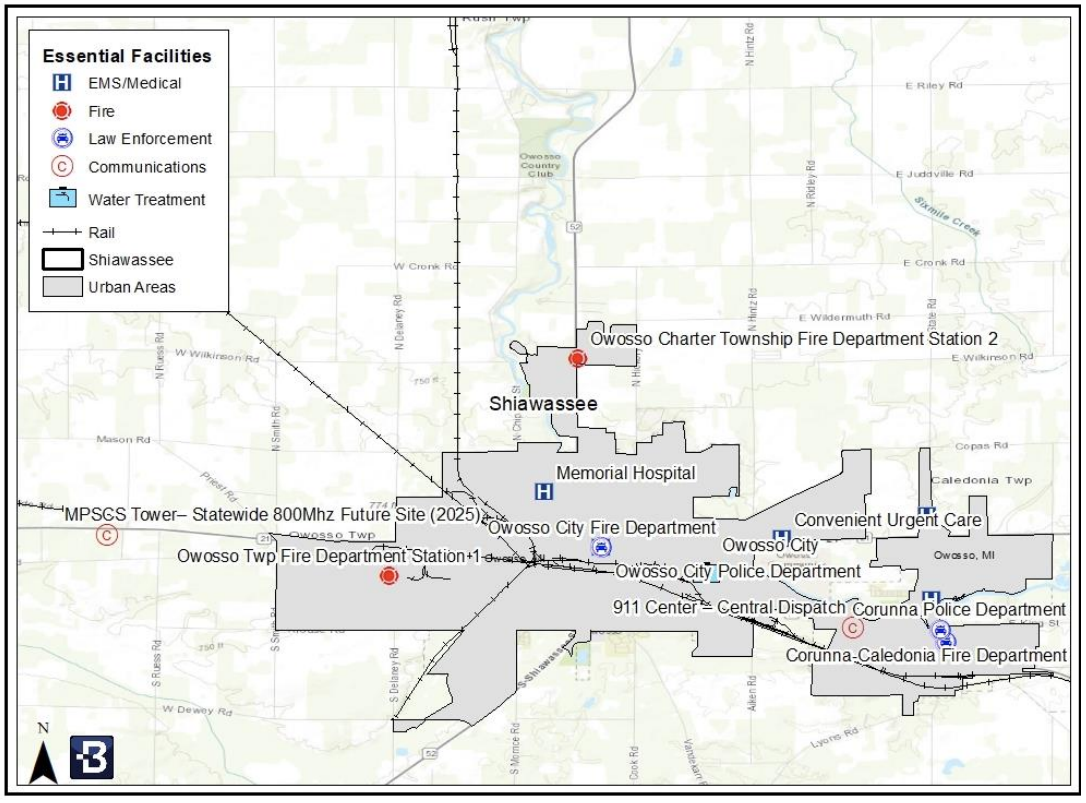
Source: Shiawassee County

Map 13: Laingsburg Critical Facilities



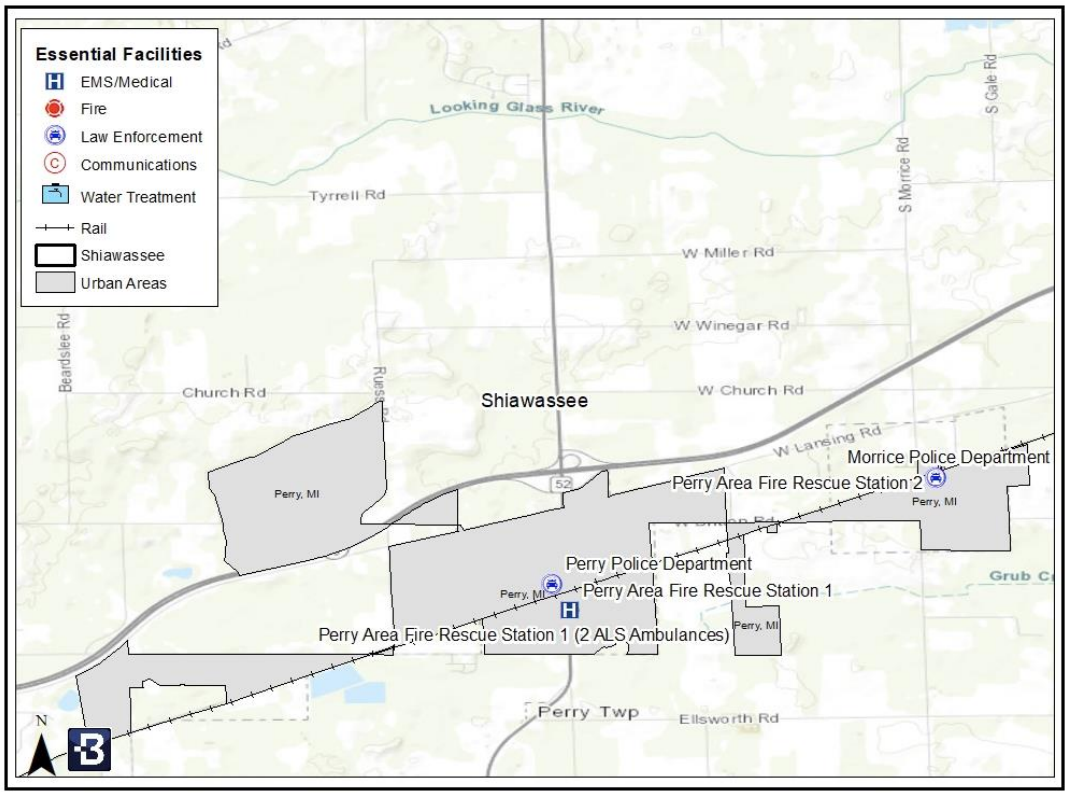
Source: Shiawassee County

Map 14: Owosso Critical Facilities



Source: Shiawassee County

Map 15: Perry Critical Facilities



Source: Shiawassee County

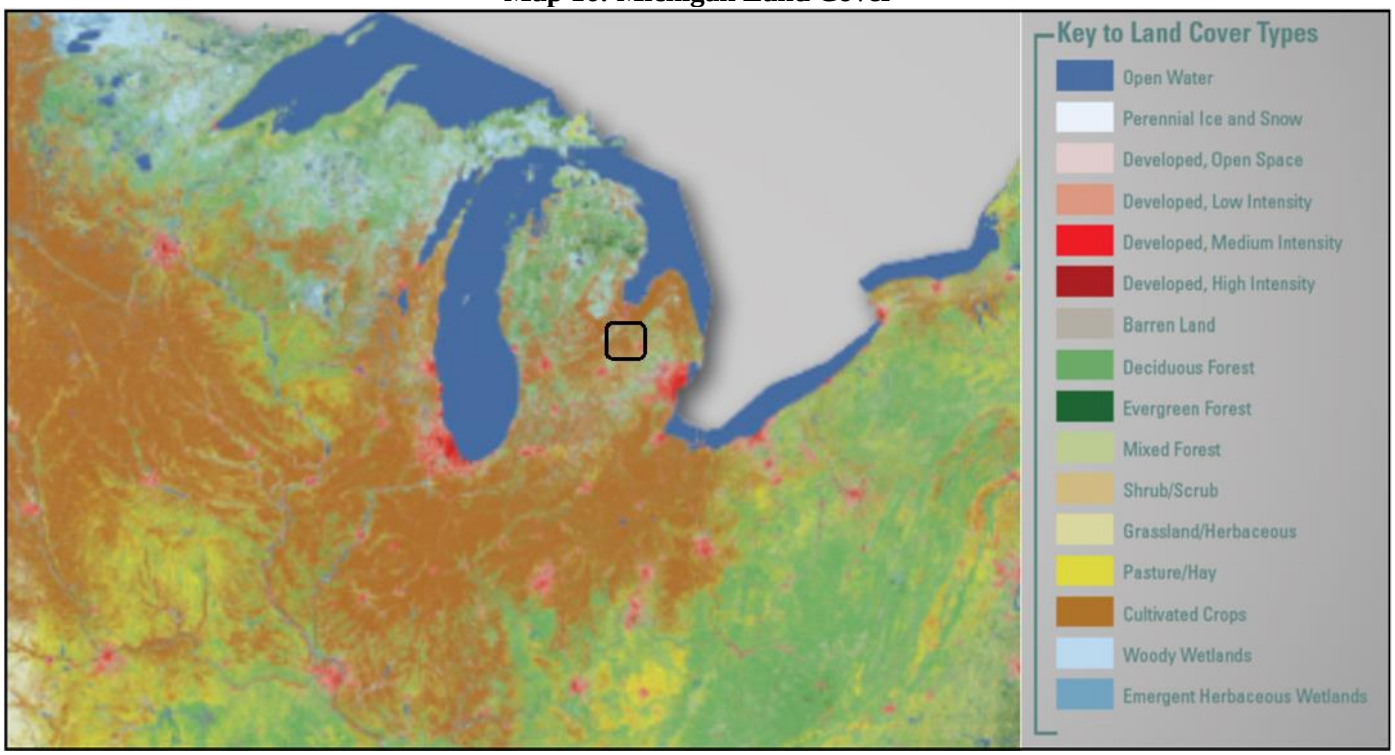
3.9 Land Use

Land use in a region has a profound and lasting impact on future development. The way land is allocated and utilized can shape the economic, social, and environmental aspects of a region for decades. Land use affects that can impact future development include:

- Economic Development: Land use decisions influence the location and type of economic activities in a region. Zoning regulations that encourage the development of industrial zones can attract manufacturing businesses, while zoning for commercial and residential areas can promote retail and housing development. These decisions can have long-term implications for job creation, revenue generation, and overall economic health.
- Transportation and Infrastructure: Land use planning is closely tied to transportation infrastructure. The location of roads and other transportation facilities is determined in part by land use decisions. Well-planned land use can lead to efficient transportation networks, reducing congestion, and improving mobility. Poorly planned land use, on the other hand, can result in traffic congestion and increased infrastructure costs.
- Housing and Urbanization: Land use policies influence the availability and affordability of housing in a region. Zoning regulations, for example, can determine the density of residential areas and the types of housing permitted. Inadequate or restrictive land use policies can lead to housing shortages and higher costs, while well-planned policies can support diverse housing options and affordability.
- Resilience to Climate Change: Land use planning plays a critical role in a region's ability to adapt to climate change. Smart land use decisions can reduce vulnerability to natural disasters, such as flooding and wildfires, by avoiding high-risk areas and implementing resilient building codes and infrastructure.
- Long-Term Costs: Land use decisions can affect the long-term costs of development. Efficient land use planning can reduce the need for costly infrastructure extensions and maintenance, while inefficient or sprawling development can strain municipal budgets.

The following map, from the USGS, indicates the type of land cover for Shiawassee Count. Land cover is indicative of overlying use.

Map 16: Michigan Land Cover



Source: USGS 2021 Nation Land Cover Database

As indicated by the map, and as Bourne out by discussions with the MPC and stakeholders, the majority of Shiawassee County is rural in nature. Rural areas tend to retain their rural nature over time, but there are several factors that can influence the evolution of these areas, including:

- Economic Conditions: The economic viability of agriculture can vary significantly over time due to factors like crop prices, weather patterns, and changes in agricultural technology. Economic challenges may lead some farmers to sell their land for non-agricultural uses or to consolidate their operations, potentially affecting the rural landscape.
- Urbanization and Development: In some cases, rural areas may experience suburbanization or the expansion of nearby urban centers. This can result in residential and commercial development encroaching on agricultural land. However, the extent of this development depends on local zoning and land use regulations.
- Infrastructure Development: The construction of new transportation infrastructure, such as highways or railroads, can influence land use patterns. Improved infrastructure may make it easier to transport agricultural products to markets or to access rural areas for development.
- Government Policies: Government policies, including agricultural subsidies, land use regulations, and conservation programs, can impact the way rural and agricultural land is used. For example, conservation programs may encourage farmers to preserve land for wildlife habitat rather than development.
- Local Planning and Zoning: Local governments play a key role in land use planning and zoning regulations. These policies can determine whether agricultural land can be converted to non-agricultural uses, such as residential or commercial development. Some areas may have strict zoning that preserves agricultural character, while others may allow more flexibility.

- Population Trends: Demographic trends, including population growth or decline, can influence the demand for land in rural areas. If there is an influx of new residents seeking a rural lifestyle, it can drive demand for residential development in formerly agricultural areas.

Based on the available data, it is likely that Shiawassee County will retain its mostly rural character during the life of this plan. Based on demographic data, Shiawassee County will see a decreased risk to identified hazards due to static and shrinking populations.

3.10 Infrastructure Development

Infrastructure repair can have a significant impact on regional development, both positive and negative. The specific effects depend on the scale of the repair projects, the quality of the infrastructure, and the overall economic and social context of the region, and may include:

- Improved Connectivity: Repairing and upgrading infrastructure, such as roads, bridges, and ports, can enhance connectivity within and between regions. This improved connectivity can reduce transportation costs, facilitate the movement of goods and people, and attract businesses and investments to the region.
- Economic Growth: Functional infrastructure supports economic activities. When infrastructure is repaired, it can create jobs directly in the construction and maintenance sectors. Additionally, it can indirectly stimulate economic growth by providing a reliable foundation for businesses to operate and expand, leading to increased production and trade.
- Enhanced Productivity: Well-maintained infrastructure can increase productivity by reducing downtime and transportation delays. This, in turn, can make regional industries more competitive and efficient.
- Attracting Investment: Regions with modern and well-maintained infrastructure are often more attractive to investors. Businesses are more likely to invest in regions with reliable transportation, utilities, and communication networks, as it reduces operational risks and costs.
- Quality of Life: Infrastructure repair can enhance the quality of life for residents by providing access to essential services such as clean water, sanitation, healthcare, and education. This can contribute to improved human development indicators and overall well-being.
- Resilience and Disaster Mitigation: Infrastructure repair can include upgrades to make infrastructure more resilient to natural disasters and climate change impacts. This can help protect communities and assets and reduce the long-term costs of recovery and reconstruction.
- Social Equity: Infrastructure repair can address disparities in access to essential services. It can benefit marginalized communities by providing them with equal access to transportation, utilities, and public facilities.

However, it is important to note that there can be negative impacts as well, including:

- Disruption During Construction: Repair projects can disrupt communities and businesses during the construction phase, leading to short-term challenges.
- Costs and Budget Constraints: Large-scale infrastructure repair projects can be costly, and they may strain regional budgets or lead to increased taxes or debt.
- Environmental Concerns: If not done carefully, infrastructure repair projects can have adverse environmental impacts, such as habitat disruption or water pollution.

The following project has recently been completed in Shiawassee County.

- Ranger Power's Assembly Solar Project: A 1,900-acre, $250,000,000 solar project in Hazelton and Venice townships.

The most current data from the Michigan Infrastructure Office indicates that as of this plan no major infrastructure or road projects were underway in Shiawassee County.

3.11 Agricultural Data

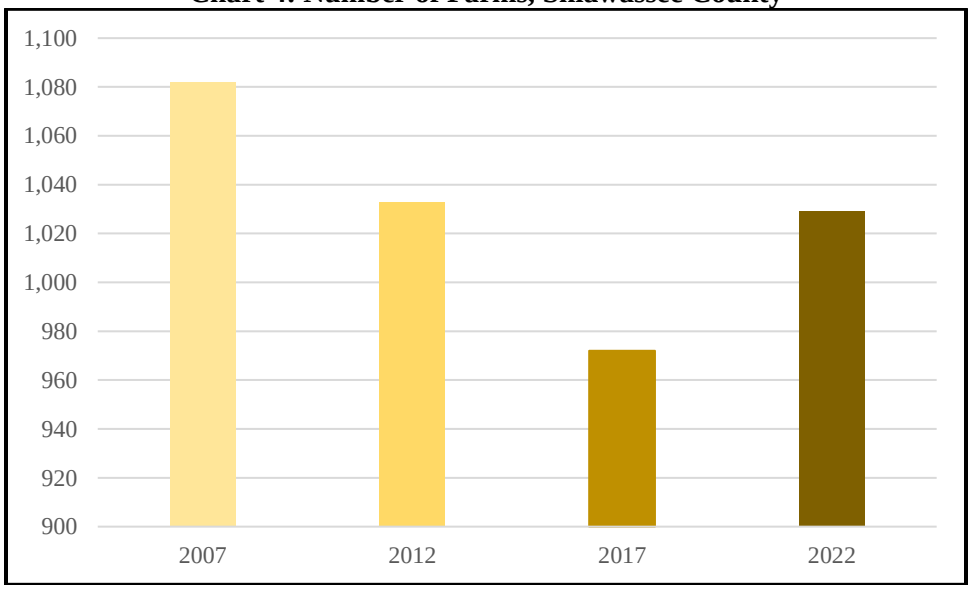
Agriculture forms a very important part of both the economic and social fabric of Shiawassee County. The United States Department of Agriculture (USDA) National Agricultural Statistics Service data was used to develop agricultural information for Shiawassee County. The following table details information from the USDA Census of Agriculture for 2007, 2012, and 2017 (the latest available data) for Shiawassee County:

Table 10: Shiawassee County Regional Agricultural Data

Agricultural Census Year	Number of Farms	Farm Acreage	Market Value of Agricultural Products Sold
2007	1,082	226,509	$87,847,000
2012	1,033	223,370	$145,170,000
2017	972	210,473	$97,476,000
2022	1,029	206,410	$156,593,000
Percentage Change, 2007 - 2017	-4.9%	-8.9%	78.3%

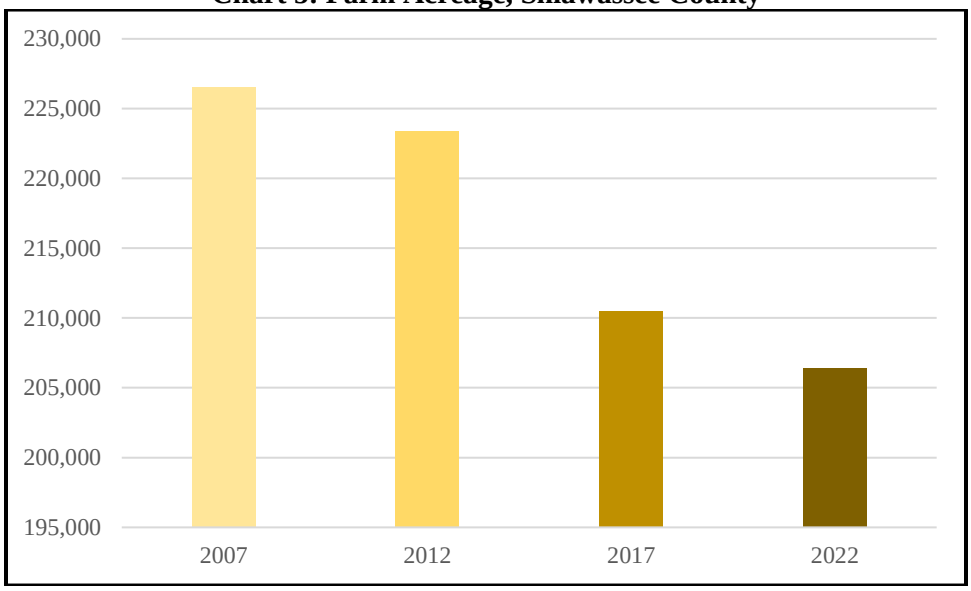
Source: United States Department of Agriculture National Agricultural Statistics Service

Chart 4: Number of Farms, Shiawassee County



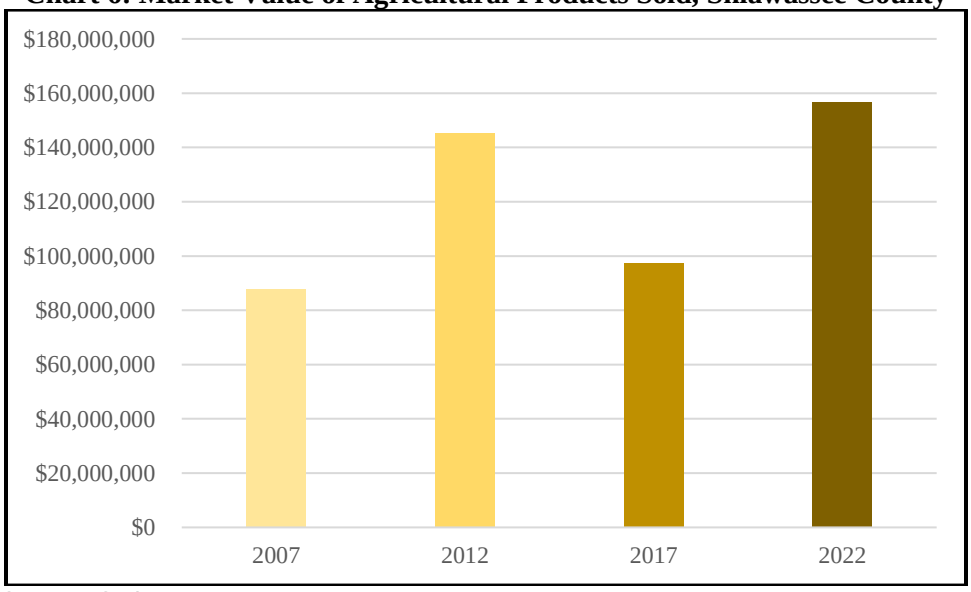
Source: USDA

Chart 5: Farm Acreage, Shiawassee County



Source: USDA

Chart 6: Market Value of Agricultural Products Sold, Shiawassee County



Source: USDA

3.12 Potential Impacts of Climate Change

For hazards related to weather patterns, climate change may cause significant changes in patterns and event frequency. There is a scientific consensus that climate change is occurring, and recent climate modeling results indicate that extreme weather events may become more common. Rising average temperatures produce a more variable climate system which may result in an increase in the frequency and severity of some extreme weather events, including:

- Longer and more intense heat waves
- An increased risk of wildfires
- Higher wind speeds
- Greater rainfall intensity, but less rainfall frequency

Specifically, according to the United State Environmental Protection Agency's "What Climate Change Means for Michigan:"

- Changing the climate is likely to increase the frequency of floods in Michigan. Over the last half century, average annual precipitation in most of the Midwest has increased by 5 to 10 percent. But rainfall during the four wettest days of the year has increased about 35 percent, and the amount of water flowing in most streams during the worst flood of the year has increased by more than 20 percent. 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.
- Changing the climate will have both beneficial and harmful effects on farming. Longer frost-free growing seasons and higher concentrations of atmospheric carbon dioxide would increase yields for some crops during an average year. But increasingly hot summers are likely to reduce yields of corn and possibly soybeans. Seventy years from now, much of Michigan's Lower Peninsula is likely to have 5 to 15 more days per year with temperatures above 95°F than it has today. More severe droughts or floods would also hurt crop yields.
- Rising temperatures can harm air quality and amplify existing threats to human health. Warmer weather can increase the production of ground-level ozone, a pollutant that causes lung and heart problems. High air temperatures can cause heat stroke and dehydration and affect people's cardiovascular and nervous systems. Midwestern cities are vulnerable to heat waves because many houses and apartments lack air conditioning. Heat stress is expected to increase as climate change brings hotter summer temperatures and more humidity. Certain people are especially vulnerable, including children, the elderly, the sick, and the poor.

Data from the NOOA NCEI Michigan 2022 State Climate Summary indicates the following concerning the climate change in the state:

- Temperatures have risen approximately 3° Fahrenheit since the beginning of the 20th century.
- Warming has been concentrated in winter and spring.
- The winter warming trend is reflected in a below average number of very cold nights since 1990.
- The frequency of extreme precipitation events has increased.
- Increases in precipitation are projected for Michigan, most likely during the winter and spring.
- The intensity of future droughts is projected to increase even if precipitation increases.

Section 4 – Hazard Profiles

4.1 Introduction

The goal of this hazard mitigation is to reduce the future impacts of hazards, including deaths and injuries, property damage, and disruption to local and county economies, and to further reduce the amount of public and private funds spent to assist recovery. To complete this goal, hazard mitigation decision-making in this plan has been based on a robust risk assessment, completed to identify natural, human caused, and technological hazards that represent a risk to Shiawassee County and its participating jurisdictions. The following provide a definition of the risk assessment terms used during this assessment:

- **Hazard:** An act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing.
- **Exposure:** The people, property, systems, or functions that could be lost to a hazard. Generally, exposure includes what lies in the area the hazard could affect.
- **Vulnerability:** Vulnerability is susceptibility to physical injury, harm, damage, or economic loss. It depends on an asset's construction, contents, and economic value of its functions.
- **Risk:** A function of hazard, vulnerability, and exposure. It refers to the likelihood of an event resulting in an adverse condition that causes injury or damage.

In order to accomplish this assessment, all relevant natural, human caused, and technological hazards, potential vulnerabilities, and exposures were identified. As potential hazards, vulnerabilities, and exposure are identified Shiawassee County can continue to develop a strategy to identify and prioritize mitigation action to defend against these potential risks.

4.2 Declared Federal Disasters

The Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. §§ 5121-5206) provides for the Federal support of State and local governments and their citizens when impacted by an overwhelming disaster. The Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, establishes the process for requesting a Presidential disaster declaration and defines the type of assistance available.

If it is apparent that a Presidential disaster declaration may be necessary to assist in the recovery of an impacted area, Shiawassee County and FEMA Region V will conduct a Preliminary Damage Assessment (PDA). This assessment is used to determine:

- The extent of the event.
- The impact of the event on individuals and public facilities.
- The types of federal assistance that may be needed.

Once the PDA is complete, and if a determination is made that the damages exceed available resources, the Governor may submit through FEMA Region V a declaration request to the President.

A major disaster declaration provides a wide range of federal assistance programs for individuals and public infrastructure, including funds for both emergency and permanent work. Not all programs, however, are activated for every disaster. The determination of which programs are authorized is based on the types of assistance specified in the Governor's request and the needs identified during the initial and subsequent PDAs. FEMA disaster assistance programs may include:

- Individual Assistance
- Public Assistance
- Hazard Mitigation

To recognize and encourage mitigation, FEMA considers the extent to which mitigation measures contributed to the reduction of disaster damages. This could be especially significant in those disasters where, because of mitigation, the estimated public assistance damages fell below the per capita indicator.

Historical events of significant magnitude or impact can result in a Presidential Disaster Declaration. The MPC reviewed the historical federal disaster declarations to assist in hazard identification. The following table details Disaster Declarations for Shiawassee County:

Table 11: Shiawassee County Presidentially Declared Disasters

Designation	Declaration Date	Incident Type	Assistance	Mitigation Grants
DR-4494-MI	03/27/2020	Covid-19	$878,572,045	$3,446,341
DR-1527-MI	06/30/2004	Severe Storms	$41,320,558	-
DR-1226-MI	06/24/1998	Severe Storms	-	-
DR-774-MI	09/18/1986	Flood	-	-
DR-744-MI	09/19/1985	Flood	-	-
DR-495-MI	03/19/1976	Severe Storms	-	-
DR-486-MI	09/30/1975	Flood	-	-
DR-465-MI	04/26/1975	Flood	-	-
DR-190-MI	04/14/1965	Tornado	-	-

Source: FEMA

The President can declare an emergency for any occasion or instance when the President determines federal assistance is needed. Emergency Declarations supplement State and local or Indian tribal government efforts in providing emergency services, such as the protection of lives, property, public health, and safety, or to lessen or avert the threat of a catastrophe. The total amount of assistance provided for in a single emergency may not exceed $5,000,000. The following types of assistance are available under an Emergency Declaration:

- Public Assistance, Categories A (debris removal) and B (emergency protective measures)
- Individual Assistance, the Individuals and Households Program

The MPC reviewed the historical federal disaster declarations to assist in hazard identification. The following table details Emergency Declarations for Shiawassee County.

Table 12: Shiawassee County Emergency Declarations

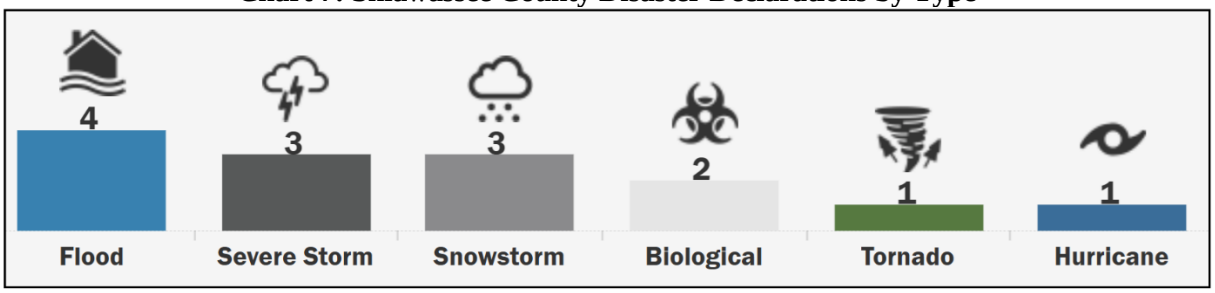
Designation	Declaration Date	Incident Type	Assistance	Mitigation Grants
EM-3455-MI	03/13/2020	Covid-19	-	-
EM-3225-MI	09/07/2005	Hurricane Katrina Evacuation	$2,078,365	-
EM-3160-MI	01/10/2001	Severe Snow	$9,209,100	-
EM-3057-MI	01/27/1978	Snowstorm	-	-
EM-3030-MI	02/05/1977	Snowstorm	-	-

Source: FEMA

The Governor, or the Governor's Authorized Representative, may submit a request for a fire management assistance declaration as required. FEMA will approve declarations for fire management assistance when it is determined that a fire or fire complex on public or private forest land or grassland threatens such destruction as would constitute a major disaster. There have been no fire management declarations for Shiawassee County.

The following chart illustrates, by category, the number of disaster declarations for Shiawassee County:

Chart 7: Shiawassee County Disaster Declarations by Type



Source: FEMA

4.3 Identified Potential Hazards

One of the first steps in developing a hazard assessment is to identify the hazards that have a reasonable risk of occurring. Proper identification allows for appropriate and well-planned action in order to mitigate the extent and cascading impacts of an incident. Furthermore, while not all disaster contingencies can be planned for, applying an all-hazards approach to the mitigation process does yield greater awareness and better preparedness for unforeseen hazard incidents overall.

The MPC met to discuss previously identified hazards and deliberate on any changes or additions to the regional hazard profile. A thorough and comprehensive revision of data for each hazard was completed as part of this plan update. Additionally, this plan has worked, as per FEMA recommendations, to merge similar hazards together with the aim of both simplifying the usage of the plan and reducing duplication of effort.

The MPC confirmed the following natural hazards that may impact the Shiawassee County and all participating jurisdictions:

Table 13: Shiawassee County Identified Natural Hazards

Natural Hazard	Included in State of Michigan HMP	Included in Shiawassee County LHMP
Celestial Events	Yes	No
Dam Failure	Yes	No
Drought	Yes	Yes
Earthquake	Yes	No
Extreme Temperatures	Yes	Yes
Flood	Yes	Yes
Fog	Yes	No
Invasive Species	Yes	No
Land Subsidence	Yes	No
Shoreline Hazards	Yes	No
Severe Weather (Lightning, Wind, and Hail)	Yes	Yes
Severe Winter Weather (blizzard, ice, snow)	Yes	Yes
Tornado	Yes	Yes
Wildfire	Yes	No

Based on discussion with the MPC, a lack of identified risk or history, and geographic improbability, numerous FEMA identified hazards such as coastal erosion, hurricane, tsunami, and volcanoes were not included in the scope of this plan. Additionally, four natural hazards included in the State of Michigan HMP, detailed below, were not included for the enumerated reasons:

- **Celestial Events:** There have been no recorded celestial events causing any damage or loss of life in Shiawassee County. Due to the lack of documented and predicted impacts on both structures and population the MPC opted to not allocate potential resources or funding to mitigate against this hazard in favor of prioritizing other hazards.
- **Dam Failure:** One high-hazard dam was identified in Shiawassee County. As no Emergency Action Plan was available for review, aerial photographs of the potential inundation area due to a dam failure were reviewed. Noted in the potential inundation area were one residential road and numerous large fields. While it is possible that a person using the road during a failure could suffer injury or death, the MPC considered the scenario unlikely. As such the MPC opted to not allocate potential resources or funding to mitigate against this hazard in favor of prioritizing other hazards.
- **Earthquake:** There have been no recorded damaging earthquakes in Shiawassee County. Additionally, mapping generated by the USGS indicates that Shiawassee County and all participating jurisdictions would expect very light damage from all modeled earthquakes. Due to the lack of documented and predicted impacts on both structures and population the MPC opted to not allocate potential resources or funding to mitigate against this hazard in favor of prioritizing other hazards.
- **Fog:** Shiawassee County has had no significant or recorded fog events for the past 15 years. As such, the MPC opted to not allocate potential resources or funding to mitigate against this hazard in favor of prioritizing other hazards.
- **Invasive Species:** The Michigan Department of Environmental Quality has indicated that no known invasive species pose an immediate critical threat to Shiawassee County that would warrant inclusion in this plan. While there exists a persistent threat from invasive species, county mitigation efforts are being managed through a combined effort of the Michigan Departments of Environmental Quality, Natural Resources, and Agriculture and Rural Development via the collaborative Michigan Invasive Species Program.
- **Land Subsidence:** There have been no recorded incidences of subsidence events in Shiawassee County. Additionally, a study performed by Michigan State University on subsidence risk does not place Shiawassee County within any identified risk zones.
- **Shoreline Hazards:** Shiawassee County has no exposure to shoreline hazards as no part of the county borders the Great Lakes. As such, the MPC opted to not allocate potential resources or funding to mitigate against this hazard in favor of prioritizing other hazards.
- **Wildfires:** There have been no recently reported damaging wildfires within Shiawassee County. Additionally, FEMA NRI data indicates that the potential risk to Shiawassee County from wildfire is very low. Finally, wildland fires tend to thrive in forested environments. The agricultural nature of Shiawassee County has limited forested areas to provide wildfire fuel. Due to the lack of documented and predicted impacts on both structures and population the MPC opted to not allocate potential resources or funding to mitigate against this hazard in favor of prioritizing other hazards.

4.4 Hazard Planning Significance

For the purposes of this plan, hazard planning significance refers to the relevance of the identified hazard to the jurisdictions of Shiawassee County when calculating risk and vulnerability. In order to help quantify the planning significance for a hazard, data was reviewed on two levels, federal (National Risk Index data) and local (researched plan data relevant to occurrence and vulnerability on a county and local level). This allowed for a comparison between data sets for each hazard type and allowed for a summation at the county level. It is recognized that inconsistencies in methodologies and data make it difficult to make a direct comparison across all data levels. However, as possible, collected data was translated into a unified model that accounted for any variability in data and methodologies.

The result of this assessment provides a larger scale snapshot of how Shiawassee County jurisdictions view risk and allowed for integration of hazard data into the LHMP.

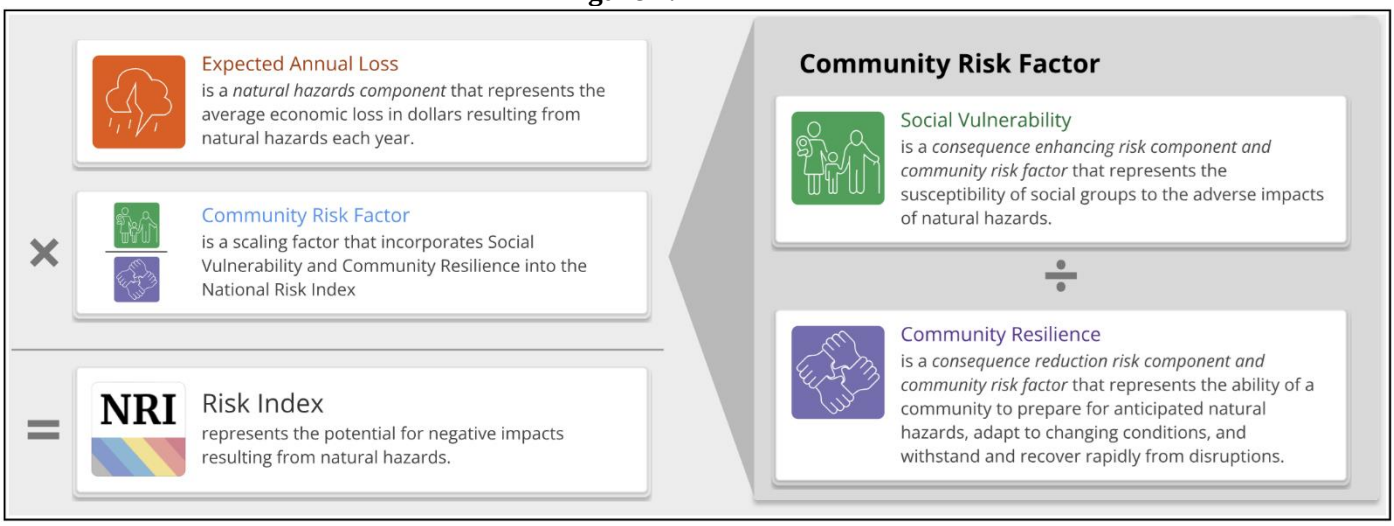
For natural hazards, data from this plan was vetted by MPC members and participating jurisdictions to ensure it matched local conditions. Additionally, Shiawassee County utilized FEMA's National Risk Index (NRI) which provides a method of understating high and local level jurisdictional vulnerability. FEMA's NRI dataset and online tool was used to help determine local community risk for identified natural hazards in this LHMP.

The risk equation behind the Risk Index includes three components, Expected Annual Loss (EAL), social vulnerability (previously discussed), and community resilience (previously discussed). The dataset supporting EAL provides estimates measured in 2022 U.S. dollars. The datasets supporting the social vulnerability and community resilience components have been standardized using a minimum-maximum normalization approach prior to being incorporated into the NRI risk calculation.
As part of the NRI, EAL represents the average economic loss in dollars resulting from a hazard each year. It quantifies loss for relevant consequence types, buildings, people, and agriculture. An EAL score and rating represent a community's relative level of expected losses each year when compared to all other communities at the same level. EAL is calculated using an equation that includes exposure, annualized frequency, and historic loss ratio risk factors. Exposure is a factor that measures the building value, population, and agriculture value potentially exposed to a natural hazard occurrence. Annualized frequency is a factor that measures the expected frequency or probability of a hazard occurrence per year. Historic loss ratio is a factor that measures the percentage of the exposed consequence type value (building, population, or agriculture) expected to be lost due to an occurrence. EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk.

To calculate Risk Index values, the NRI generates a Community Risk Adjustment to scale EAL values up or down, depending on their community risk factors, increasing with social vulnerability and decreases with community resilience. For a jurisdiction, a higher social vulnerability results in a higher Risk Index value while higher community resilience results in a lower Risk Index value.

Using these three components, Risk Index values are calculated for each jurisdiction (county and Census tract). The calculated Risk Index values form an absolute basis for measuring Risk within the NRI, and they are used to generate Risk Index percentiles and ratings across communities. The risk equation behind the NRI is as follows:

Figure 2: FEMA NRI



Source: FEMA

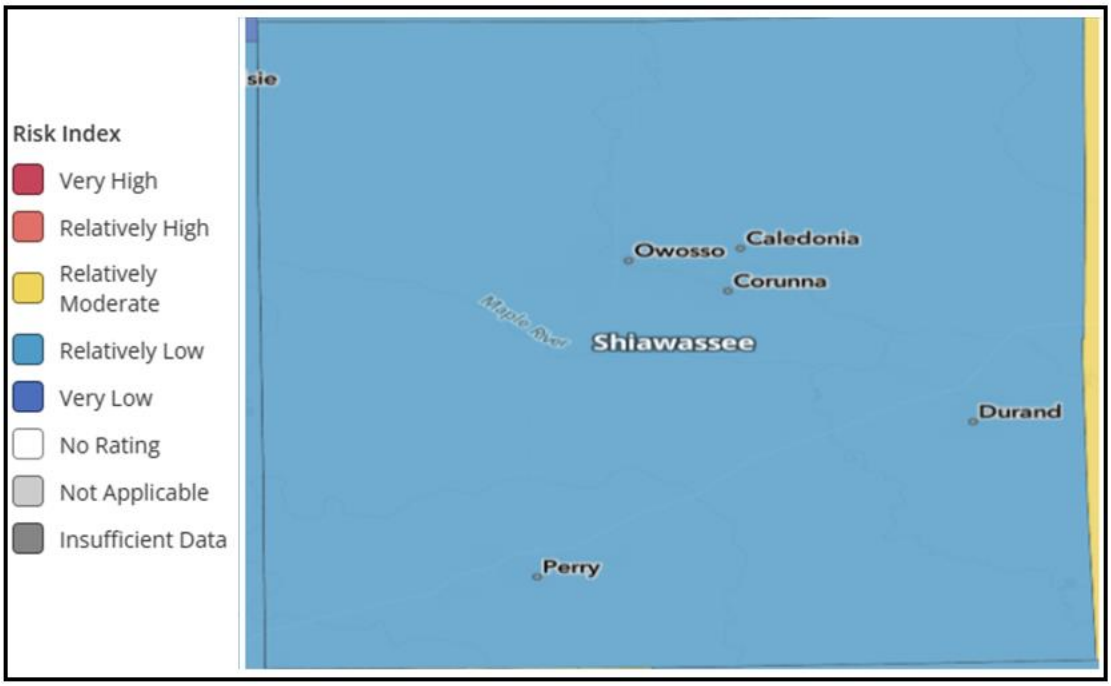
For both the Risk Index and EAL there is a qualitative rating that describes the nature of a community's score in comparison to all other communities at the same level, ranging from "Very Low" to "Very High." Because all ratings are relative, there are no specific numeric values that determine the rating.

The National Risk Index provides relative Risk Index percentiles and ratings based on data for Expected Annual Loss due to natural hazards, Social Vulnerability, and Community Resilience. Separate percentiles and ratings are also provided for each component: Expected Annual Loss, Social Vulnerability, and Community Resilience. For the Risk Index and Expected Annual Loss, percentiles and ratings can be viewed as a composite score for all hazards or individually for each of the 18 hazard types.

A community's score is represented by its percentile ranking among all other communities at the same level for Risk, Expected Annual Loss, Social Vulnerability and Community Resilience. For example, if a given Census tract's Risk Index percentile for a hazard type is 84.32 then its Risk Index value is greater than 84.32% of all US Census tracts. These scores are then assigned a qualitative rating that describes the community in comparison to all other communities at the same level, ranging from "Very Low" to "Very High." To determine Risk and Expected Annual Loss ratings, a methodology known as k-means clustering or natural breaks is applied to each value. This approach divides all communities into five groups such that the communities within each group are as similar as possible (minimized variance) while the groups are as different as possible (maximized variance). A cubed root transformation is applied to both Risk and Expected Annual Loss values before k-means clustering. Without the transformation, these values are heavily skewed by an extreme range of population and building value densities between urban and rural communities. By applying a cube root transformation, the National Risk Index controls for this characteristic and provides ratings with greater differentiation and usefulness.

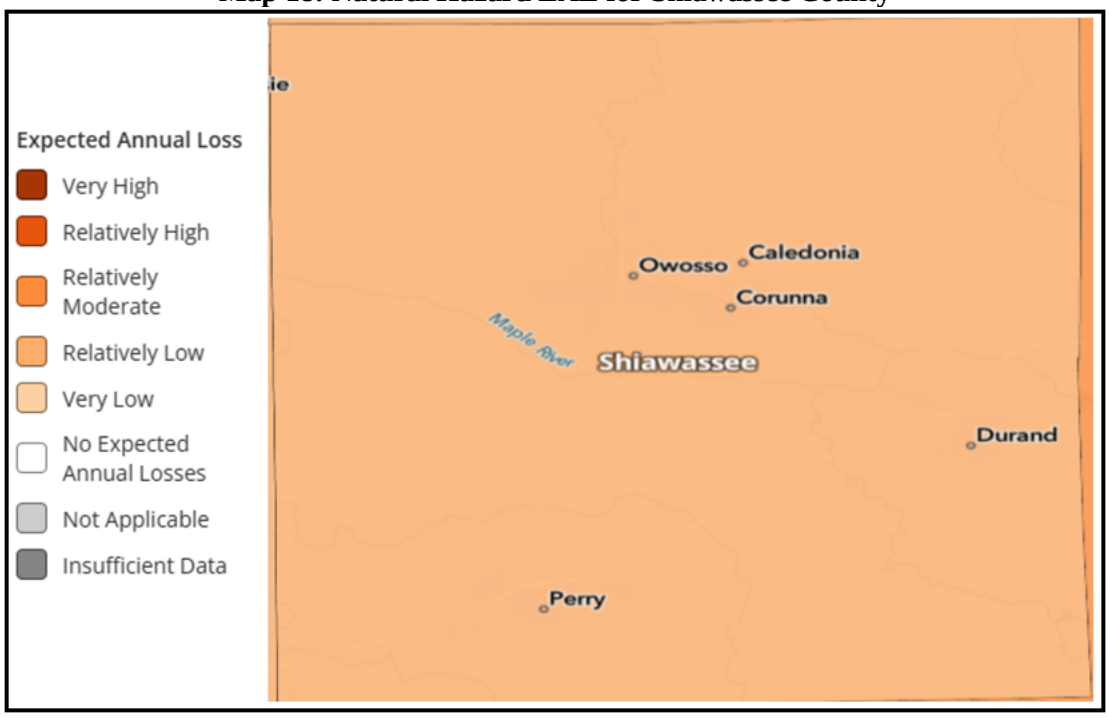
The following maps indicate the natural hazard composite NRI and EAL for Shiawassee County:

Map 17: Natural Hazard Risk Index for Shiawassee County



Source: FEMA NRI

Map 18: Natural Hazard EAL for Shiawassee County

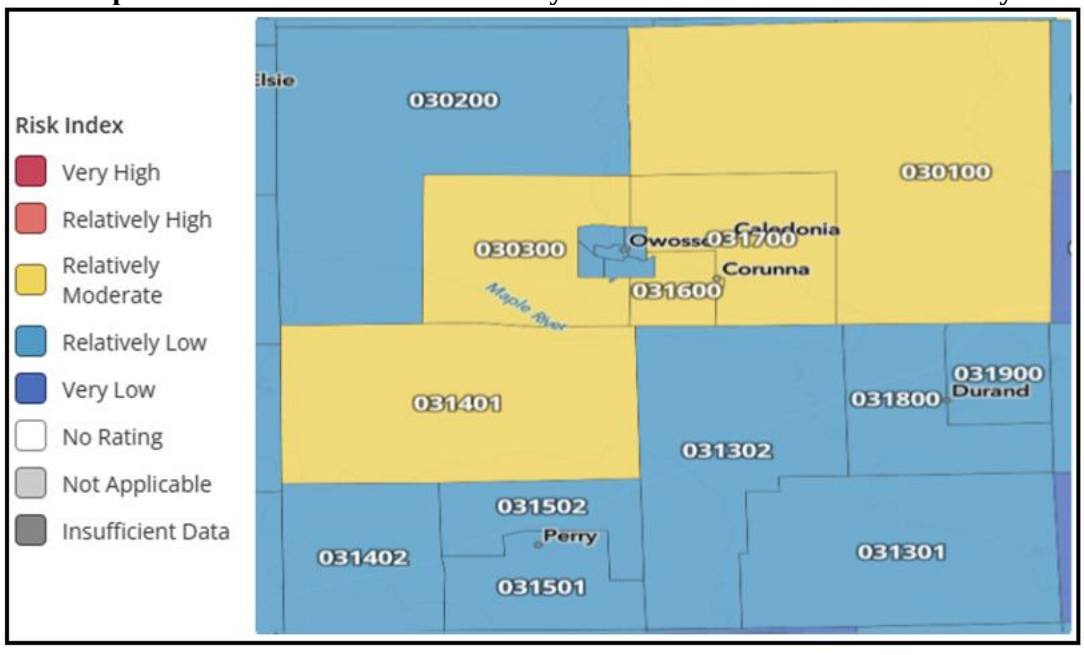


Source: FEMA NRI

To help understand the risk and vulnerability to the identified hazards in this LHMP for participating jurisdictions, risk index and EAL mapping from the FEMA NRI was run on a census tract level. As the NRI does not generate mapping for individual jurisdictions, census tract analysis is the closest analogue available to understand individual jurisdiction conditions.

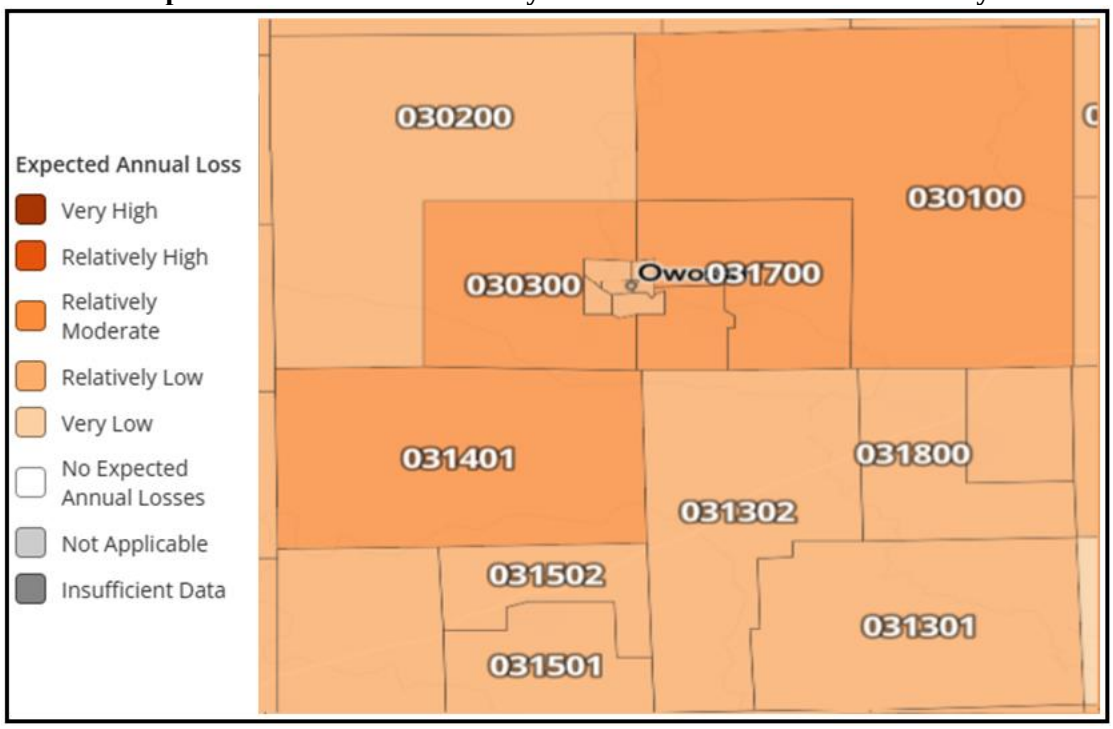
The following maps indicate the composite NRI and EAL for Shiawassee County census tracts:

Map 19: Natural Hazard Risk Index by Jurisdiction for Shiawassee County



Source: FEMA NRI

Map 20: Natural Hazard EAL by Jurisdiction for Shiawassee County



Source: FEMA NRI

To further help determine risk and vulnerability, risk index and EAL data is presented in the following sections for each identified hazard by both county and jurisdiction as available. Additionally, a United States Census Bureau census tract map is included in Appendix C to assist in assigning jurisdictions to census tracts. Where appropriate, differences in vulnerability to identified hazards are noted in each individual hazard section.

4.5 Hazard Occurrence and Assessment Data

NOAA's NCEI Storm Events Database was used as the primary source of information for previous occurrences of storm events. Where data sets were unavailable for a hazard, local reporting from participating jurisdictions was relied upon. It is worth noting that damage estimates indicated by the NCEI are often artificially low. This underreporting is a result of the way the events are reported to the NCEI, often by the local and/or National Weather Service (NWS) office. When reporting an event oftentimes the NWS office does not have access to the actual damage assessment resulting from that event. As such, the report often details a very low amount or zero-dollar amount for damages. Most of the events from NCEI are not associated with a federal emergency or disaster. If the event occurred at the same time as an event that was later determined to be a federal emergency or disaster, it is included with the NCEI data even if it occurred in a county not included in the federal declaration.

Data was also obtained and utilized using Hazus-MH, Version 2.2 SP1, a program administered by the FEMA used to model losses. Modelling for hazards uses Hazus analysis to estimate losses and projected impacts from historical and annualized hazard events. Hazus default data was used in the analysis, including the 2020 Census and other State and Federal government facility databases.

4.6 Jurisdictional Critical Facilities, Assets, and Community Lifelines

Certain facilities and assets, such as infrastructure and community lifelines, have a net positive value on the community as they contribute to the public good by facilitating the basic functions of society. These facilities maintain order, public health, education, and help the economy function. Additionally, there are infrastructure and facilities integral to disaster response and recovery operations. Conversely, some infrastructure and facilities are of extreme importance due to the negative externalities created when they are impacted by a disaster. What fits these definitions will vary slightly from community to community, but the definitions remain as a guideline for identifying critical facilities and infrastructure.

Shiawassee County and participating jurisdictions maintain specific critical facility details under separate cover for security purposes. For this LHMP, it is assumed that all critical facilities are at equal risk to non-point hazard occurrence but may have varying risk to point hazard occurrence (flood). Data concerning critical facilities potentially impacted by these point hazards, as available, is detailed under the respective hazard section.

Each hazard section provides a discussion on potentially vulnerable community lifelines. Community lifelines enable the continuous operation of critical government and business functions and are essential to human health and safety or economic security, and include safety, health, energy, communication, transportation, and water systems.

4.7 Hazard Profiles

Each identified hazard is profiled in the subsequent sections, with the level of detail varying based on available information. Sources of information are cited in the detailed hazard profiles below.

Each hazard section provides a discussion on potentially vulnerable community lifelines. Community lifelines enable the continuous operation of critical government and business functions and are essential to human health and safety or economic security, and include safety, health, energy, communication, transportation, and water systems.

For hazards that have a higher chance of occurrence for specific jurisdictions throughout Shiawassee County a discussion is provided as to the differing levels of potential vulnerability. All other hazards have been determined to have an equal chance of occurrence for all participating jurisdictions.

With each update of this plan, new information will be incorporated to provide for better evaluation and prioritization of the hazards.

The following hazards are presented in alphabetical order, and not by planning significance, for ease of reference.

4.8 Drought

4.8.1 Hazard Description

Drought is defined as an abnormally dry period lasting months or years when an area has a deficiency of water and precipitation in its surface and or underground water supply. It is, however, a normal, seasonal, and recurrent feature of climate that occurs in virtually all climate zones—typically in late spring through early fall. The duration of drought varies widely. There are cases when drought develops relatively quickly and lasts a very short period of time, exacerbated by extreme heat and/or wind, and there are other cases when drought spans multiple years, or even decades. The hydrological imbalance can be grouped into the following non-exclusive categories:

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

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

Periods of drought can have significant environmental, agricultural, health, economic, and social consequences. The effects vary depending upon vulnerability and regional characteristics. Droughts can also reduce water quality through a decreased ability for natural rivers and streams to dilute pollutants and increase contamination. The most common effects are diminished crop yield, increased erosion, dust storms, ecosystem damage, reduced electricity production due to reduced flow through hydroelectric dams, shortage of water for industrial production, and increased risk of wildland fires.

4.8.2 Location & Extent

All of Shiawassee County is susceptible to drought conditions. However, the specific susceptibility to drought depends on various factors, including climate patterns, land use practices, and water management strategies.

Droughts are regularly monitored by multiple federal agencies using a number of different indices. One of the best indicators of historic drought periods is provided by the U.S. Drought Monitor. The U.S. Drought Monitor provides a summary of drought conditions across the United States, including Shiawassee County. Often described as a blend of art and science, the map is updated weekly by combining a variety of data-based drought indices and indicators, along with local expert input, into a single composite drought indicator. The following table details the U.S. Drought Monitor categories:

Table14: U.S. Drought Monitor Categories

Rating	Described Condition
None	No drought conditions
D0	Abnormally Dry
D1	Moderate Drought
D2	Severe Drought
D3	Extreme Drought

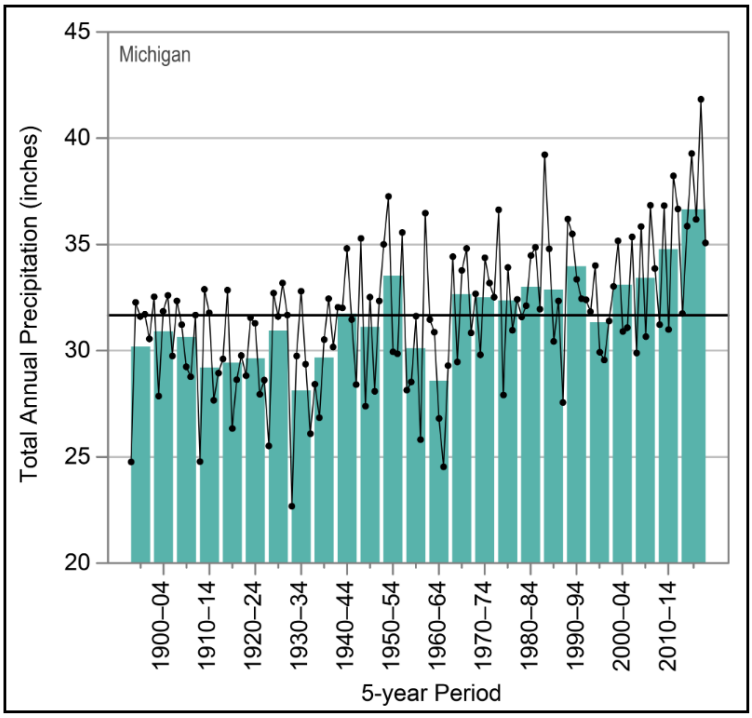
Table14: U.S. Drought Monitor Categories

Rating	Described Condition
D4	Exceptional Drought

Source: U.S. Drought Monitor

Precipitation data is collected by the NWS throughout the State of Michigan. Additional rainfall data is also collected by the NWS through citizen weather rainfall sites. The following chart indicates annual precipitation averages from 1895 to 2020:

Chart 8: Michigan Observed Annual Precipitation



Source: NOAA NCEI State Climate Summary 2022 for Michigan

Current drought conditions, along with information on the current PDI and SPI may be found on the US Drought Monitor webpage.

4.8.3 Previous Occurrences

Drought is a normal climate pattern that has occurred in varying degrees of length, severity, and size. One of the best indicators of historic drought periods is provided by the U.S. Drought Monitor, which lists weekly drought conditions for the Shiawassee County. Historical data was gathered from the U.S. Drought Monitor weekly reports for the 10-year period between 2013 and 2022 (with the years 2103 and 2022 being full dataset years). This data was compiled and aggregated to provide a yearly estimate of the percentage of Shiawassee County in each Drought Monitor category.

Table 15: Percentage Area in U.S. Drought Monitor Category

Year	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
2023	52.5%	47.4%	31.1%	1.67%	0%	0%
2022	62.0%	37.9%	11.4%	0.62%	0%	0%
2021	65.2%	34.7%	19.2%	5.50%	0%	0%
2020	85.3%	14.6%	0%	0%	0%	0%
2019	91.1%	8.8%	0%	0%	0%	0%
2018	80.0%	19.9%	12.6%	0%	0%	0%
2017	81.4%	18.5%	0.01%	0%	0%	0%

Table 15: Percentage Area in U.S. Drought Monitor Category

Year	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
2016	69.3%	30.6%	13.6%	0.31%	0%	0%
2015	51.1%	48.8%	1.24%	0%	0%	0%
2014	98.1%	1.8%	0%	0%	0%	0%
2013	72.9%	27.0%	0%	0%	0%	0%

Source: U.S. Drought Monitor

As a result of drought conditions, Shiawassee County has observed the following impacts for each of the identified drought monitor categories that have impacted the county over the last 10 years:

Table 16: Shiawassee County Drought Impacts

Category	Historically Observed Impacts
D0	Low soil moisture
	Fire danger increase
D1	Livestock need supplemental feed and water
	Crops need supplemental water
	Fire danger increases
D2	Wildfire occurrence increase
	Well water decreases

As of this plan, no county or jurisdictional facilities have been impacted by drought conditions, with no dollar losses reported.

4.8.4 Probability of Future Events

Historically, drought has affected the Shiawassee County region on a reoccurring basis. In reviewing historical data from the U.S. Drought Monitor weekly reports from January 2013 through December 2022 a yearly average can be created indicating the percentage time in each Drought Monitor category. This average can be used to extrapolate the potential likelihood of future drought conditions.

Table 17: Estimated Probability of Shiawassee County Being in U.S. Drought Monitor Category

None	D0-D4	D1-D4	D2-D4	D3-D4	D4
73.5%	26.4%	8.12%	0.73%	0%	0%

Data: U.S. Drought Monitor

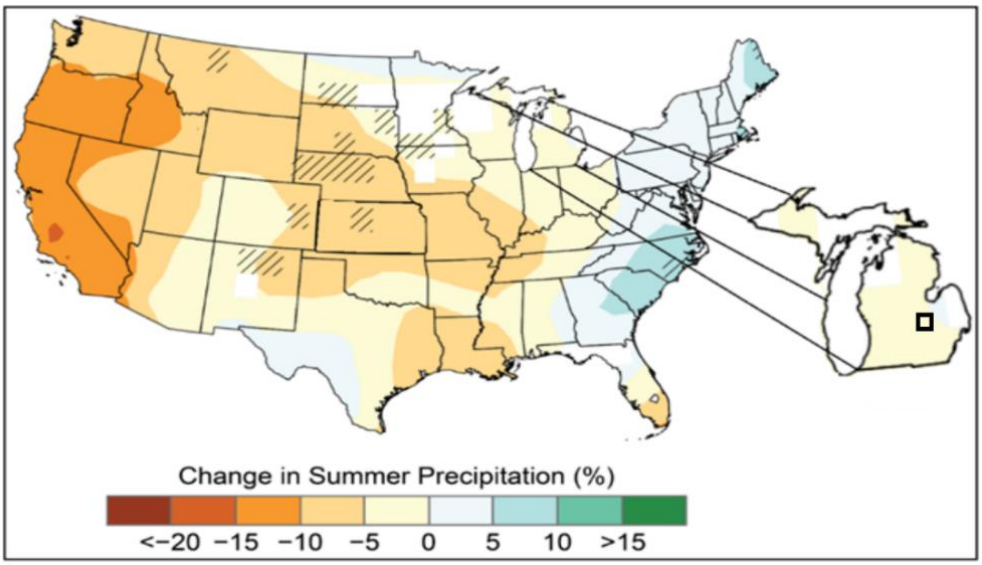
4.8.5 Projected Changes in Hazard Location, Intensity, Frequency, and Duration

According to the National Institutes of Health National Center for Biotechnology Information publication Global Drought Trends and Future Projections "Drought is one of the most difficult natural hazards to quantify and is divided into categories (meteorological, agricultural, ecological and hydrological), which makes assessing recent changes and future scenarios extremely difficult." However, using long term data estimates of future drought conditions can be determined through a combination of climate modeling, historical data analysis, and scientific assessments. This modelling takes into account factors such as temperature, precipitation, soil moisture, and other relevant variables.

Current modelling from the NOAA State Climate Summary 2022 for Michigan suggests that projections of overall annual precipitation are uncertain, but generally believed to slightly decrease. However, summer precipitation is projected to decrease across the state, while winter precipitation is projected to increase. Winter precipitation increases could benefit agricultural production during the spring, but summer drying would have negative impacts on rain-fed summer crops and rangeland. Although increased precipitation is projected, naturally occurring droughts are projected to be more intense because higher temperatures will increase evaporation rates.

The following map indicates the expected change in precipitation for Shiawassee County:

Map21: State of Michigan Change in Annual Precipitation



Source: NOAA NCEI State Climate Summary 2022 for Michigan

The NOAA NCEI State Climate Summary 2022 for Michigan indicates that the intensity of future droughts is projected to increase. Although projections of overall precipitation are uncertain, higher temperatures will increase the rate of soil moisture loss during dry spells, leading to more serious conditions during future naturally occurring droughts, including an increase in the occurrence and severity of wildfires.

Additionally, the -4.9% decrease in population in Shiawassee County over the past 20 years, and the projected continued decrease during the life of this plan, may serve to mitigate this hazard due to a potential drop in water demands.

The agriculture base of Shiawassee County is vulnerable to the short- and long-term effects of drought. Continued development in the agricultural sector will likely increase both the exposure to, and damages from, a drought event. As indicated in the data above, Shiawassee County is seeing a decrease in farm acreage and in the number of farms. These decreases may result in a future decline in vulnerability to drought events.

4.8.6 Vulnerability and Impact

Droughts are rarely a direct cause of death, though the associated heat, dust, and stress can all contribute to increased mortality. However, drought can severely challenge a public water supplier through depletion of the raw water supply and greatly increased customer water demand. Even if the raw water supply remains adequate, problems due to limited treatment capacity or limited distribution system capacity may be encountered. Water supply planning is the key to minimizing the effects of drought on the population. Public water suppliers should continue to work to identify vulnerabilities and develop infrastructure, conservation plans, and partnerships to reduce the likelihood of running out of water during a drought.

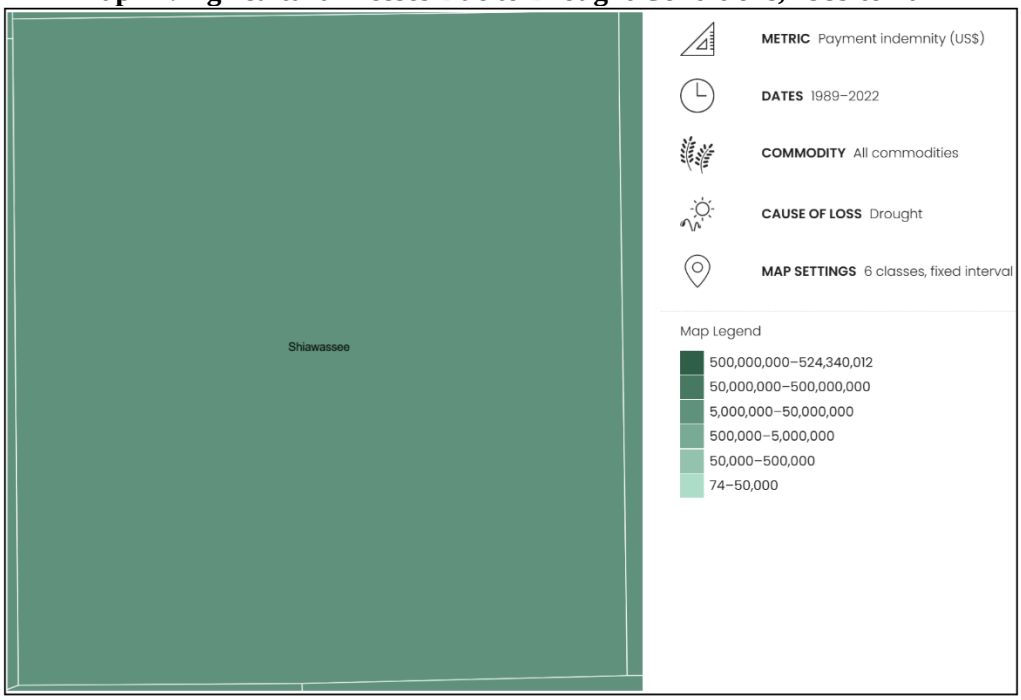
At greater risk may be the vulnerable populations, including the especially young, the elderly, and those below the poverty level. Hazard occurrences can exacerbate existing vulnerabilities and create new challenges. Vulnerable populations may have pre-existing health conditions that make them more susceptible to heat-related illnesses and dehydration, both of which can be exacerbated during droughts. Persons on fixed incomes and with limited resources may face difficulties in adapting their homes to withstand hazard conditions or may lack financial resources to cope with the increased costs of food, water, and energy. Details concerning potentially vulnerable populations may be found in Section 3.4.

In general, critical facilities and infrastructure are not directly vulnerable to losses as a result of drought. However, there is a potential that operations could be impacted by power failures caused by either increased utility demand or damaged

power delivery infrastructure. In addition, drinking water infrastructure may be specifically vulnerable to the impacts of drought. Any decrease in groundwater supplies would stress this infrastructure and may cause shortages or rationing.

Drought conditions can cause significant agricultural impacts. 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. Droughts also bring increased problems with insects and disease to forests and reduce growth. The incidence of wildfires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk. The following map from the United States Department of Agriculture details total agricultural losses due to drought conditions from 1989 to 2021:

Map 22: Agricultural Losses Due to Drought Conditions, 1989 to 2021



Source: USDA

Although environmental losses are difficult to quantify, increasing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects. Environmental losses are the result of damage to plant and animal species, wildlife habitat, and air and water quality, wildfires, 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. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from it if it is a temporary aberration. However, the degradation of landscape quality, with increased soil erosion, may lead to a more permanent loss of biological productivity of the landscape.

Governmental operations and facilities will likely experience minimal impacts from drought conditions, unless there are substantial power, communications, or water outages. However, reduced water availability would likely have an immediate impact on firefighting efforts in urban and suburban areas as fire suppression equipment requires a minimum level of water pressure to activate.

Potentially Vulnerable Community Lifelines

Water utilities are particularly vulnerable to drought conditions due to the direct impact on water availability and supply. Water utilities can be affected by drought through:

- Reduced Water Availability: The reduction in water availability directly impacts the amount of water that water utilities can draw from local sources.
- Lower Reservoir Levels: Lower reservoir levels can affect the ability to meet water demand during periods of high usage.
- Declining Groundwater Levels: Lower groundwater levels make it more challenging for utilities to extract water.
- Water Quality Challenges: Lower water levels can lead to higher concentrations of contaminants, minerals, and sediments in the available water sources, requiring more extensive and costly treatment processes.
- Increased Treatment Costs: Treating water from depleted or lower-quality sources during drought conditions may require additional treatment steps, technologies, or chemicals, leading to increased operational costs for water utilities.
- Competition for Water Resources: During droughts, there is increased competition for limited water resources among various users, including agriculture, industry, and households. Water utilities may face challenges in securing sufficient water supplies amid this heightened competition.
- Impact on Water Infrastructure: Reduced water flow in rivers and streams can expose water infrastructure, such as pipelines, to the risk of corrosion.
- Water Use Restrictions: To conserve water during droughts, authorities may implement water use restrictions and conservation measures. These restrictions can impact water utilities' revenue and their ability to meet customer demand.

Shiawassee County and participating jurisdictions are covered by the following domestic water suppliers:

Table 18: Shiawassee County Community Water Supply Providers

Public Water Supply ID	Water Supply Name	Population Served	Source	Owner
MI0040458	Alan's Park - Durand	50	Groundwater	Private
MI0000370	Village of Bancroft	616	Groundwater	Local
MI0001020	Village of Byron	581	Groundwater	Local
MI0001640	City of Corunna	2,028	Groundwater	Local
MI0040457	County Manor	87	Groundwater	Private
MI0040450	Countryside Village	490	Groundwater	Private
MI0001900	City of Durand	3,446	Groundwater	Local
MI0040454	Evergreen Pleasant Valley Trailer Park	94	Groundwater	Private
MI0003131	Hidden Glen Apartments	50	Groundwater	Private
MI0040451	Lakeview Estates	380	Groundwater	Private
MI0003946	Looking Glass Terraces Apts.	31	Groundwater	Private
MI0040452	Moon Lake Estates	31	Groundwater	Private
MI0040643	Morrice Meadows	258	Groundwater	Private
MI0004700	Village of New Lothrop	610	Groundwater	Local
MI0040453	Northwoods Community	238	Groundwater	Private
MI0005039	Orchard Place Manor Apartments	120	Groundwater	Private
MI0005120	City Of Owosso	16,353	Groundwater	Local
MI0005280	City of Perry	2,065	Groundwater	Local
MI0040456	Quiet Cove Trailer Park	70	Groundwater	Private
MI0040639	Woods and Fields Communities East	528	Groundwater	Private
MI0040455	Woods and Fields Communities West	185	Groundwater	Private

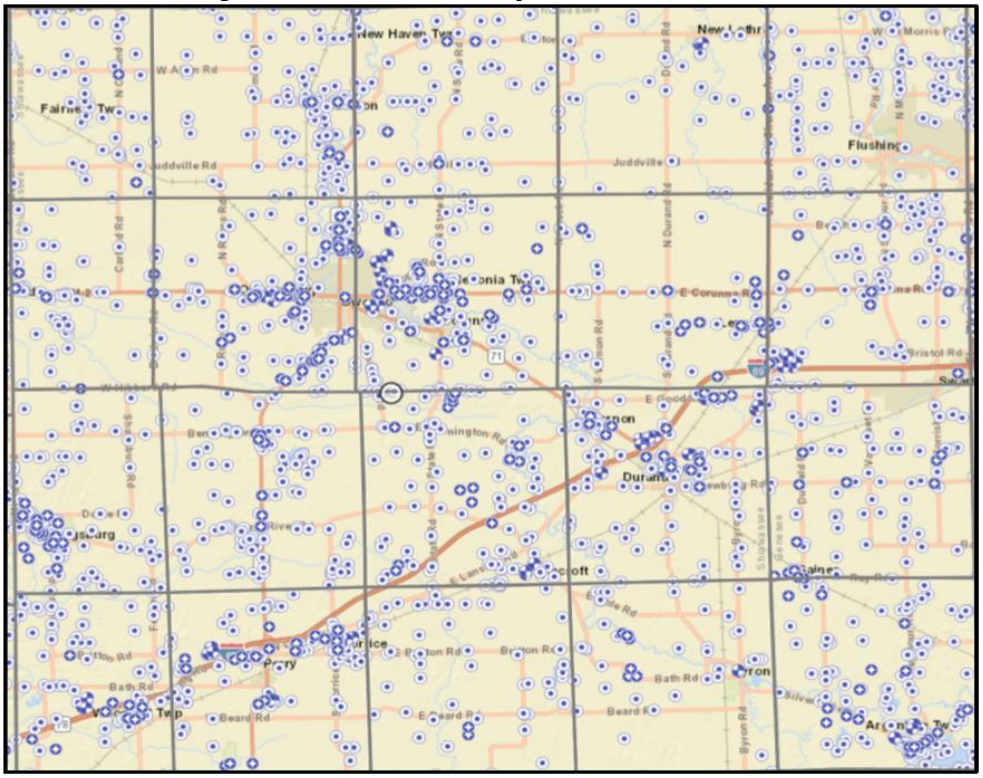
Source: State of Michigan

Communities and citizens served by private wells rather than water supply districts may be at higher risk to drought conditions, and may see the following impacts:

- Lowering of Water Table: Drought conditions can lead to a lowering of the water table, which is the level at which groundwater is located. Private wells that rely on groundwater may experience reduced yields or, in extreme cases, may run dry.
- Decreased Well Recharge: Drought reduces the amount of precipitation, leading to decreased recharge of groundwater. Private wells depend on a sustainable recharge rate to maintain a consistent and reliable water supply.
- Increased Competing Demands: During a drought, increased water demand for agricultural irrigation, municipal water supply, and other uses can create competition for the available groundwater. Private wells may face challenges due to this increased demand.
- Water Quality Concerns: Lower groundwater levels during droughts can lead to changes in water quality. Concentrations of minerals, contaminants, and pollutants may increase, affecting the suitability of water for drinking and other uses.

The following map, from the State of Michigan GIS Open Data, shows the locations of private wells throughout Shiawassee County:

Map 23: Shiawassee County Private Water Wells



Source: State of Michigan

Should it be required to drill a private well deeper to accommodate for drought conditions impacting the level of the water table, on average, the cost to drill a private water well in the United States can range from $15 to $45 per foot. However, it's important to note that this is a general estimate, and actual costs can vary based on geological and hydrogeological conditions and well depth.

Consequence Analysis

This consequence analysis lists the potential impacts of a hazard on various elements of community and state infrastructure. The impact of each hazard is evaluated in terms of disruption of operations, recovery challenges, and

overall wellbeing to all Shiawassee County residents and first responder personnel. The consequence analysis supplements the hazard profile by analyzing specific impacts.

Table 19: Drought Consequence Analysis

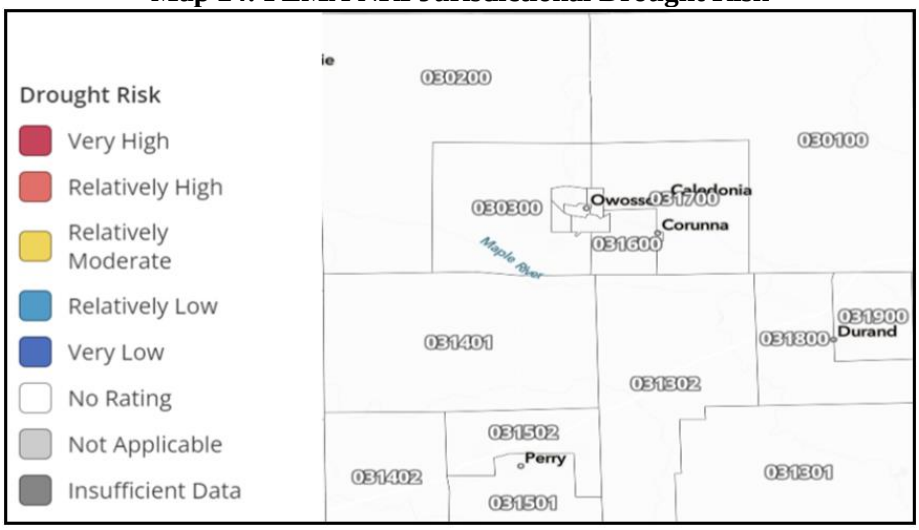
Subject	Potential Impacts
Impact on the Public	If the drought coincides with warmer months, vulnerable populations may face an increased risk of dehydration, death, heat-related illness, heat stroke. Lower quantities of water may also increase the likelihood of contamination due to higher concentrations of bacteria. During droughts, dry soils and wildfires increase the number of airborne particles, such as pollen and smoke, which can worsen chronic respiratory illnesses.
Impact on Responders	Reduced water availability would likely complicate firefighting efforts in urban and suburban areas where wildfire-fighting tactics such as chemical retardants and controlled burns are less suitable. Some fire suppression equipment requires a minimum level of water pressure to activate. If the drought coincides with warm months, first responders may face increased risk of heat-related injuries or death.
Continuity of Operations	Local jurisdictions maintain continuity plans which can be enacted as necessary based on the situation. While the expectation is minimal, this threat may impact an agency's ability to implement their continuity plan based on the hazard's potential to impact power, communications, or water outages. Critical life-saving activities and fire suppression will be directly impacted by these outages.
Delivery of Services	Droughts may impact the delivery of goods and services if there are shortages of raw materials.
Property, Facilities, and Infrastructure	Drought conditions may threaten levels or quality of municipal public water supplies or impact small communities and/or private potable water wells.
Impact on Environment	The potential of drought-related impacts could have significant impacts on supplies of animal feed, livestock, meat and dairy products, and processed grain products, and on crop production. Drought conditions may also increase the potential for fires. Drought is also associated with insect infestations, plant disease, wind erosion of soil, and decrease in levels of water produced by natural aquifers.
Economic Conditions	The economic impacts from a drought could be significant. Droughts have the potential to drain local resource, which will have a significant fiscal impact on government.
Public Confidence in Governance	Droughts can adversely affect the public, first responders, infrastructure, agriculture, economy, and overall operations. Direct, effective, and timely response by all levels of government is required for public confidence in the state's governance, especially in recognizing and mitigating economic impacts of the drought.

4.8.7 Jurisdictional Risk and Vulnerability

To help understand the risk and vulnerability to drought conditions of participating jurisdictions mapping from the FEMA NRI was run on a census tract level. As the NRI does not generate mapping for individual jurisdictions, census tract analysis is the closest analogue available to understand individual jurisdiction conditions.

Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following map was created indicating the potential risk to participating jurisdictions from drought.

Map 24: FEMA NRI Jurisdictional Drought Risk

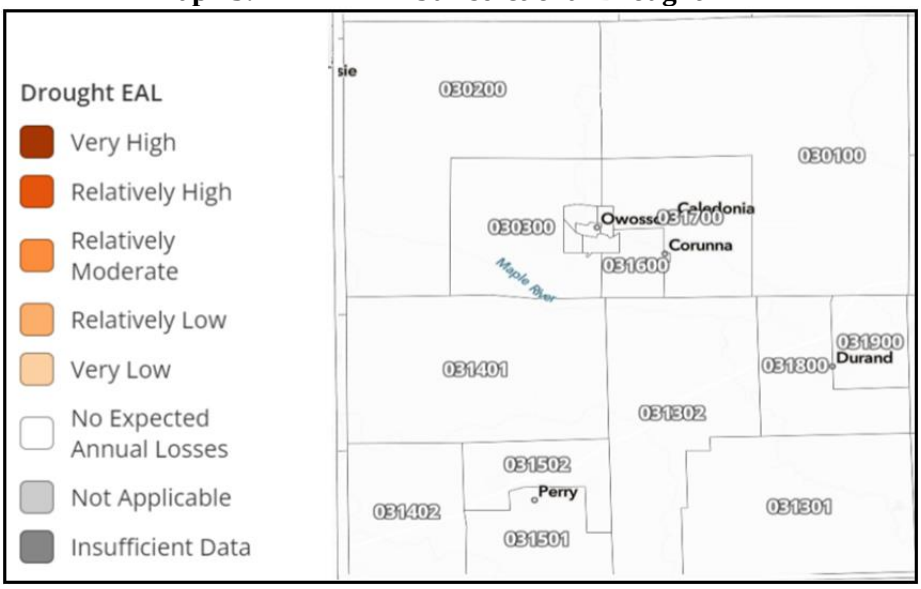


Source: FEMA NRI

No Rating indicates there is an NRI component with a score of 0, and the Risk Index score cannot be calculated for that hazard or community.

As part of the NRI, EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following map indicates the EAL for drought for participating jurisdictions within Shiawassee County:

Map 25: FEMA NRI Jurisdictional Drought EAL



Source: FEMA NRI

No Rating indicates there is an NRI component with a score of 0, and the Risk Index score cannot be calculated for that hazard or community.

The following table indicates the FEMA NRI and EAL analysis for drought for each participating Shiawassee County jurisdiction:

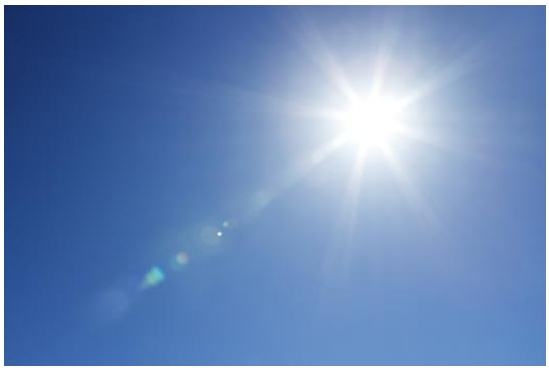
Table 20: Shiawassee County FEMA EAL and NRI for Drought

Jurisdiction	EAL	Risk Index
Shiawassee County	No rating	No rating
City of Durand	No rating	No rating
City of Laingsburg	No rating	No rating
City of Owosso	No rating	No rating
City of Perry	No rating	No rating
Township of Owosso	No rating	No rating

Source: FEMA NRI

At greater risk may be the vulnerable populations, including the especially young, the elderly, and those below the poverty level. Hazard occurrences can exacerbate existing vulnerabilities and create new challenges. Vulnerable populations may have pre-existing health conditions that make them more susceptible to heat-related illnesses and dehydration, both of which can be exacerbated during droughts. Persons on fixed incomes and with limited resources may face difficulties in adapting their homes to withstand hazard conditions or may lack financial resources to cope with the increased costs of energy and water. Data concerning vulnerable populations may be found in Section 3.4, page 14.

4.9 Extreme Temperatures



4.9.1 Hazard Description

Extreme temperature events occur when climate conditions produce temperatures well outside of the predicted norm. These extremes can have severe impacts on human health and mortality, natural ecosystems, agriculture, and other economic sectors.

The Center for Disease Control identifies the following six groups as being especially vulnerable to extreme temperatures:

- Older Adults (aged 65)
- Infants and Children
- Individuals with Chronic Conditions
- Low-income Individuals
- Athletes
- Outdoor workers

4.9.2 Location & Extent

In general, Shiawassee County has a humid continental climate that sees wet, warm summers, cold winters, and evenly distributed rainfall throughout the year. However, all of Shiawassee County is at rick to extreme temperatures, defined as:

- Extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Ambient air temperature is one component of heat conditions, with relative humidity being the other. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when an area of high atmospheric pressure traps moisture laden air near the ground.
- Although no specific definition exists for extreme cold, an extreme cold event can generally be defined as temperatures at or below freezing for an extended period of time. Extreme cold events are usually part of winter storm events but can occur during anytime of the year and can have devastating effects on agricultural production.

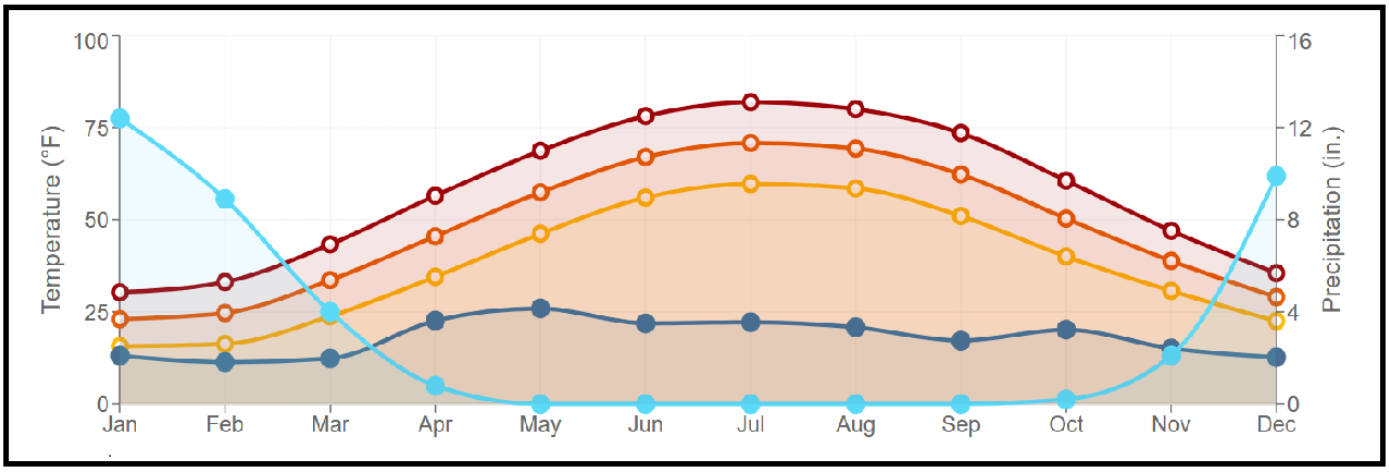
The following table and chart present average climate data for Shiawassee County.

Table 21: Regional Average High Temperatures (Degrees Fahrenheit)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Maximum (F)	29	32	44	55	67	76	80	78	73	59	46	35
Average Minimum (F)	17	18	28	38	49	58	62	61	55	44	33	26

Source: https://www.weatherwx.com/climate-averages/mi/calhoun+county.html

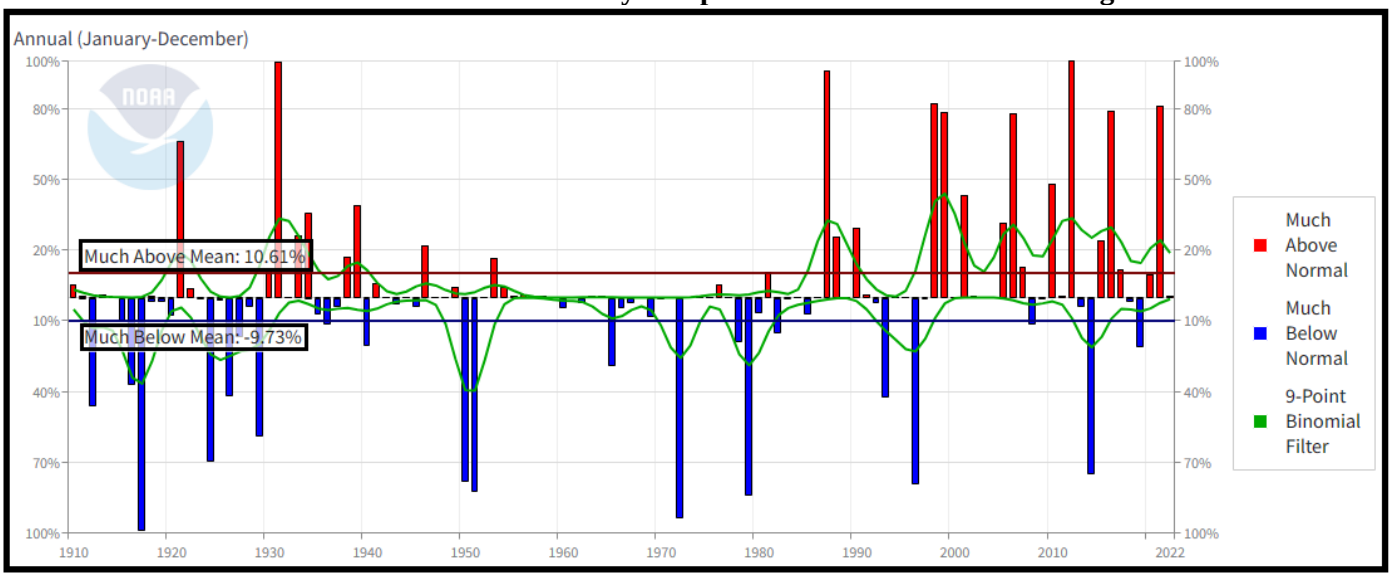
Chart 9: Shiawassee County Average Monthly Temperatures (Degrees Fahrenheit)



Source: NOAA

Data from NOAA indicates that Shiawassee County experienced a record high temperature of 102(F) in 1936, and a record low temperature of -20(F) in 1994. However, it is believed that both the average high temperatures and the record high temperature will likely increase over the coming years. As indicated by the below graph, using data generated from the NCEI, temperatures for Shiawassee County are more frequently exceeding average temperatures, likely an impact of climate change.

Chart 10: Shiawassee County Temperature Difference from Average



Source: NCEI

4.9.3 Previous Occurrences

The following table presents NCEI identified extreme temperature events and the resulting damage totals in Shiawassee County from 1993 to 2022, with the years 1993 and 2022 being full dataset years, for the region. Data was reviewed regionally as the extreme temperature events covered large areas.

Table 22: Shiawassee County NCEI Extreme Temperature Events, 1950 - 2023

County	Event Type	Number of Events	Property Damage	Deaths and Injuries
Extreme Cold	Cold	5	$0	0

Table 22: Shiawassee County NCEI Extreme Temperature Events, 1950 - 2023

County	Event Type	Number of Events	Property Damage	Deaths and Injuries
Extreme Heat	Heat	2	$0	0

Source: NOAA NCEI

4.9.4 Probability of Future Events

Predicting the probability of extreme heat occurrences is tremendously challenging due to the large number of factors involved. Data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to extreme heat events:

Table 23: Shiawassee County Extreme Temperature Probability Summary

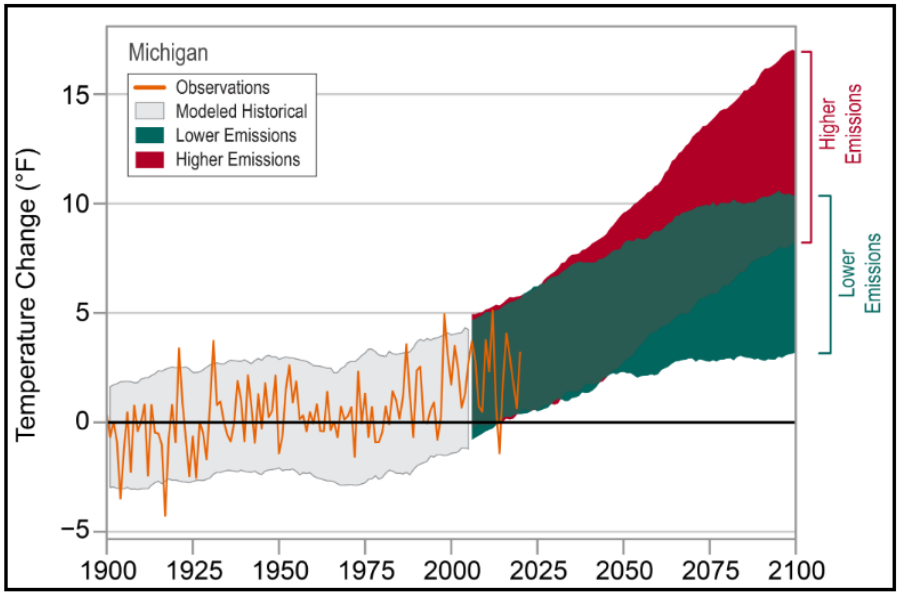
Data	Days
Number of Days with NCEI Reported Excessive Heat or Cold Event (1950-2023)	7
Average Events per Year	<1
Number of Days with NCEI Reported Extreme Cold Event (1950-2023)	5
Average Extreme Temperature Events per Year	<1

Source: NCEI

4.9.5 Projected Changes in Location, Intensity, Frequency, and Duration

When discussing extreme temperatures, climate change should be considered as it may markedly change future events. Recent climate modeling results indicate that extreme temperature events may become more common for Shiawassee County, especially heat. The following chart indicates the projected temperature change for Michigan utilizing two global climate models. One model utilizes information in which greenhouse gas emissions continue to increase (higher emissions), with the other model utilizing information in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in Michigan, detailed by the orange line, have risen 3° F since the beginning of the early 1900s. Based on both the higher emission and lower emission models, continued warming is projected throughout this century.

Chart 11: Michigan Observed and Projected Temperature Change Based on Greenhouse Gas Emissions



Source: NOAA NCEI State Climate Summary 2022 for Michigan

Rising average temperatures produce a more variable climate system which may result in an increase in the frequency and severity of some extreme weather events including longer and hotter heat waves (and by correlation, an increased risk of wildfires, higher wind speeds, and tornado formation). Additionally, rising temperatures can harm air quality

and amplify existing threats to human health. Warmer weather can increase the production of ground-level ozone, a pollutant that causes lung and heart problems. Heat stress is expected to increase as climate change brings hotter summer temperatures and more humidity. Certain people are especially vulnerable, including children, the elderly, the sick, and those living below the poverty line.

The agriculture base of Shiawassee County is increasingly vulnerable to the short- and long-term effects of extreme temperatures. Future development of agricultural resources would tend to increase the risk and impact of an extreme temperature event. As indicated in the data above, Shiawassee County is seeing a continuing projected increase in the market value of agricultural products sold and thus a potential greater future vulnerability to extreme temperature events. However, as indicated in the data above, Shiawassee County and all participating jurisdictions have been seeing generally declining populations. This declining population base could decrease the impact to citizens from an extreme temperature event through the reduction of demand on infrastructure systems.

4.9.6 Vulnerability and Impact

Data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to extreme temperature events:

Table 24: Shiawassee County Extreme Temperature Impact Summary

Data	Recorded Impact
Number of Days with NCEI Reported Event (1950-2023)	7
Average Events per Year	<1
Number of Deaths or Injuries (1950-2023)	0
Average Number of Deaths or Injuries	0

Source: NCEI

While difficult to quantify, the impacts of future extreme temperature may have far reaching impacts. The incidence of wildfires increases substantially during extended periods of extreme heat, which in turn places both human and wildlife populations at higher levels of risk. Although environmental impacts are difficult to quantify, losses to plant and animal species, wildlife habitat, and air and water quality, wildfires, degradation of landscape quality, loss of biodiversity, and soil erosion may result from extended periods of extreme temperatures.

A primary concern with this hazard is human health safety issues, as extreme temperatures can be a direct cause of death. Specific at-risk groups include outdoor workers, farmers, young children, and senior citizens. Compounding these concerns is the potential loss of electric power due to increased strain on power generation and distribution due to increased air conditioning or heating needs.

Extreme temperature impacts on humans can be measured for both heat and cold. The following table discusses potential impacts on human health related to excessive heat.

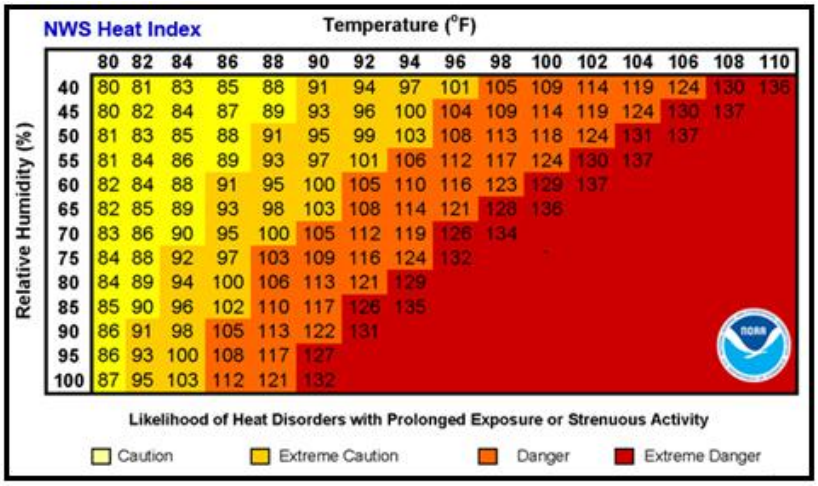
Table 25: Extreme Heat Impacts on Human Health

Heat Index Temperature	Potential Impact on Human Health
80-90° F	Fatigue possible with prolonged exposure and/or physical activity
90-105° F	Sunstroke, heat cramps, and heat exhaustion possible
105-130° F	Heatstroke/sunstroke highly likely with continued exposure

Source: National Weather Service Heat Index Program

Exposure to direct sun can increase Heat Index values by as much as 15°F. The zone above 105°F corresponds to a Heat Index that may cause increasingly severe heat disorders with continued exposure and/or physical activity. The following graph, from the NWS, indicates Heat Index values.

Chart 12: Heat Index



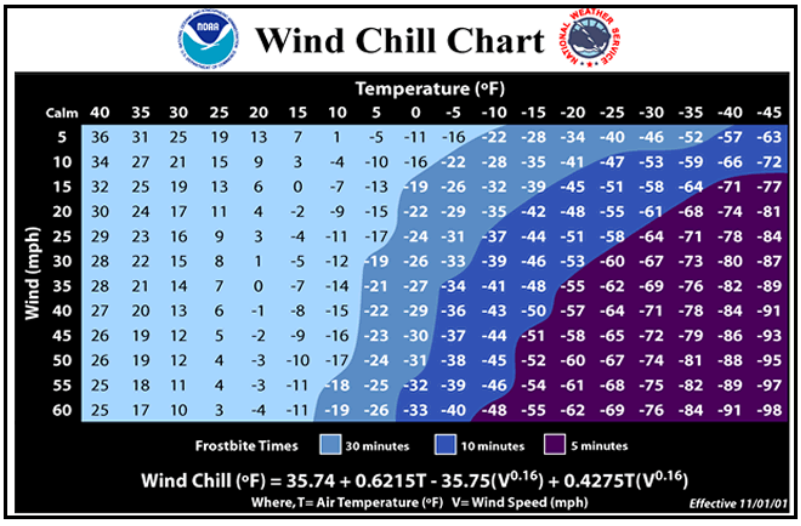
Source: NWS

Extreme cold temperatures can result in a variety of concerns, including:

- Frostbite: The freezing of skin and the body tissue just beneath it
- Hypothermia: Dangerously low body temperature (and the most common winter weather killer)

When extremely cold temperatures are accompanied by strong winds the result can be potentially lethal wind chills. Wind chill is the temperature your body feels when the air temperature is combined with the wind speed, and is based on the rate of heat loss from exposed skin caused by the effects of wind and cold. As the speed of the wind increases, it can carry heat away from your body much more quickly, causing skin temperature to drop. The wind chill chart shows the difference between the actual air temperature and the perceived temperature due to wind, and amount of time until frostbite occurs.

Chart 13: Wind Chill Chart



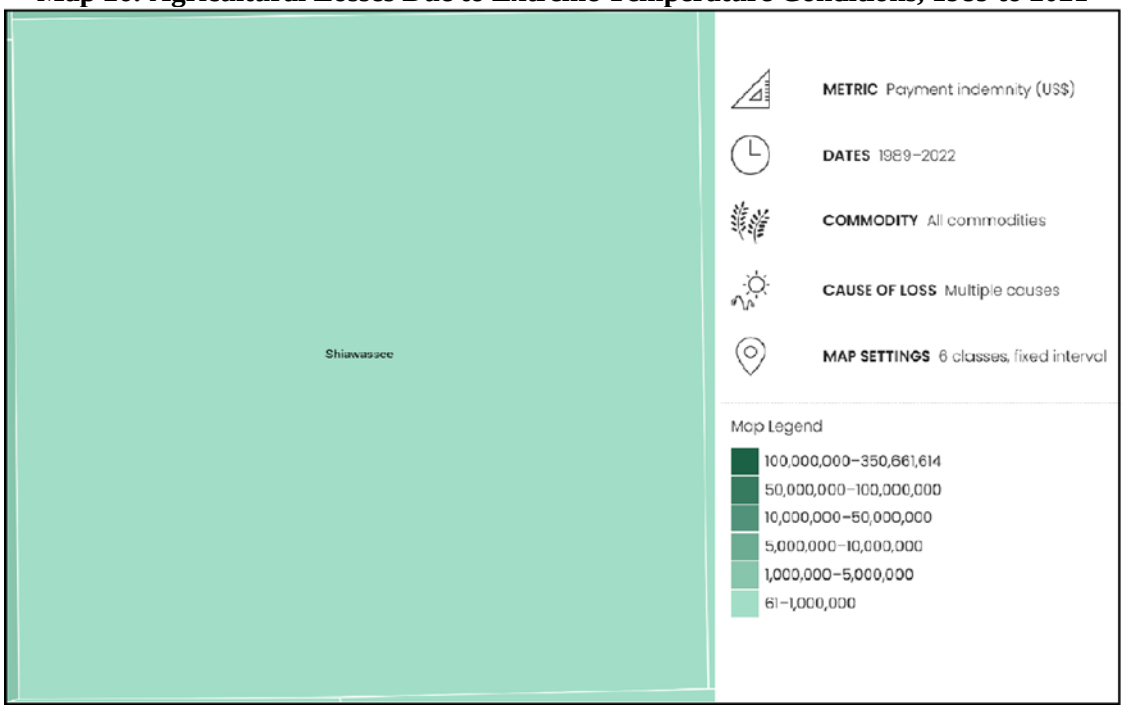
Source: NOAA

Extreme heat can cause significant damage to the local environment by dehydrating vegetation and wildlife, which may result in cascading effects to the surrounding environment, such as drought, wildfires, mudslides, or landslides. Extreme temperatures may severely decrease the yield of the agricultural sector. The yield of cash crops may be reduced, livestock may be adversely impacted by extreme heat, or grazing losses may be incurred by farmers or ranchers;

potentially resulting in decreased food security. In the event of significant agricultural losses caused by extreme heat or drought, some assistance may be available to impacted farms or ranches.

Extreme heat conditions can cause significant agricultural impacts. The following map from the United States Department of Agriculture details total agricultural losses, by county, due to extreme conditions from 1989 to 2021:

Map 26: Agricultural Losses Due to Extreme Temperature Conditions, 1989 to 2021



Source: USDA

Extreme temperatures can pose various risks to local and county operations, and may include:

- Health and Safety Risks: High temperatures, especially during heatwaves, can pose significant health risks to government employees. Heat-related illnesses such as heat exhaustion and heatstroke can occur, potentially leading to hospitalizations or fatalities. Cold temperatures can also lead to cold-related illnesses and injuries, such as frostbite and hypothermia.
- Transportation Disruptions: Extreme heat can cause pavement to soften and buckle, leading to road closures and transportation disruptions. Extreme cold can result in icy road conditions and reduce visibility, making travel hazardous.
- Emergency Response: Government agencies may need to respond to extreme weather events, such as providing emergency shelter during heatwaves or responding to weather-related accidents and emergencies. These responses can strain resources and personnel.
- Budgetary Impact: The costs associated with responding to and mitigating the effects of extreme temperatures can strain state budgets. This includes expenses related to emergency response, infrastructure repairs, and healthcare.

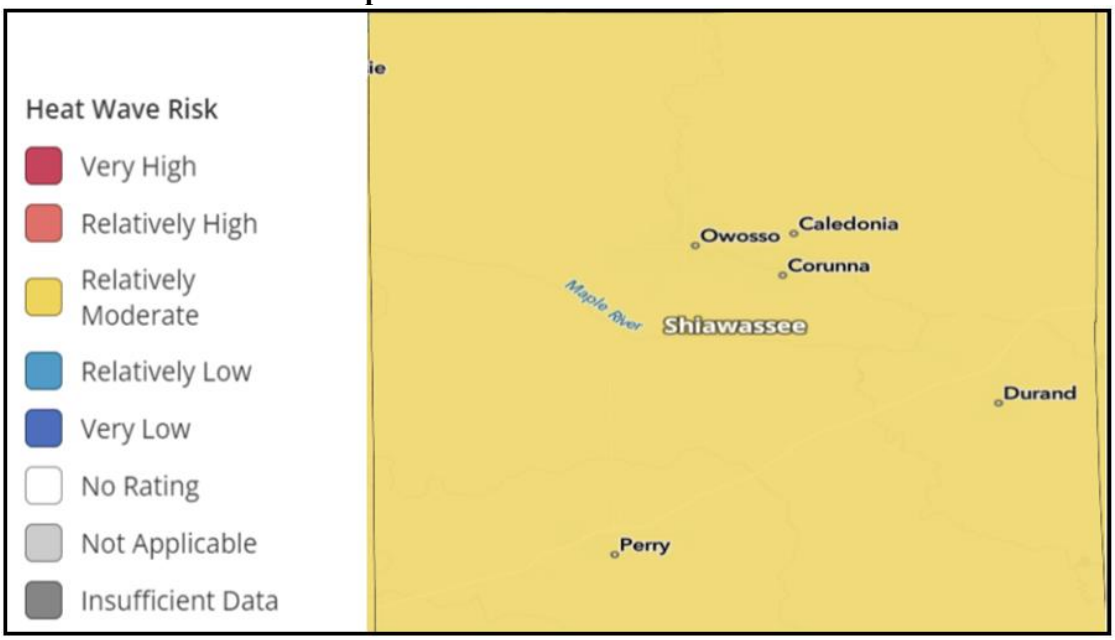
While not directly vulnerable to extreme temperatures, all county assets may be vulnerable in the following ways:

- Power Grid Strain: Extreme temperatures, whether hot or cold, can lead to increased demand for electricity. This can strain the power grid, potentially causing power outages, which can disrupt government operations, including the functioning of critical infrastructure such as hospitals, emergency services, and data centers.

- Infrastructure Stress: Buildings and infrastructure can suffer damage due to extreme temperatures. For example, prolonged exposure to high temperatures can lead to structural damage, such as cracking and warping. Extreme cold can freeze and damage pipes, leading to water leaks and flooding when temperatures rise.

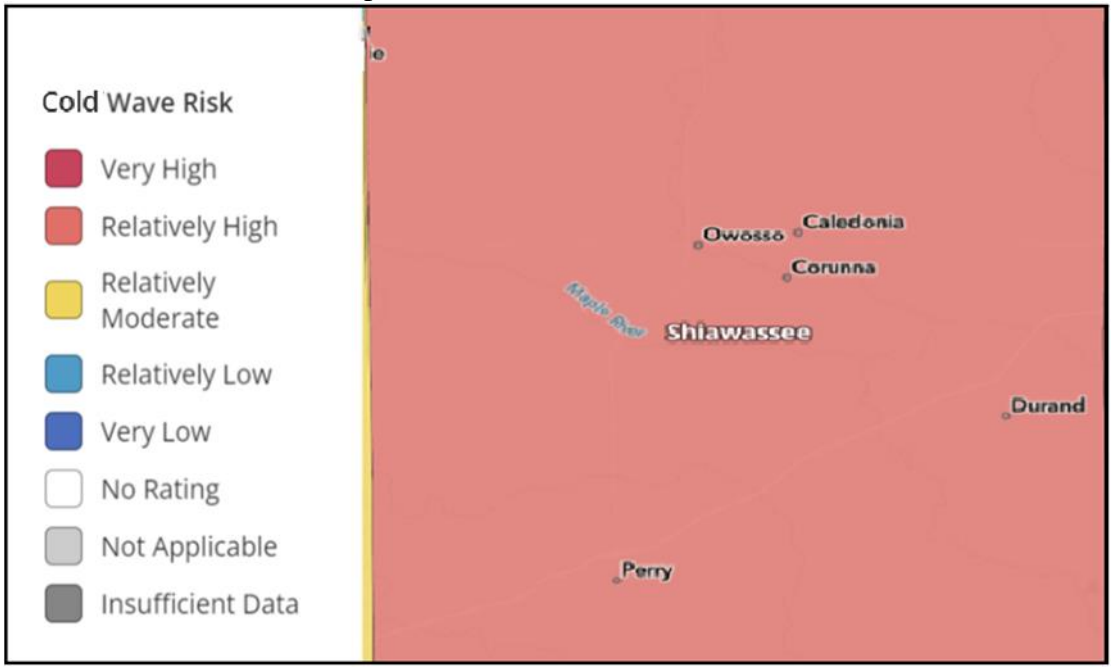
Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following maps were created indicating the potential risk to Shiawassee County from heat waves and cold waves:

Map 27: FEMA NRI Heat Wave Risk



Source: FEMA NRI

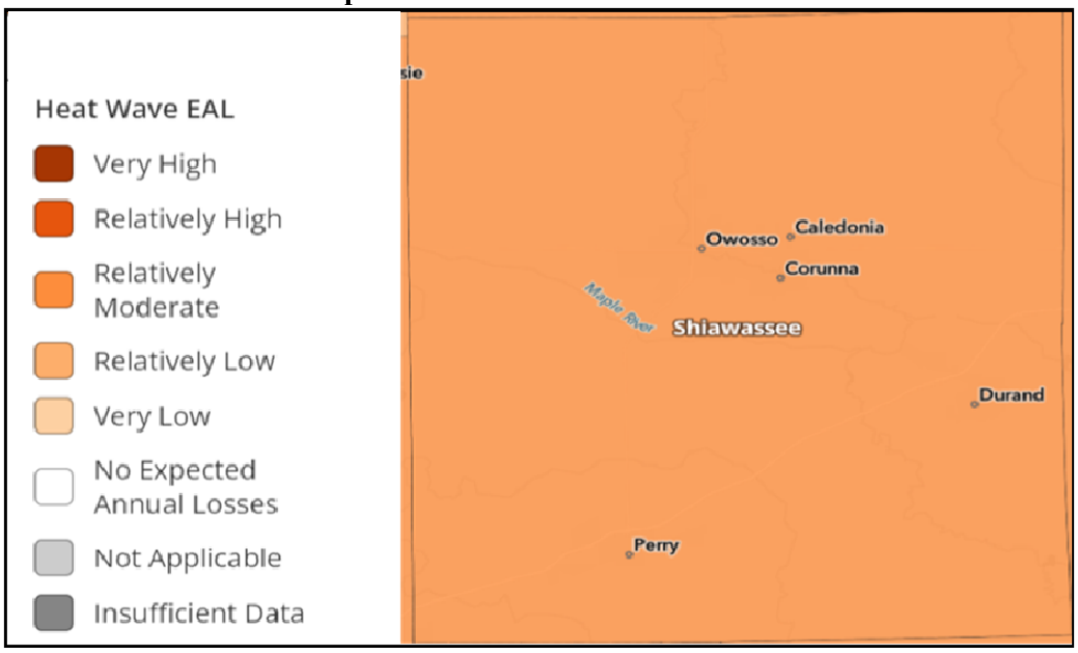
Map 28: FEMA NRI Cold Wave Risk



Source: FEMA NRI

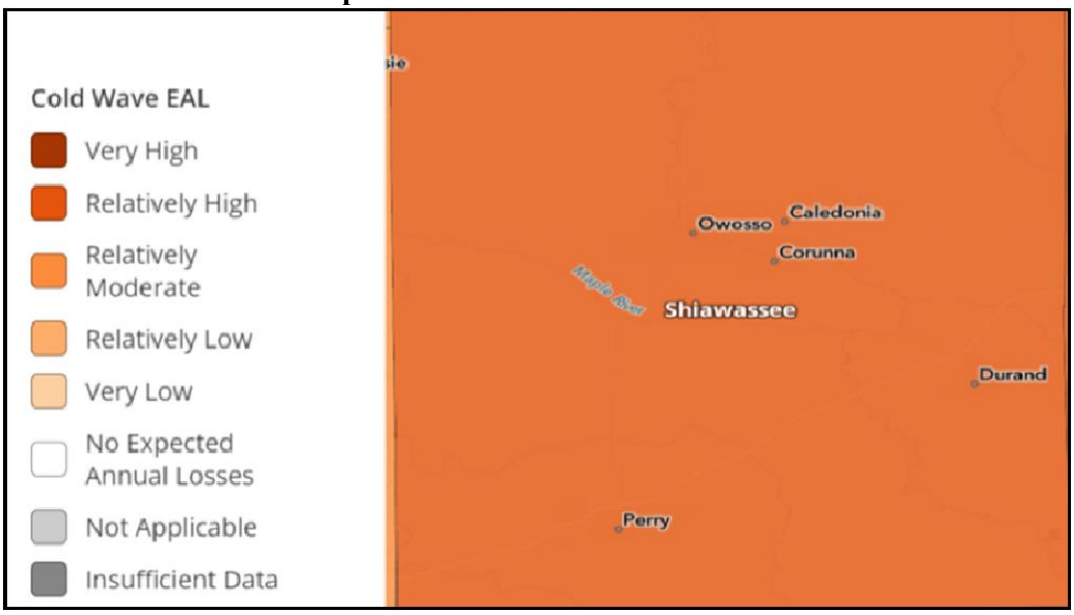
As part of the NRI, EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following maps indicate the EAL for heat waves and cold waves for Shiawassee County:

Map 29: FEMA NRI Heat Wave EAL



Source: FEMA NRI

Map 30: FEMA NRI Cold Wave EAL



Source: FEMA NRI

Potentially Vulnerable Community Lifelines

Extreme temperatures, whether excessively hot or cold, can impact various community lifelines, critical systems and services that communities rely on for their functioning. Vulnerabilities arise due to the stress that extreme temperatures place on infrastructure, resources, and operational processes.

Extreme heat and extreme cold can have significant impacts on roads, leading to various issues and challenges. Extreme temperatures can cause the following impacts:

- Softening of Asphalt: High temperatures can cause asphalt to soften and become more susceptible to deformation. This leads to the development of ruts and potholes as the road surface loses its stability.
- Rutting and Raveling: The combination of high temperatures and heavy traffic loads can result in rutting, where depressions or grooves form on the road surface. Raveling, the disintegration of the asphalt surface, may also occur.
- Expansion and Contraction: Materials like concrete and asphalt expand in high temperatures and contract in cooler temperatures. This expansion and contraction can lead to cracking and deterioration of the road surface over time.
- Freeze-Thaw Cycles: Fluctuations between freezing and thawing can lead to the formation of ice within the road structure. The expansion of water as it freezes can result in cracks and damage to the road surface.
- Frost Heaving: During freeze-thaw cycles, moisture in the soil beneath the road can freeze, causing the ground to heave upward. This can result in uneven surfaces and damage to the road structure.

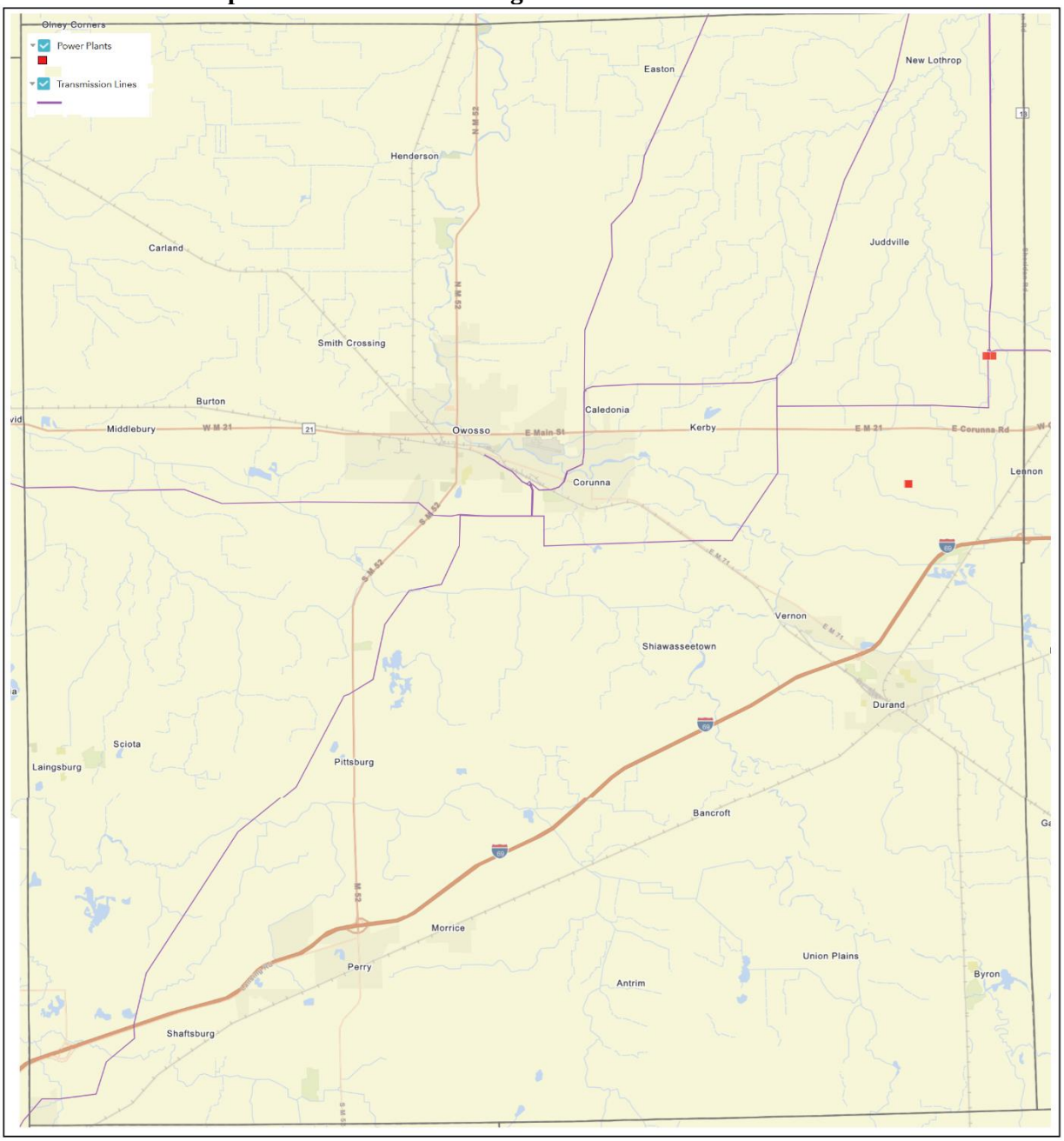
The cost to replace a road can vary significantly based on several factors, including the type of road, local labor and material costs, the complexity of the project, and the specific requirements of the replacement. As a rough estimate, road construction costs can range from $1,000,000 to $10,000,000 million per mile.

Extreme heat and extreme cold can impact electrical utilities in various ways, potentially leading to disruptions in service. These impacts include:

- Power Outages: High temperatures can strain electrical systems, leading to increased demand for cooling systems like air conditioners. This heightened demand can overload power grids, resulting in power outages.
- Transformer Overheating: Transformers, which are crucial components in power distribution, can overheat in extreme temperatures. This can lead to malfunctions, reduced efficiency, or even failures, causing power disruptions.
- Equipment Failure: Electrical equipment, such as cables and switches, may experience higher resistance and increased stress during extreme heat, increasing the likelihood of equipment failures.
- Reduced Efficiency in Power Plants: Power generation facilities may experience reduced efficiency during heatwaves due to elevated ambient temperatures. This can affect the output of power plants and potentially lead to supply shortages.
- Icing on Power Lines: Ice accumulation on power lines can lead to increased weight, potentially causing lines to sag or break. This can result in power outages and safety hazards.
- Communication Disruptions: Both extreme heat and cold can impact communication infrastructure. For example, extreme cold can affect the performance of fiber optic cables, while extreme heat can lead to equipment failures in communication systems.

The following map, from the U.S. Energy Atlas, details the location of both electrical generating plants and high-capacity transmission lines within Shiawassee County:

Map 31: Electrical Generating Plants and Transmission Lines



Source: U.S. Energy Atlas

The cost to replace electrical lines can vary widely based on several factors, including the type of electrical lines, the distance of the replacement, local labor and material costs, the complexity of the project, and any specific requirements or challenges involved. Additionally, costs can be significantly different for residential, commercial, or industrial projects. Additionally, urban and rural locations may have varying cost factors. As a rough estimate, the cost to replace electrical lines can range from a few thousand dollars to several thousand dollars per mile.

Major hospitals identified in Shiawassee County include the Memorial Healthcare Hospital. The total in-patient bed capacity of these facilities is approximately 148 beds. While these, and other smaller medical facilities, may see an increase in heat or cold related illness during an extreme temperature event, it is considered unlikely that this increase will impact or overload capacity. However, extreme temperatures can increase the demand for emergency shelters, particularly in cases of widespread power outages. Setting up and managing these shelters can strain resources.

Consequence Analysis

This consequence analysis lists the potential impacts of a hazard on various elements of community and state infrastructure. The impact of each hazard is evaluated in terms of disruption of operations, recovery challenges, and overall wellbeing to all Shiawassee County residents and first responder personnel. The consequence analysis supplements the hazard profile by analyzing specific impacts.

Table 26: Extreme Temperature Consequence Analysis

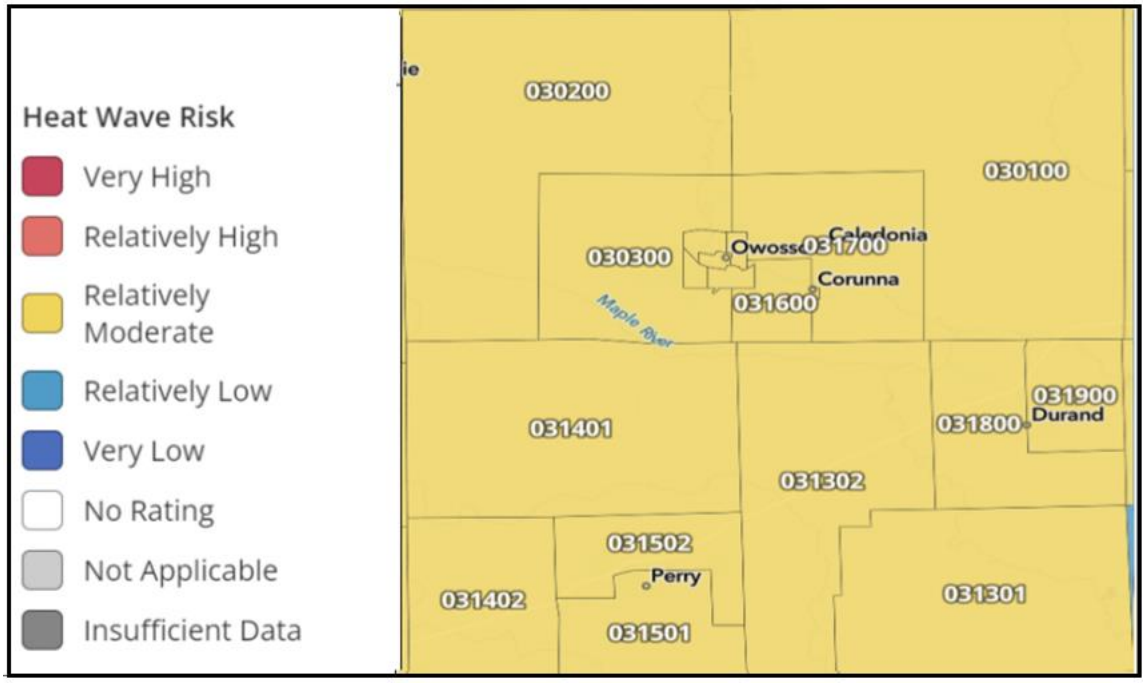
Subject	Potential Impacts
Impact on the Public	Extreme temperatures can have severe consequences for health, particularly for the elderly and young. Loss of electricity may impact heating or air conditioning leading to poorly tolerated indoor temperatures. Physical effects of extreme temperatures can cause major health problems and may lead to injury or death.
Impact on Responders	Without proper mitigation efforts, responders may be susceptible to temperature related illness. Extreme temperatures may also damage instruments or equipment necessary for response activities. First responders may face dangerous road conditions leading to accidents and prolonged response times.
Continuity of Operations	Local jurisdictions maintain continuity plans which can be enacted as necessary based on the situation. This hazard may impact an agency's ability to implement continuity operations due to power outages. If the activation of alternate facilities was required, continuity of operations may be difficult due to lack of computer/network access during power outages.
Delivery of Services	Extreme temperatures can impact efficient delivery or inability of goods or services due to potential health impacts on workers. Equipment and vehicles may be damaged, and the delivery of services may be delayed due to poor travel conditions
Property, Facilities, and Infrastructure	Facility integrity is at risk with regards to power cables and stations being overused and limiting operations. This could lead to limits on facility heating or cooling.
Impact on Environment	Extreme temperatures can cause significant damage to the local environment and result in habitat loss, invasive species, and changes in migration. Extreme temperatures may severely decrease the yield of cash crops. Livestock are adversely affected by extreme temperatures and may suffer medical problems or death.
Economic Conditions	Extreme temperatures may drain local resources. Under some conditions, some of the costs can be recouped through federal grant reimbursements.
Public Confidence in Governance	Governmental response, on all levels, requires direct actions that must be immediate and effective to maintain public confidence.

4.9.7 Jurisdictional Risk and Vulnerability

To help understand the risk and vulnerability to drought conditions of participating jurisdictions mapping from the FEMA NRI was run on a census tract level. As the NRI does not generate mapping for individual jurisdictions, census tract analysis is the closest analogue available to understand individual jurisdiction conditions.

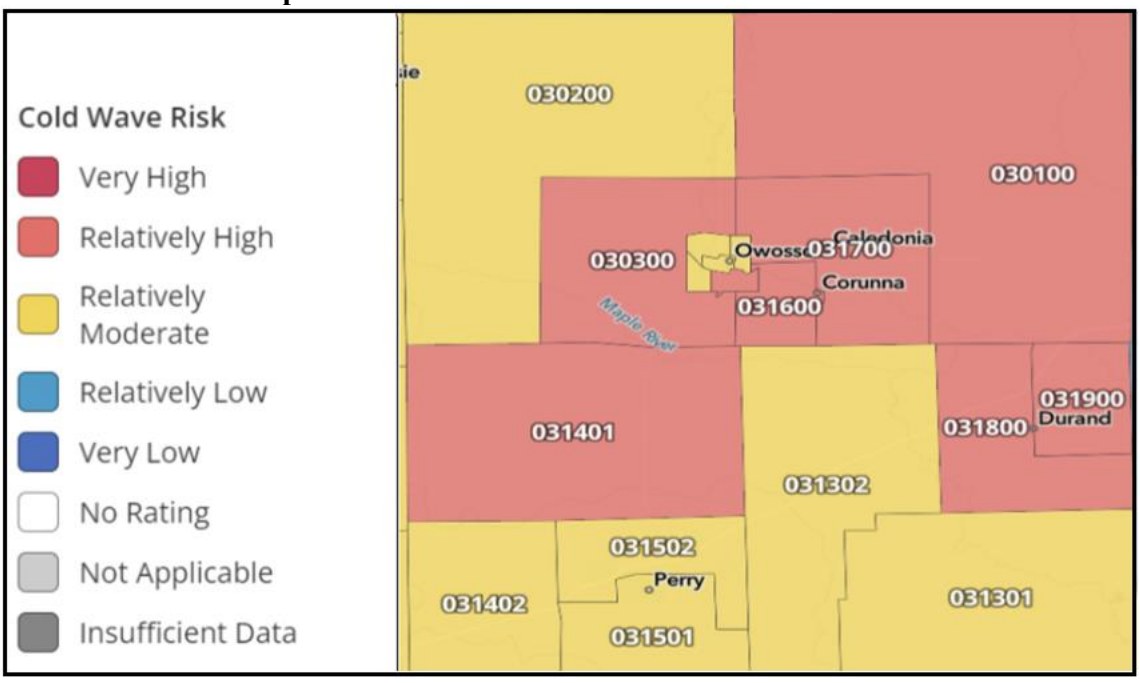
Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following map was created indicating the potential risk to participating jurisdictions from extreme temperature:

Map 32: FEMA NRI Jurisdictional Heat Wave Risk



Source: FEMA NRI

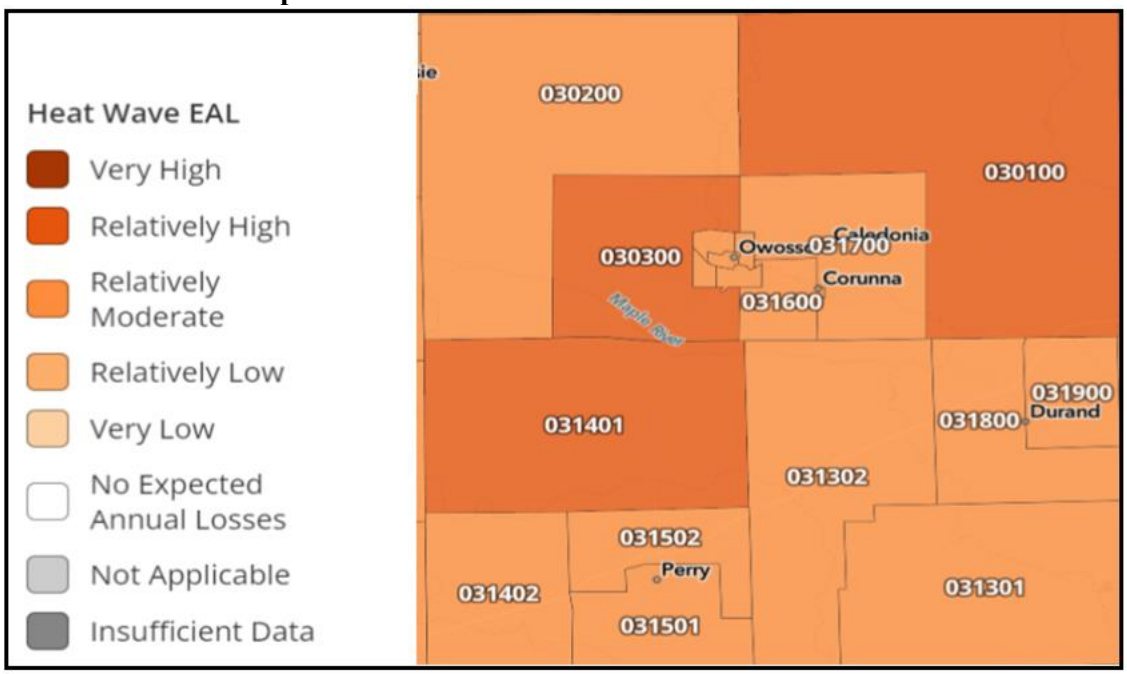
Map 33: FEMA NRI Jurisdictional Cold Wave Risk



Source: FEMA NRI

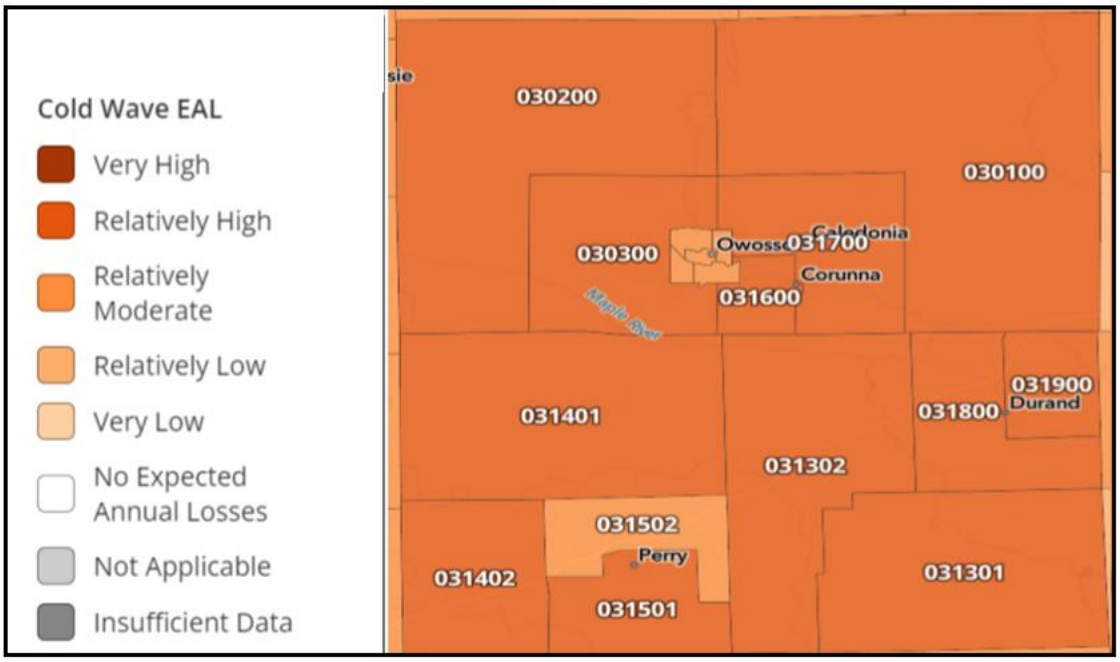
As part of the NRI, EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following map indicates the EAL for extreme temperatures for participating jurisdictions within Shiawassee County:

Map 34: FEMA NRI Jurisdictional Heat Wave EAL



Source: FEMA NRI

Map 35: FEMA NRI Jurisdictional Cold Wave EAL



Source: FEMA NRI

The following table indicates the FEMA NRI and EAL analysis for extreme temperature for each participating Shiawassee County jurisdiction:

Table 27: Shiawassee County EAL and NRI for Extreme Temperatures

Jurisdiction	Heat EAL	Heat Risk Index	Cold EAL	Cold Risk Index
Shiawassee County	Relatively Moderate	Relatively Moderate	Relatively High	Relatively High
City of Durand	Relatively Moderate	Relatively Moderate	Relatively High	Relatively High

Table 27: Shiawassee County EAL and NRI for Extreme Temperatures

Jurisdiction	Heat EAL	Heat Risk Index	Cold EAL	Cold Risk Index
City of Laingsburg	Relatively Moderate	Relatively High	Relatively High	Relatively High
City of Owosso	Relatively Moderate	Relatively Moderate	Relatively High	Relatively Moderate
City of Perry	Relatively Moderate	Relatively Moderate	Relatively High	Relatively High
Township of Owosso	Relatively Moderate	Relatively Moderate	Relatively High	Relatively Moderate

Source: FEMA NRI

Of particular concern, socially vulnerable and at-risk populations that may have difficulty with medical issues, poverty, extremes in age are often at increased susceptibility to the impacts of hazards. These populations suffer a disproportionate impact due to:

- Inadequate access to heating or cooling
- Constrained financial resources
- Limited access to healthcare

Data concerning potentially vulnerable populations may be found in Section 3.4, page 14.

4.10 Flood

4.10.1 Hazard Description

Flooding, as defined by the National Weather Service (NWS), is the rising and overflowing of a body of water onto normally dry land. It can result from any overflow of inland or tidal waters, or an unusual accumulation or runoff of surface waters from any source. Flooding is loosely classified as inland, riverine, or coastal.

Inland flooding, also known as "urban flooding" or "flash flooding," can be caused by intense, short-term rain or by moderate rainfall over several days, which can overwhelm existing drainage infrastructure. Other factors that affect the dynamics of this type of flood include slope, width, and vegetation in place along the watercourse banks. The slope that a flash flood traverses has a definite relationship to the overall speed in which the water will travel. The incline on which the water moves affects the width of the flooding area. Generally, the faster the water moves, the narrower that channel will be created, since the water digs the channel deeper as it flows. When water flows over shallower slope, it tends to spread out more, decreasing its potential to cause mass damage but still considered dangerous. Finally, the type of vegetation located along the flood's path can prevent further erosion of the channel banks. A structure that lies along a flood channel with no surrounding vegetation is at risk of having its foundation undercut, which can cause structural damage, or in some cases, a building's complete collapse. Riverine or alluvial, flooding occurs when excessive rainfall over an extended period of time causes a river to exceed its capacity. Typical causes of flooding, both inland and riverine, include tropical cyclonic systems, frontal systems, and isolated thunderstorms combined with other environmental variables such as changes to the physical environment, topography, ground saturation, soil types, basin size, drainage patterns, and vegetative cover. The rate of onset and duration of flooding events depends on the type of flooding (typical flood or flash flood). The spatial extent of a flooding event depends on the amount of water overflowing but can usually be mapped because of existing floodplains.

A floodplain is a flat or nearly flat land adjacent to a river or stream that experiences occasional or periodic flooding environment, topography, ground saturation, soil types, Floodplains, or Special Flood Hazard Areas (SFHAs), are made when floodwaters exceed the capacity of the main channel or escape the channel by eroding its banks. The sediments (rock and debris) that build up over time from the floodplain's floor. Floodplains also include a floodway, which consists of the water channel and adjacent areas that carry flood flows and the flood fringe, which are areas covered by the flood but do not experience a strong current.

In its common usage, floodplains refer to areas inundated by the 100-year flood, i.e., the flood that has a 1% chance of being equaled or exceeded in any given year and the 500-year flood, i.e., the flood that has a 0.2% chance of being equaled or exceeded in any given year. The 100-year flood is the national minimum standard to which communities regulate their floodplains through the National Flood Insurance Program (NFIP). The NFIP aims to reduce the impact of flooding on private and public structures. It does so by providing affordable insurance to property owners, renters, and businesses and by encouraging communities to adopt and enforce floodplain management regulations. These efforts help mitigate the effects of flooding on new and improved structures. Overall, the program reduces the socio-economic impact of disasters by promoting the purchase and retention of general risk insurance and flood insurance.

The adverse impacts of flooding can include structural damage; agricultural crop loss; the death of livestock; loss of access to critical facilities due to roads being washed out or overtopped; unsanitary conditions resulting from materials such as dirt, oil, solvents, and chemicals being deposited during the recession; infestations of disease-carrying mosquitoes; mold and mildew, which pose a severe health risk to small children and the elderly; and temporary backwater effects in sewers and drainage systems. Raw sewage is a breeding ground for bacteria, such as E. coli and

other disease-causing agents. A boil order may need to be issued to protect people and animals from contaminated water.

Of equal concern is the long-term psychological effect that flooding has on the people impacted by it. They must contend with the loss of life, property, livelihood, etc., as they cope with the aftermath. The clean-up can take months. The cost to restore a home may be too much, especially for the unprepared or uninsured. Plus, there is the looming fear that it may flood again. The resulting stress on floodplain residents takes its toll in the form of aggravated physical and mental health problems.

Unfortunately, the risks from future floods are significant, given expanded development in coastal areas and floodplains, unabated urbanization, land-use changes, and climate change. Because of this, flooding may intensify in many regions across the country, even in areas where total precipitation is projected to decline.

According to the FEMA, water, and flooding account for about 40% of the Presidential declared disasters in the United States.

4.10.2 Location and Extent

A variety of factors affect the severity of flash and riverine flooding within the planning area. These include topography, weather characteristics, development, and geology. Intense flooding will create havoc in any jurisdiction affected. The predicative magnitude of flash and riverine floods varies greatly.

Flash Flooding

Flash flooding occurs during heavy or extended periods of rain, generally when the ground is unable to rapidly absorb the water. Most flash flooding in Shiawassee County is caused by intense and stationary thunderstorms or rapid snow melting. Heavy sustained rain or rapidly melting snow can create rapid flooding very quickly, and flooding can occur miles away from where the rain fell. Factors that can contribute to the severity of flash flooding include rainfall intensity, duration, drainage condition, and ground conditions (paved or unpaved). Flash floods are particularly dangerous to people and property, as six inches of moving water can knock a person down and two feet can lift a vehicle. As there is often little warning of a flash flood event, they are the cause of most flood fatalities.

Riverine Flooding

Riverine flooding refers to the overflow of water from a river or a stream onto adjacent land areas. This type of flooding occurs when the water level in a river or stream rises significantly and exceeds its banks, inundating the surrounding areas. The severity of riverine flooding can be influenced by the amount and intensity of rainfall in the watershed, the size, shape, and slope of the river or stream channel, and the presence of dams on the river system.

Urban Flooding

FEMA defines urban flooding as ‘the inundation of property in a built environment, particularly in more densely populated areas, caused by rain falling on increased amounts of impervious surfaces and overwhelming the capacity of drainage systems.” In Shiawassee County, urban flooding has consistently increased due to a number of factors, including the filling for development of natural wetlands and waterways, the reduction of permeable surfaces, and the aging and insufficient capacity of stormwater systems.

To establish floodplains, FEMA adopted the Base Flood Elevation (BFE), which is the computed elevation that floodwater is anticipated to rise during a flood that has a1% chance of occurring in any given year. The BFE establishes the regulatory requirement for the elevation or floodproofing of structures, and the relationship between the BFE and a given structure’s elevation determines the flood insurance premium through the National Flodd Insurance Program (NFIP).

FEMA, through the Risk Mapping, Assessment, and Planning (Risk MAP) program, FEMA works with partners to assess and map these flood risks (Flood Insurance Rate Maps (FIRMs). As an additional benefit, the FIRMs serve as the basis for National Flood Insurance Program (NFIP) regulations and flood insurance purchase requirements.

Special Flood Hazard Areas (SFHAs) are defined as the area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. The 1% annual chance flood is also referred to as the base flood or 100-year flood. The FIRM depicts the SFHA, including the 1%-annual-chance flood. These areas are labeled on the map as zone, as explained in the following table:

The following table details FEMA's FIRM flood zone classifications.

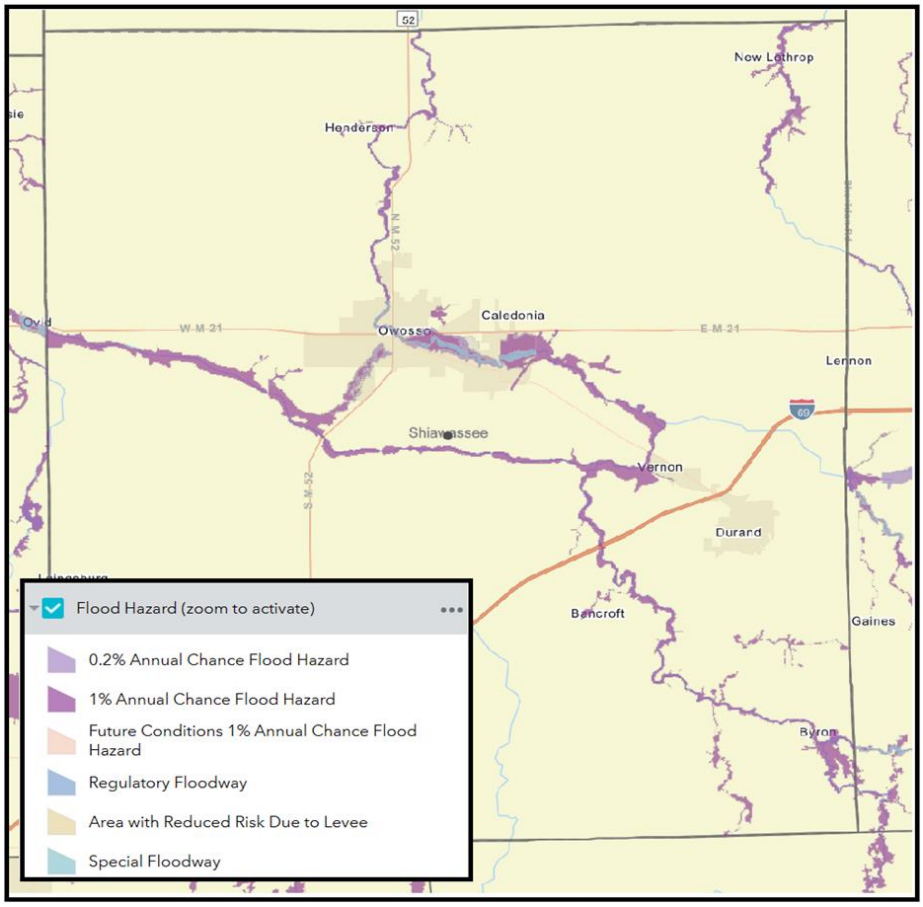
Table 28: Flood Zone Classifications

Zone	Description
A	The 1%-annual-chance or base floodplain. There are six (6) types of A Zones.
AE	The base floodplain where base flood elevations are provided.
AH	Shallow flooding base floodplain. BFEs are provided.
AO	The base floodplain with sheet flow, ponding, or shallow flooding. Base flood depths are provided.
AR	The base floodplain that results from the decertification of a previously accredited flood protection system that is in the process of being restored to provide a 1%-annual-chance or greater level of flood protection.
A99	Area to be protected from base flood by levees or Federal Flood Protection Systems under construction. BFEs are not determined.
B or Shaded X	Areas between the limits of the base flood and the 0.2% annual-chance (or 500-year) flood.
C or Unshaded X	Areas of minimal flood hazard, which are the areas outside the SFHA and higher than the elevation of the 0.2% annual-chance flood

Source: FEMA

The following maps use FEMA FIRM data to depict the location of identified flood zones within Shiawassee County.

Map 36: Shiawassee County Flood Zones



Source: FEMA RAPT

4.10.3 Previous Occurrences

Historical events of significant magnitude or impact can result in a Presidential Disaster Declaration. The following table details Disaster Declarations for Shiawassee County relating to flood events, form 1953 to 2023:

Table 29: Shiawassee County Presidentially Declared Flood Disasters

Designation	Declaration Date	Incident Type	Assistance	Mitigation Grants
DR-774-MI	09/18/1986	Flood	-	-
DR-744-MI	09/19/1985	Flood	-	-
DR-486-MI	09/30/1975	Flood	-	-
DR-465-MI	04/26/1975	Flood	-	-

Source: FEMA

The following table presents NCEI identified flood events and the resulting damage totals in Shiawassee County from 1950 to 2023. with the years 2003 and 2022 being full dataset years.

Table 30: Shiawassee County NCEI Flood and Flash Flood Events, 1950 - 2023

County	Event Type	Number of Days with Events	Property Damage	Deaths and Injuries
Shiawassee	Flood	12	$70,000	0
	Flash Flood	3	$1,101,000	0

Source: NCEI

The following provides both local accounts and NCEI descriptions of notable recorded events:

- **May 4, 2012, Shiawassee County:** A few severe storms developed in the late afternoon and evening. Training of showers and thunderstorms then dumped half a foot of rain on the Flint area, Stranding cars on roadways and forcing the boat evacuation of some residents. Damages estimated at 1.1 million.

4.10.4 Probability of Future Incidents

The definition of each flood zone's classification is used for the purpose of calculating the yearly probability of a riverine flood. Jurisdictions with property in a 100-year floodplain can expect a 1% annual chance of flooding within the designated areas. Jurisdictions with property in a 500-year floodplain can expect a 0.2% annual chance of flooding within the designated areas. Further, data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to riverine flood events:

Table 31: Shiawassee County Riverine Flood Probability Summary

Data	Days
Number of Days with NCEI Reported Event (1950-2023)	12
Average Events per Year	<1

Source: NCEI

Data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to flash flood events:

Table 32: Shiawassee County Flash Flood Probability Summary

Data	Days
Number of Days with NCEI Reported Event (1950-2023)	3
Average Events per Year	<1

Source: NCEI

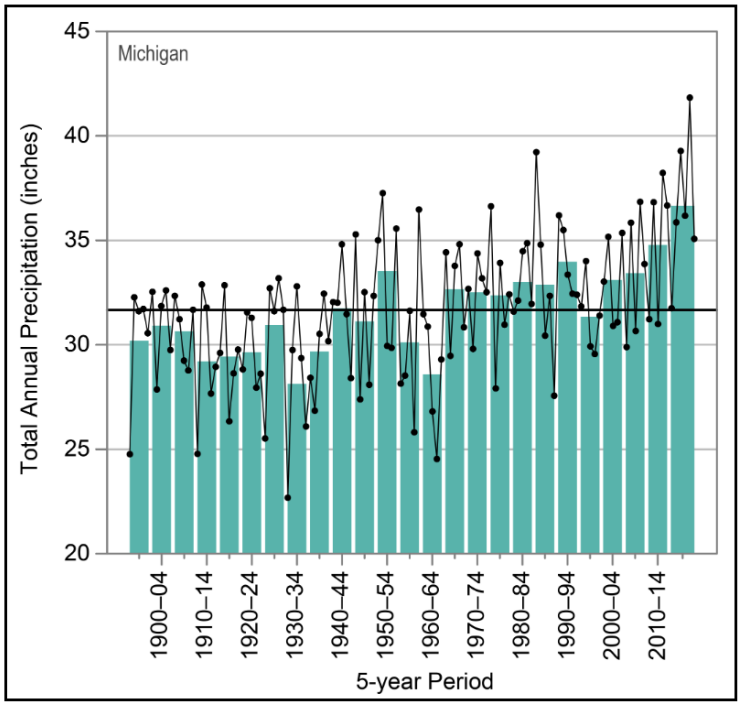
4.10.5 Projected Changes in Location, Intensity, Frequency, and Duration

Available data indicates that the impacts of climate change upon Shiawassee County's built and natural environments are wide-ranging and, in many cases, growing in severity. Related to flooding, models suggest that the county and all participating jurisdictions will experience more extreme and intense precipitation events. The NOAA NCEI Summary

2022 for Michigan indicates that the frequency of extreme precipitation events has increased. Multiyear averages for two-inch extreme precipitation events for the 2010–2014 and 2015–2020 periods are the highest on record. The frequency and intensity of extreme precipitation are also projected to increase, potentially increasing the frequency and intensity of floods. Springtime flooding, in particular, could pose a threat to Michigan's important agricultural industry by delaying planting and threatening yield losses. Under a higher emissions pathway, it is expected that Shiawassee County will see a continued increase in frequency and intensity of extreme precipitation events.

The NOAA NCEI State Climate Summary 2022 for Michigan indicates that the total annual precipitation has generally been above average in recent decades, as indicated by the following chart:

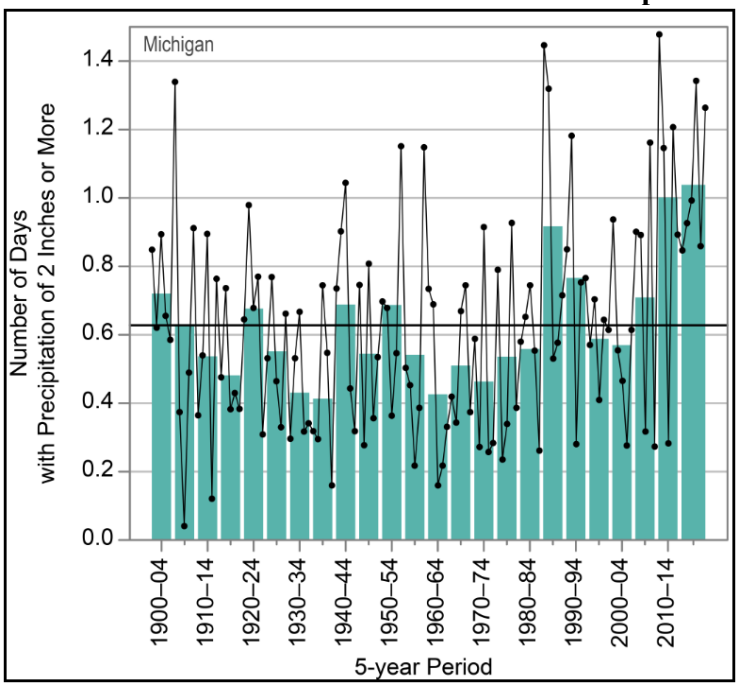
Chart 14: Michigan Total Annual Precipitation



Source: NOAA NCEI Summary 2022 for Michigan

Additionally, the NOAA NCEI State Climate Summary 2022 for Michigan indicates that the number of 2-inch extreme precipitation events has been increasing since 2000, as indicated by the following chart:

Chart 15: Observed Number of Two-Inch Extreme Precipitation Days



Source: NOAA NCEI Summary 2022 for Michigan

Shiawassee County's current land-use regulations require the consideration of flood hazards during the development review process. Additionally, the generally static, or declining, nature of population growth during the past ten years in all participating jurisdictions indicates that both current and future development may decline. As such, the vulnerability to flood events may decrease.

4.10.6 Vulnerability and Impact

Data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to riverine flood events:

Table 33: Shiawassee County Riverine Flood Impact Summary

Data	Recorded Impact
Number of Days with NCEI Reported Event (1950-2023)	12
Average Events per Year	<1
Number of Deaths or Injuries (1950-2023)	0
Average Number of Deaths or Injuries	0

Source: NCEI

Data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to flash flood events:

Table 34: Shiawassee County Flash Flood Impact Summary

Data	Recorded Impact
Number of Days with NCEI Reported Event (1950-2023)	3
Average Events per Year	<1
Number of Deaths or Injuries (1950-2023)	0
Average Number of Deaths or Injuries	0

Source: NCEI

The results of the HAZUS analysis were utilized to estimate potential losses for riverine flooding. The intent of this analysis was to enable Shiawassee County to estimate where flood losses could occur and the degree of severity using a consistent methodology. The HAZUS model helps quantify risk along known flood-hazard corridors as well as lesser streams and rivers that have a drainage area of 10 square miles or more. HAZUS®, version 5.0, was used to perform the analysis for Shiawassee County using essential facility data available through HAZUS databases and HIFLD data.

The analysis was completed by BOLDplanning. For this hazard, the risk assessment data and maps involved were from an analysis of 1% annual chance flood event (100-Year Flood). The reported losses are based upon essential facility and census data as part of HAZUS. We are also mapping updated essential facilities provided by Shiawassee County Emergency Management in relation to the flooded areas from HAZUS Level One modeling efforts.

HAZUS determines the displaced population based on the inundation area, not necessarily impacted buildings. As a result, there may be a population vulnerable to displacement even if the structure is not vulnerable to damage. Individuals and households will be displaced from their homes even when the home has suffered little or no damage either because they were evacuated or there was no physical access to the property because of flooded roadways.

Flood sheltering needs are based on the displaced population, not the damage level of the structure. HAZUS determines the number of individuals likely to use government-provided short-term shelters through determining the number of displaced households as a result of the flooding. To determine how many of those households and the corresponding number of individuals will seek shelter in government-provided shelters, the number is modified by factors accounting for income and age. Displaced people using shelters will most likely be individuals with lower incomes and those who do not have family or friends within the immediate area. Since the income and age factors are taken into account, the proportion of displaced population and those seeking shelter will vary from county to county.

Additionally, HAZUS takes into account flood depth when modeling damage (based on FEMA's depth-damage functions). Generated reports capture damage by occupancy class (in terms of square footage impacted) by damage percent classes. Occupancy classes include agriculture, commercial, education, government, industrial, religion, and residential. Damage percent classes are grouped by 10 percent increments up to 50%. Buildings that sustain more than 50% damage are considered to be substantially damaged.

The following table provides the HAZUS results for vulnerable populations and the population estimated to seek short term shelter as well as the numbers of damaged and substantially damaged buildings for Shiawassee County.

Table 35: Shiawassee County HAZUS Flood Scenario Displaced Population Building Damages

Displaced Population	Persons Seeking Shelter	Damaged Buildings	Destroyed Buildings
1,247	277	53	0

Source: FEMA HAZUS

Especially critical is timely evacuation orders, and adherence to those orders. If evacuation is not heeded, or flood waters rise quickly enough, citizens could drown or become trapped for extended periods of time with no access to services or medical care. Of special concern are long term care and medical facilities where it can take longer to evacuate, or evacuation may be impossible. Additionally, lower income citizens may not have the means to relocate, whether it be lack of transportation or lack of resources to afford temporary shelter. Expected impacts of flooding on citizens may include:

- Loss of Life: Flooding is one of the leading causes of weather-related fatalities worldwide. Fast-rising floodwaters can lead to drowning and other water-related accidents, resulting in the tragic loss of lives.
- Injuries: Floods can cause injuries due to waterborne diseases, contaminated floodwaters, debris, and accidents during evacuation or rescue operations.
- Displacement: Many people may be forced to evacuate their homes during floods and will require emergency shelter or temporary housing. Prolonged displacement can be emotionally and economically challenging.
- Health Risks: Floodwaters often contain pollutants, sewage, and hazardous materials. Exposure to contaminated water can lead to waterborne diseases, infections, and other health risks.
- Mental Health Effects: Survivors of floods may experience a range of emotional and psychological challenges, including post-traumatic stress disorder, anxiety, depression, and grief.
- Food and Water Shortages: Floods can contaminate water supplies and disrupt the distribution of food. This can lead to shortages of clean drinking water and essential food items.

- Impact on Vulnerable Populations: Vulnerable populations, including the elderly, children, people with disabilities, and those living in poverty, are often disproportionately affected by floods due to limited resources and mobility challenges.
- Long-Term Consequences: Some flood impacts, such as mold growth, structural damage, and land degradation, can have long-term consequences that persist even after the floodwaters recede.

Floods can have significant and often costly impacts on facilities and critical infrastructure. These impacts can disrupt essential services, damage infrastructure, and pose safety risks. The extent of the impact depends on factors such as the severity of the flood, the preparedness of the infrastructure, and the effectiveness of flood management measures. Here are some of the common impacts of floods on facilities and critical infrastructure:

- Structural Damage: Floodwaters can cause extensive damage to buildings, including critical infrastructure such as power plants, water treatment facilities, hospitals, and transportation hubs. The force of moving water can weaken foundations, erode structural elements, and compromise the integrity of buildings.
- Electrical and Mechanical Systems: Floodwaters can damage electrical systems, including transformers, switchgear, and electrical panels, leading to power outages and the disruption of critical services. Mechanical systems, such as heating, ventilation, and air conditioning, may also be affected.
- Water and Wastewater Infrastructure: Floods can overwhelm water supply and wastewater treatment systems. Contamination of drinking water sources can lead to water shortages and health risks, while damage to wastewater treatment plants can result in the discharge of untreated sewage into water bodies.
- Transportation Networks: Floods can damage roads, bridges, railways, and airports, making transportation difficult or impossible.
- Communication Infrastructure: Floods can disrupt telecommunications and internet services, hindering communication among emergency responders and the public. Loss of communication can impede coordination and response efforts.
- Healthcare Facilities: Damage to healthcare infrastructure can limit the capacity to provide medical care during a crisis.
- Energy Infrastructure: Floods can damage power generation facilities, including hydroelectric dams and power plants, leading to power outages and potential safety hazards.

HAZUS analysis also provides an estimate of the repair costs for impacted buildings as well as the associated loss of building contents and business inventory. Building damage can also cause additional losses to a community by restricting a building's ability to function properly. Income loss data accounts for losses such as business interruption and rental income losses as well as the resources associated with damage repair and job and housing losses. These losses are calculated by HAZUS using a methodology based on the building damage estimates.

The damaged building counts generated by HAZUS are susceptible to rounding errors and are likely the weakest output of the model due to the use of census blocks for analysis. Generated reports include this disclaimer: "Unlike the earthquake and hurricane models, the flood model performs its analysis at the census block level. This means that the analysis starts with a small number of buildings within each census block and applies a series of distributions necessary for analyzing the potential damage. The application of these distributions and the small number of buildings make the flood model more sensitive to rounding errors that introduces uncertainty into the building count results." Additionally, losses are not calculated for individual buildings, but instead are based on the performances of entire classes of buildings obtained from the general building stock data. In the flood model, the number of grid cells (pixels) at each flood depth value is divided by the total number of grid cells in the census block. The result is used to weight the flood depths applied to each specific occupancy type in the general building stock. First floor heights are then applied to determine the damage depths to analyze damages and losses.

The following table provides the HAZUS results for building damages and business interruption loss due to these damages.

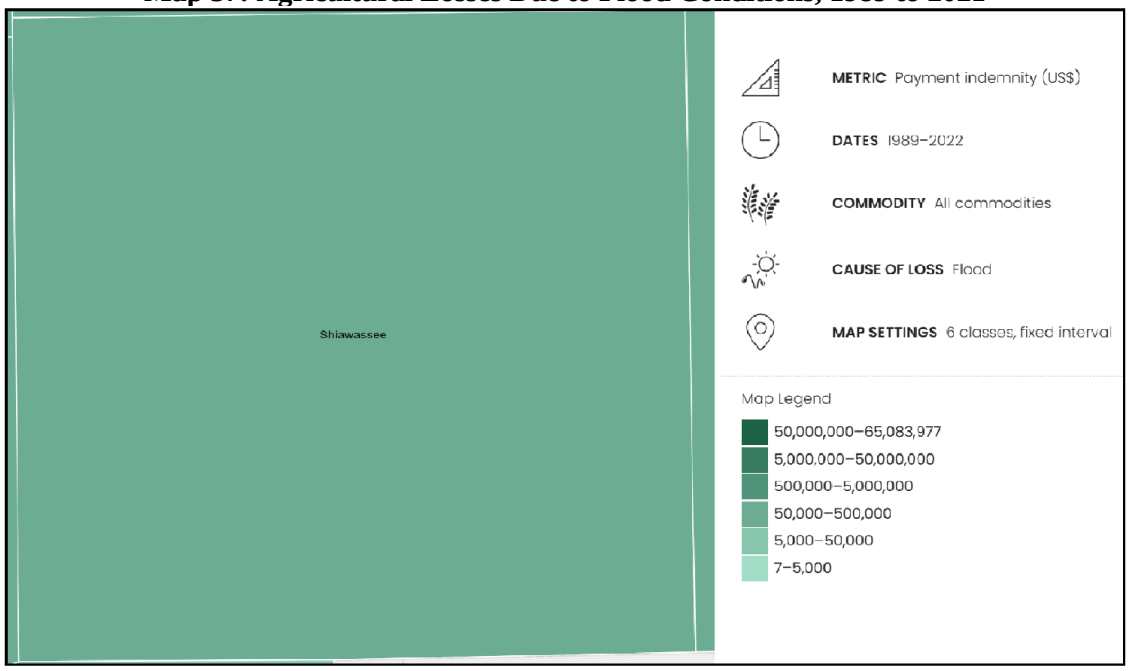
Table 36: Shiawassee County HAZUS Flood Scenario Structural Damage and Income Loss

Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Business Interruption Loss	Total Loss
$16,060,000	$23,630,000	$1,370,000	$41,070,000	$105,740,000	$146,810,000

Source: FEMA HAZUS

Flood conditions can cause significant agricultural impacts. The following map from the United States Department of Agriculture details total agricultural losses, by county, due to extreme conditions from 1989 to 2021:

Map 37: Agricultural Losses Due to Flood Conditions, 1989 to 2021



Source: USDA

Of particular concern related to flooding is the safety of citizens. Especially critical is timely evacuation orders, and adherence to those orders. If evacuation is not heeded, or flood waters rise quickly enough, citizens could drown or become trapped for extended periods of time with no access to services or medical care. Of special concern are long term care and medical facilities where it can take longer to evacuate, or evacuation may be impossible. Additionally, lower income citizens may not have the means to relocate, whether it be lack of transportation or lack of resources to afford temporary shelter.

Environmental impacts from flooding can be far reaching. Of particular concern is flood related runoff, potentially carrying sewage, pesticides, or hazardous chemicals, which can cause long lasting environmental harm. Expected negative outcomes could include changes in habitat, a decrease of available food, and an increase in the spread of vector-associated disease due to standing water.

Floods can pose significant risks to county operations and buildings, as they can result in a wide range of immediate and long-term consequences. Some of the potential risks to county operations and facilities associated with floods include:

- Loss of Life and Injury: Flooding can lead to loss of life and injuries, particularly if people are unable to evacuate in time or if they underestimate the dangers of floodwater. This is a primary concern during flooding events.

- Infrastructure Damage: Floodwaters can cause extensive damage to critical infrastructure, including roads, bridges, public buildings, and utilities such as water treatment plants and power substations. This can disrupt government operations and essential services.
- Evacuation and Displacement: Flooding often necessitates the evacuation of residents and businesses from affected areas. Government agencies may need to establish emergency shelters and provide support to displaced populations.
- Economic Impact: Flooding events can have a severe economic impact. This includes costs associated with infrastructure repairs, property damage, crop loss, business interruption, and the strain on local economies.
- Emergency Response: State and local government agencies must respond swiftly to manage flood-related crises, coordinate evacuations, provide emergency services, and ensure public safety. This can strain resources and personnel.

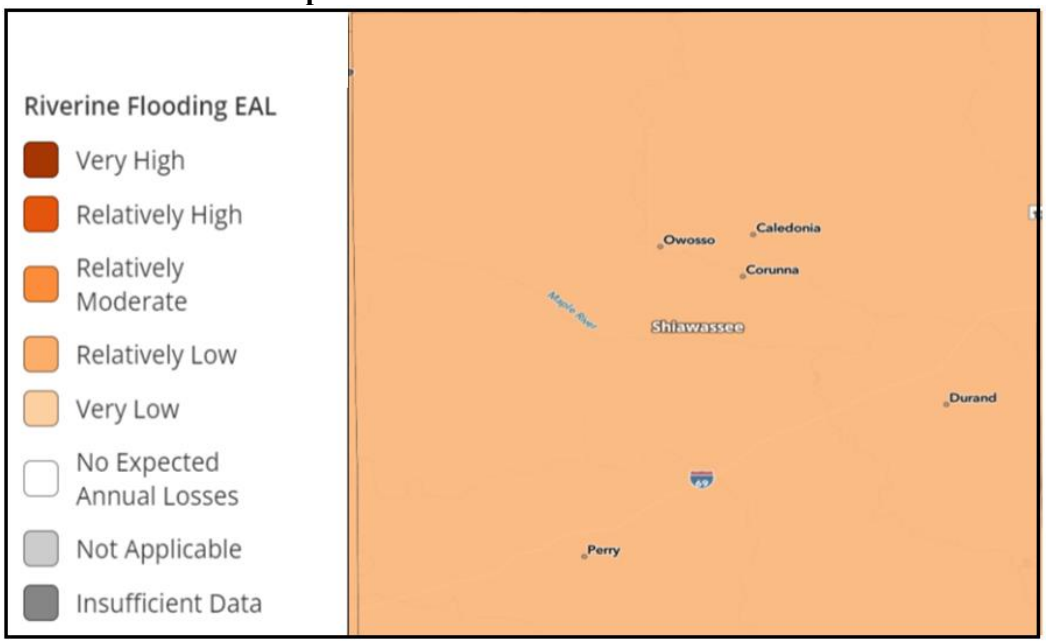
Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following map weas created indicating the potential risk to Shiawassee County from riverine flooding:

Map 38: FEMA NRI Riverine Flood Risk

Source: FEMA NRI

As part of the NRI, EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following maps indicate the EAL for riverine flooding for Shiawassee County:

Map 39: FEMA NRI Riverine Flood EAL



Source: FEMA NRI

Potentially Vulnerable Community Lifelines

Flooding can impact various community lifelines, critical systems and services that communities rely on for their functioning. Vulnerabilities arise due to the stress that flooding can place on infrastructure, resources, and operational processes.

The Hazus model indicated that three Shiawassee County or jurisdictional critical facilities are estimated to be at least moderately damaged from the flood scenario.

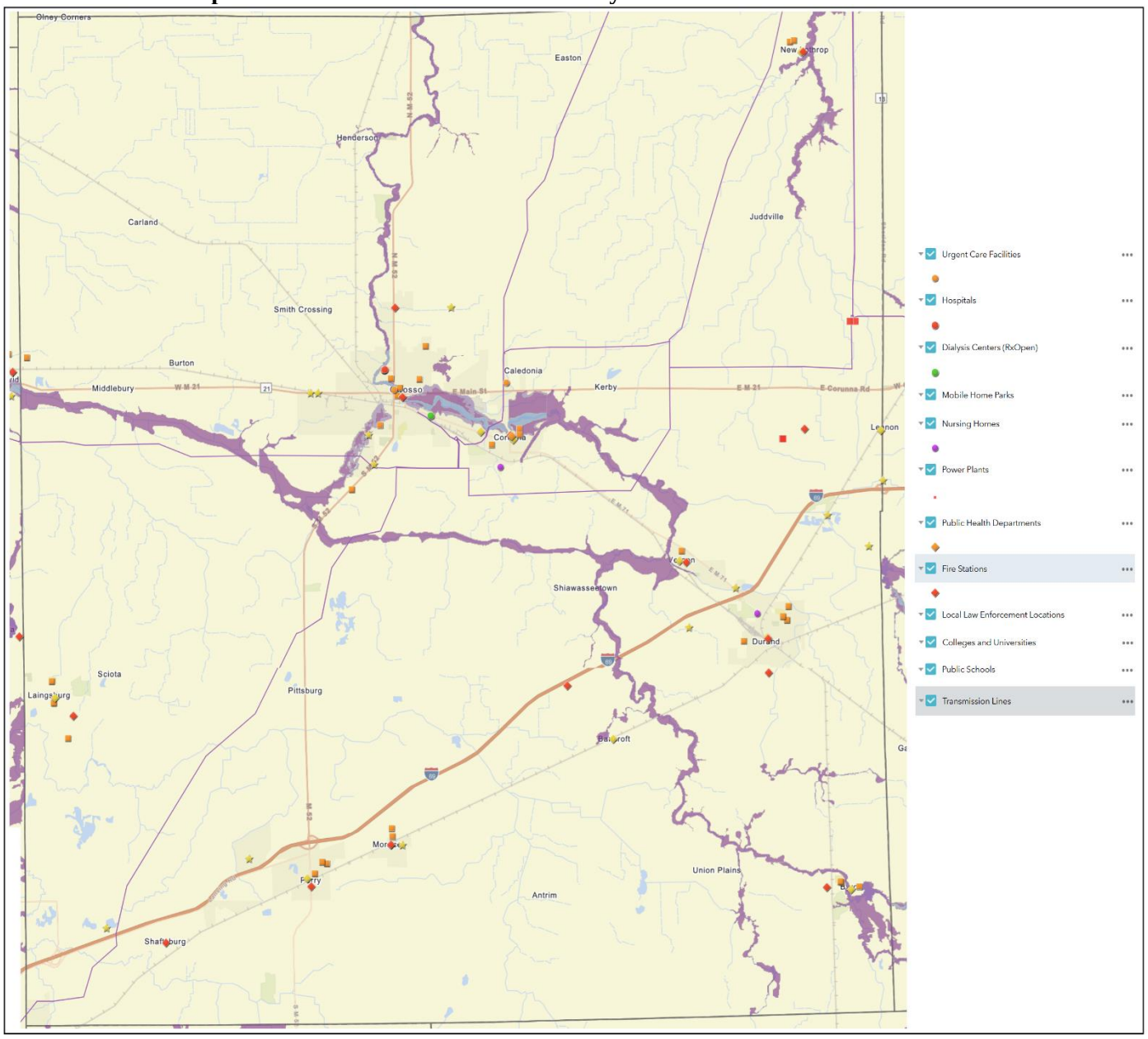
Table 37: Hazus Flood Scenario Number of Critical Facilities Damaged or Impacted

Jurisdiction	Emergency Operations Centers	Fire Stations	Hospitals	Police Stations	Schools
Shiawassee County	0	1	0	1	1

Source: FEMA HAZUS

A Hazus analysis was performed to determine critical facility locations relative to the potential flood areas. Using GIS, flood zones were overlaid on the critical facility location data:

Map 40: Critical Facilities and Community Lifelines in Potential Flood Areas



Source: FEMA RAPT

As per HAZUS, before the flood analyzed in this scenario, the region had 107 hospital beds available for use. On the day of the scenario flood event, the model estimates that 107 hospital beds are available in the region.

Flooding can have significant and widespread impacts on road infrastructure. The extent of the damage depends on factors such as the severity and duration of the flood, the type of flooding (river overflow, flash flooding), and the design and resilience of the road infrastructure. Impacts may include:

- Structural Damage: Floodwaters can erode road surfaces, weaken foundations, and damage bridges and culverts. The force of flowing water can undermine the structural integrity of roads and cause washouts.
- Road Surface Erosion: The erosion caused by floodwaters can remove the top layer of road surfaces, leading to potholes, cracks, and a general deterioration of the road condition.

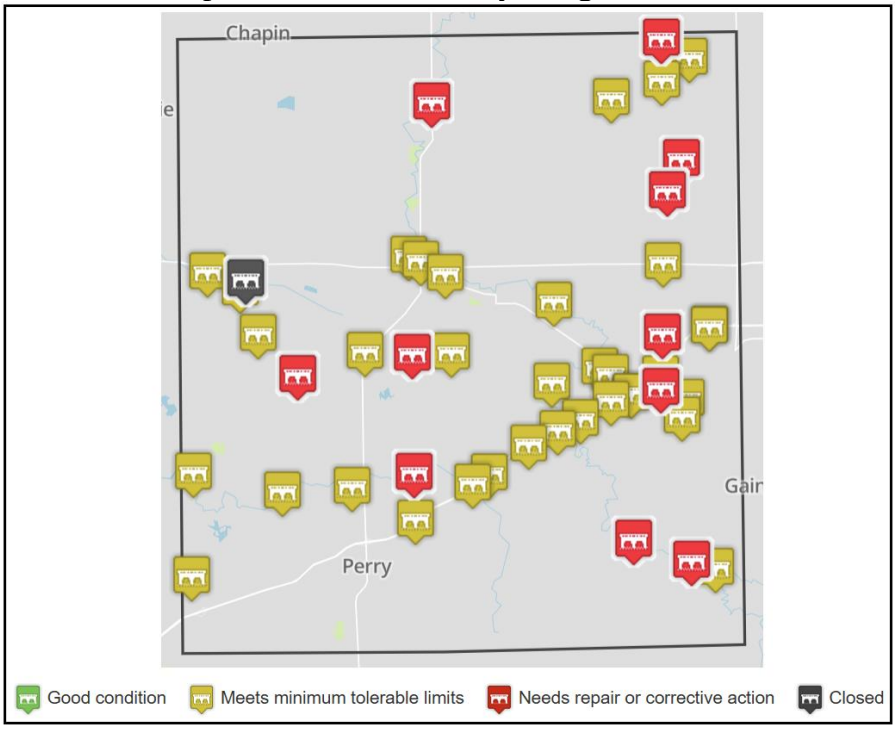
- Subsidence and Sinkholes: The infiltration of water into road foundations can cause subsidence or create sinkholes.
- Debris Accumulation: Floodwaters often carry debris such as logs, branches, and sediment. The accumulation of debris on roads can impede drainage systems, block culverts, and hinder the flow of water.
- Road Closures: Flooding can result in the closure of roads due to safety concerns. High water levels, washouts, or structural damage may make roads impassable, leading to disruptions in transportation.
- Loss of Road Markings and Signs: Floodwaters can wash away road markings and signs, reducing visibility and creating safety hazards for motorists.
- Long-Term Damage: Even after floodwaters recede, long-term damage to road infrastructure may persist. Subsurface waterlogging, soil destabilization, and residual structural weaknesses can contribute to ongoing deterioration.

The cost to replace a road can vary significantly based on several factors, including the type of road, local labor and material costs, the complexity of the project, and the specific requirements of the replacement. As a rough estimate, road construction costs can range from $1,000,000 to $10,000,000 million per mile.

Bridges crossing rivers can pose significant concerns during flooding events due to the increased risk of structural failure. Floodwater can exert powerful hydraulic forces on bridge structures, with the flow of water, debris, and floating objects impacting the bridge's substructure and foundation. Scouring, the removal of soil or sediment around bridge foundations can increase during a flood event increasing the risk of failure. Floodwater can also cause the deformation and misalignment of bridge components. As water levels rise and fall, the structural elements may undergo stress and strain, potentially leading to long-term damage and misalignment.

A structurally deficient bridge is a bridge that has one or more components showing signs of deterioration or damage, affecting its overall structural integrity. A structurally deficient bridge is not necessarily in immediate danger of collapse, but rather contains elements that require attention and may need repair, rehabilitation, or replacement. The following map details all bridges, including structurally deficient bridges, in Shiawassee County:

Map 41: Shiawassee County Bridge Locations



Source: Shiawassee County

Of particular concern for flooding are bridges identified as structurally deficient crossing rivers or streams. The following table details structurally deficient bridges crossing a river or stream:

Table 38: Structurally Deficient Bridges Crossing Rivers

Bridge	Nearest Jurisdiction	Owner	Average Daily Traffic
Shipman Road over Rushbed Creek	Juddville	Shiawassee County	144
Bennington Road over Bear Creek	Bennington	Shiawassee County	1,504
Durand Road over Northwood Creek	New Lothrop	Shiawassee County	1,409
Lehring Road over Shiawassee River	Union Plains	Shiawassee County	360
M-21 over Rush Creek	Kerby	State Michigan	9,700
Main Street over Holly Drain	Vernon	Vernon	1,209
Bennington Road over Shiawassee River	Shiawasseetown	Shiawassee County	1,096
Vernon Road over Porter Creek	Easton	Shiawassee County	135
Bath Road over Looking Glass River	Shaftsburg	Shiawassee County	910
Austin Road over Maple River	Burton	Shiawassee County	Closed

Source: Federal Highway Administration National Bridge Inventory

Flooding can have substantial and often severe impacts on electrical utilities, disrupting power generation, transmission, and distribution systems. The consequences of flooding on electrical utilities can vary depending on factors such as the depth and duration of the flooding and the type of infrastructure affected, and may include:

- Substation and Power Plant Damage: Floodwaters can inundate electrical substations and power plants, damaging critical equipment such as transformers, switchgear, and control systems. Substantial damage to these facilities can lead to prolonged outages.
- Electrical Equipment Short-Circuits: Water infiltration into electrical equipment can cause short-circuits, leading to equipment failure and potentially causing fires. This can result in widespread power outages and safety hazards.
- Transmission Line Disruptions: Floodwaters can impact the stability of transmission towers and lines. Structural damage or collapse of transmission infrastructure can disrupt the flow of electricity over long distances.
- Distribution Network Damage: Localized flooding can damage distribution infrastructure, including power lines, poles, and transformers. This can lead to outages in specific neighborhoods or communities.
- Transformer Submersion: Floodwaters can submerge transformers, which are critical components in power distribution. Submersion can cause these transformers to malfunction or fail, leading to service interruptions.
- Underground Cable Damage: Underground power cables can be damaged by flooding, especially in areas with subterranean infrastructure. Water infiltration can compromise cable insulation, leading to electrical faults and outages.
- Loss of Fuel Supply: Natural gas power plants may face challenges in maintaining a stable fuel supply if transportation routes are disrupted due to flooding.

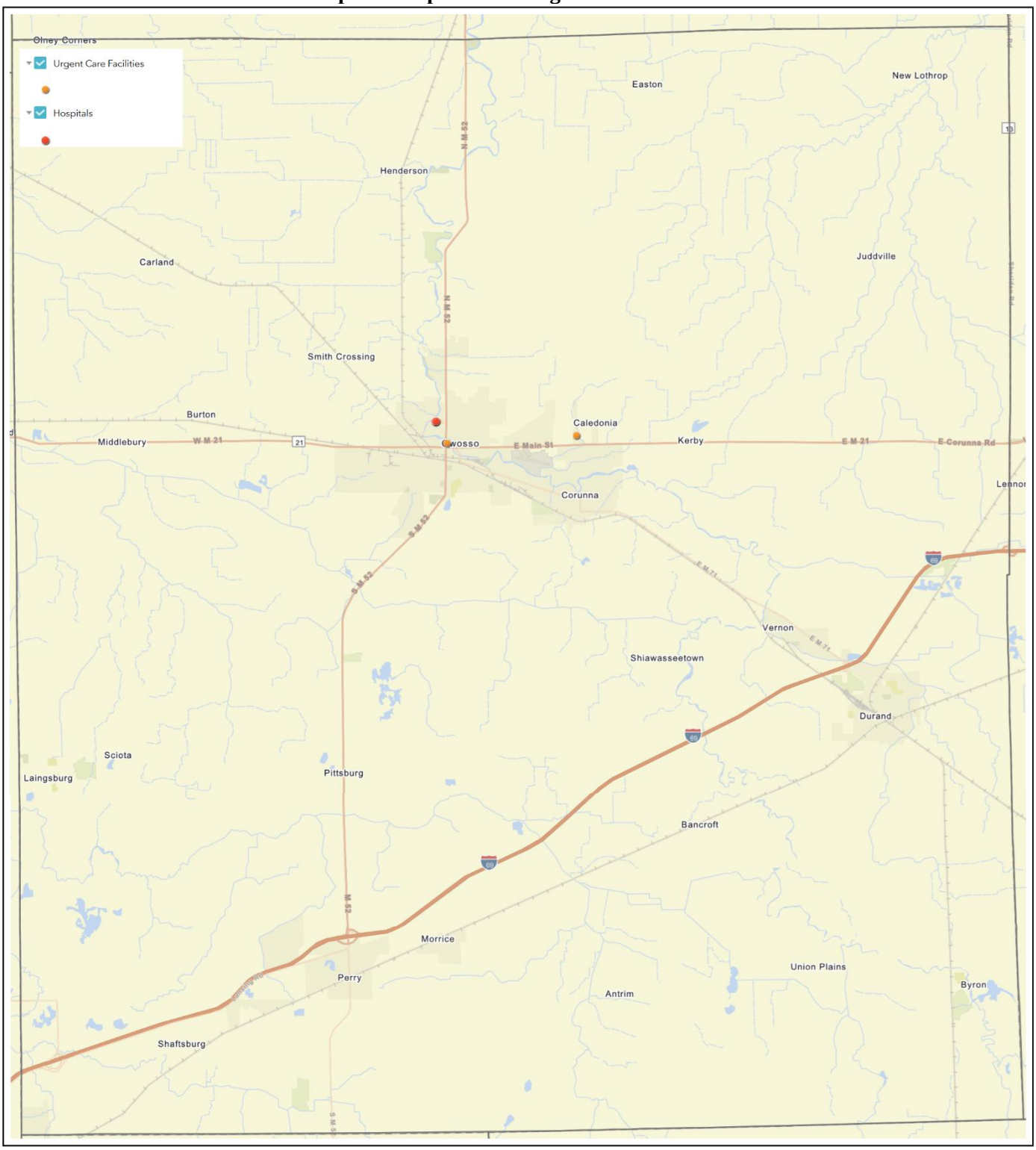
Details concerning electrical generating stations and high-capacity transmission lines can be found in Map 31, page 63.

The cost to replace electrical lines can vary widely based on several factors, including the type of electrical lines, the distance of the replacement, local labor and material costs, the complexity of the project, and any specific requirements or challenges involved. Additionally, costs can be significantly different for residential, commercial, or industrial projects. Additionally, urban and rural locations may have varying cost factors. As a rough estimate, the cost to replace electrical lines can range from a few thousand dollars to several thousand dollars per mile.

Major hospitals identified in Shiawassee County include the Memorial Healthcare Hospital in Owosso, with a total in-patient bed capacity of approximately 161 beds. Additionally, two urgent care facilities were identified within the county, with no in-patient beds, only out-patient treatment capabilities. While these medical facilities may see an

increase in flood related injuries during an event, it is considered unlikely that this increase will impact or overload capacity. The following map details the location of hospitals and urgent care facilities in Shiawassee County:

Map 42: Hospitals and Urgent Care Facilities



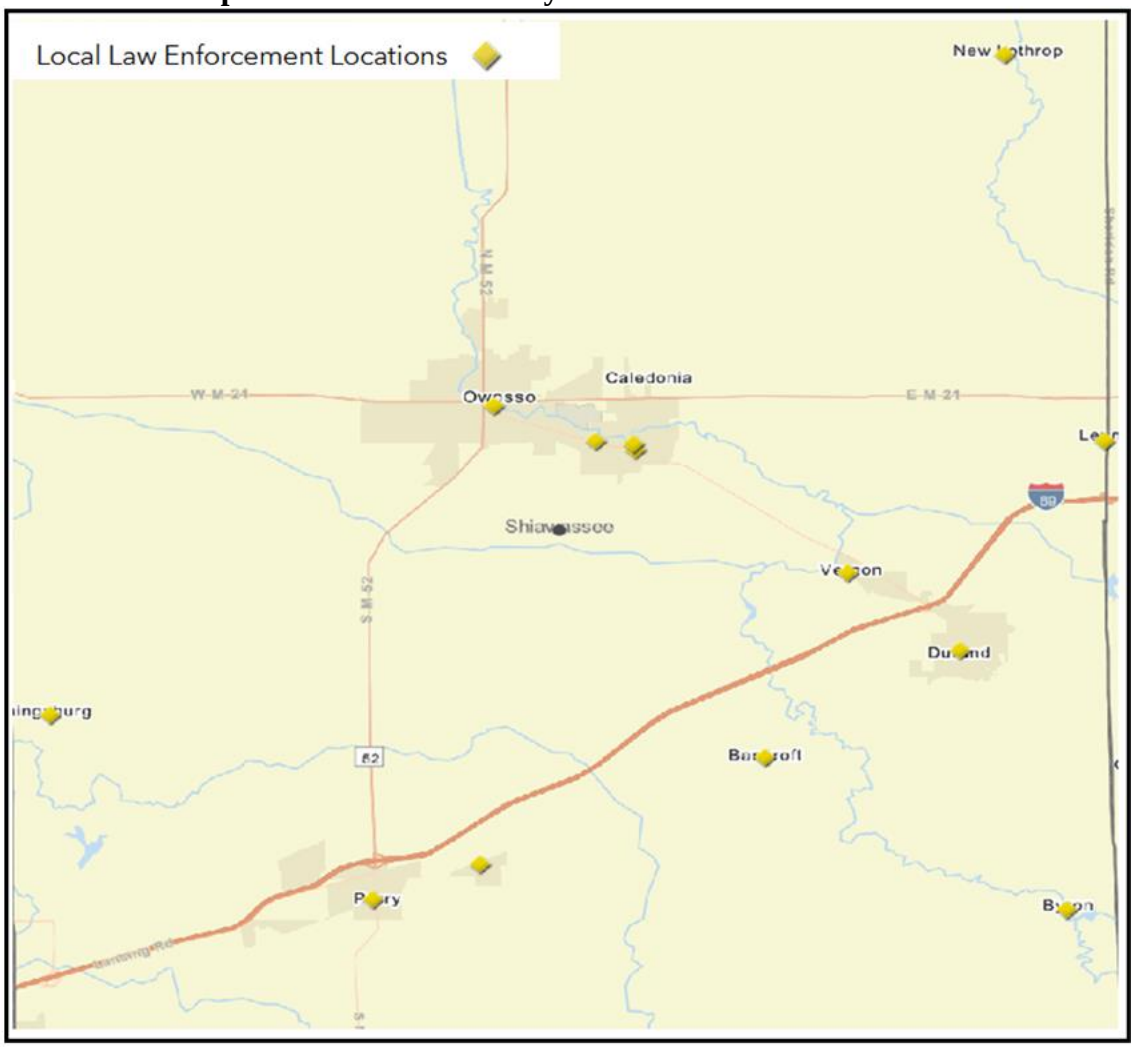
Source: FEMA RAPT

Flooding can significantly impact emergency response infrastructure, creating challenges for first responders and organizations involved in managing and mitigating the effects. Flooding can impact emergency response through:

- Transportation Disruptions: Water and debris accumulation on roads can hinder the ability of emergency vehicles to navigate and reach affected areas promptly. Hazardous road conditions may result in delays in response times.
- Communication Disruptions: Flooding can disrupt communication networks, affecting the ability of emergency responders to coordinate and communicate effectively. Downed power lines and damage to communication infrastructure contribute to these disruptions.
- Resource Allocation Challenges: Flood events often require the allocation of additional resources, including personnel, equipment, and supplies, to address immediate needs. This can strain emergency response organizations and impact their ability to respond to other concurrent incidents.
- Logistical Challenges: Flood events may create logistical challenges for the transportation of supplies, equipment, and personnel to affected areas, hindering the overall effectiveness of emergency response efforts.

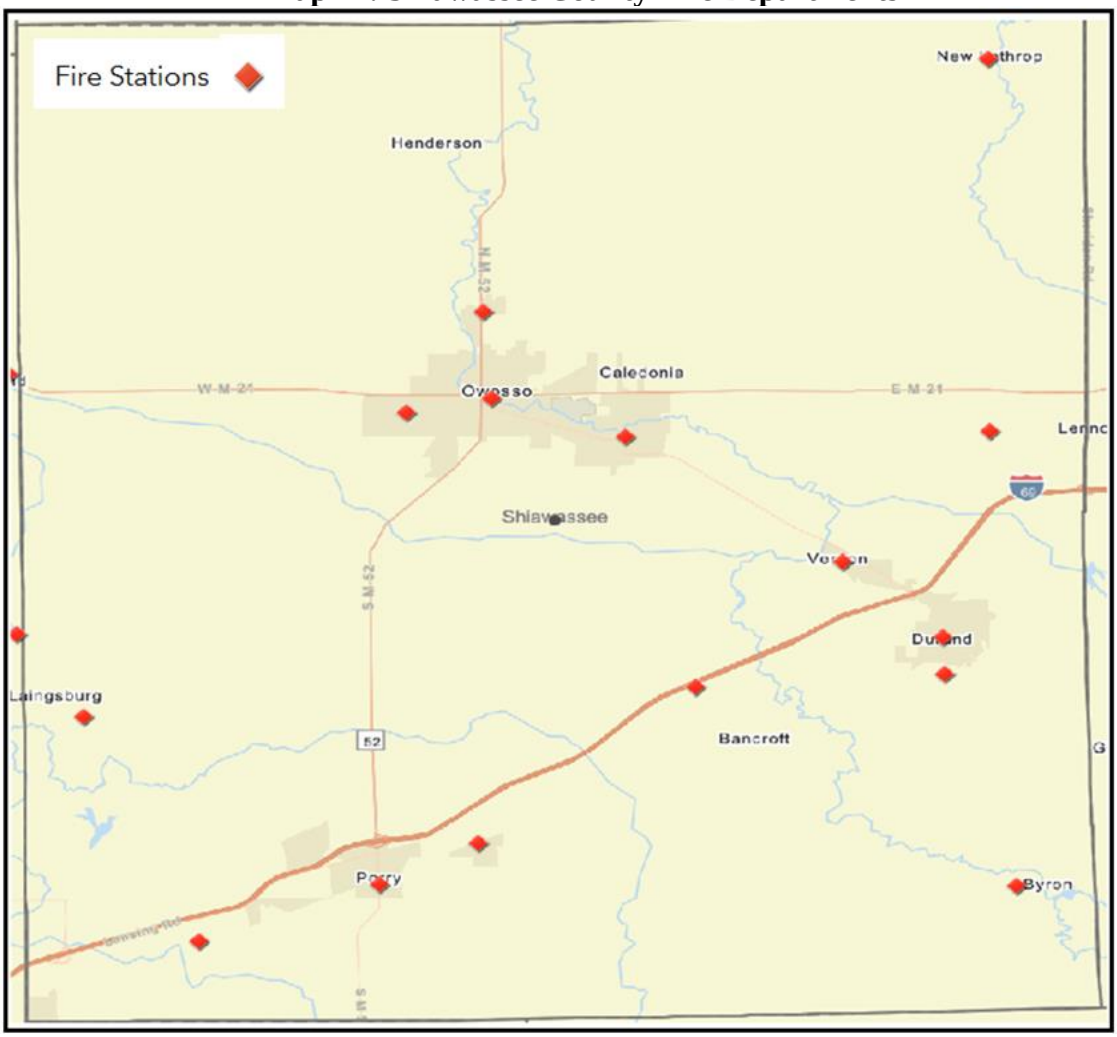
The following maps detail law enforcement and fire station locations throughout Shiawassee County:

Map 43: Shiawassee County Law Enforcement Locations



Source: FEMA RAPT

Map 44: Shiawassee County Fire Departments



Source: FEMA RAPT

Consequence Analysis

This consequence analysis lists the potential impacts of a hazard on various elements of community and state infrastructure. The impact of each hazard is evaluated in terms of disruption of operations, recovery challenges, and overall wellbeing to all Shiawassee County residents and first responder personnel. The consequence analysis supplements the hazard profile by analyzing specific impacts.

Table 40: Flood Consequence Analysis

Subject	Potential Impacts
Impact on the Public	Significant flooding events can lead to the damage and loss of homes, property, and businesses. Flash flooding and excessive rainfall may lead to dangerous conditions on roadways. Closures of medical facilities is a major public health concern if flooding damages those facilities. Water sources may become contaminated, and water or sewer systems may be disrupted. Vector-associated disease may increase.
Impact on Responders	Responders may be called on to evacuate people from impacted areas, close roads, and attend to the injured. Responders may face challenges with transportation. Flash floods can also injure responders, as well as delay response operations.
Continuity of Operations	Local jurisdictions maintain continuity plans which can be enacted as necessary based on the situation. Floods which create power outages, debris damage, and road closures are not uncommon. This threat may impact an agency's ability to maintain operations.

Table 40: Flood Consequence Analysis

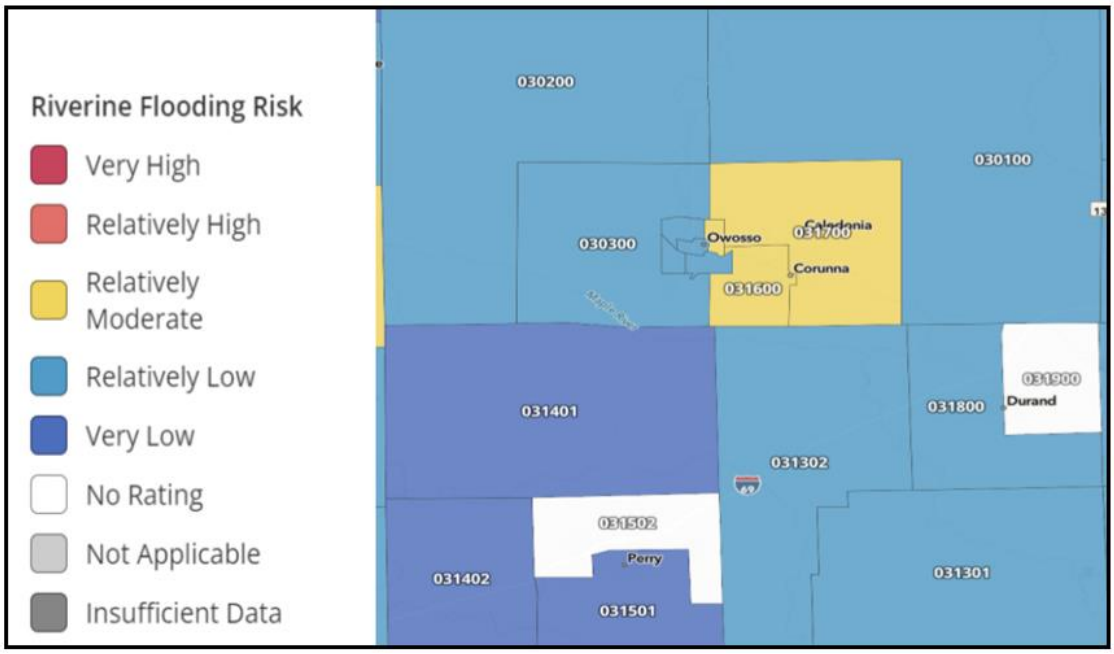
Subject	Potential Impacts
Delivery of Services	Flooding can cause road and bridge closures, as well as disrupt transit services, impacting the ability to deliver goods and services. Exposure to flood waters may also damage or destroy physical goods such as food, clothing, and hygiene products.
Property, Facilities, and Infrastructure	Flooding can cause significant property destruction. Floods can disrupt normal daily activities due to the potential impact on schools, hospitals, and other public infrastructure. Transportation infrastructure can be damaged which could impact the freedom of movement or provision of utilities. Water sources can become contaminated. Water and sewer systems may be disrupted. Solid-waste collection and disposal may also be impacted, causing dangerous public health risks.
Impact on Environment	Rising waters from flooding impact the environment by spreading pollution, inundating water and wastewater treatment plants, and disrupting wildlife. Standing water following a flood event can facilitate the spread of vector-associated diseases.
Economic Conditions	Significant and repeated flooding can lower property value throughout the state, which can have a deleterious effect on the tax base. Furthermore, flooding drains response resources, which can be costly during a large flooding event for disaster reimbursement
Public Confidence in Governance	Ineffective flooding response can decrease the public's confidence in the ability to respond and govern. Multi-level government response requires direct actions that must be immediate and effective to maintain public confidence. Efficiency in response and recovery operations is critical in keeping public confidence high.

4.10.7 Jurisdictional Risk and Vulnerability

To help understand the risk and vulnerability to drought conditions of participating jurisdictions mapping from the FEMA NRI was run on a census tract level. As the NRI does not generate mapping for individual jurisdictions, census tract analysis is the closest analogue available to understand individual jurisdiction conditions.

Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following map was created indicating the potential risk to participating jurisdictions from flooding:

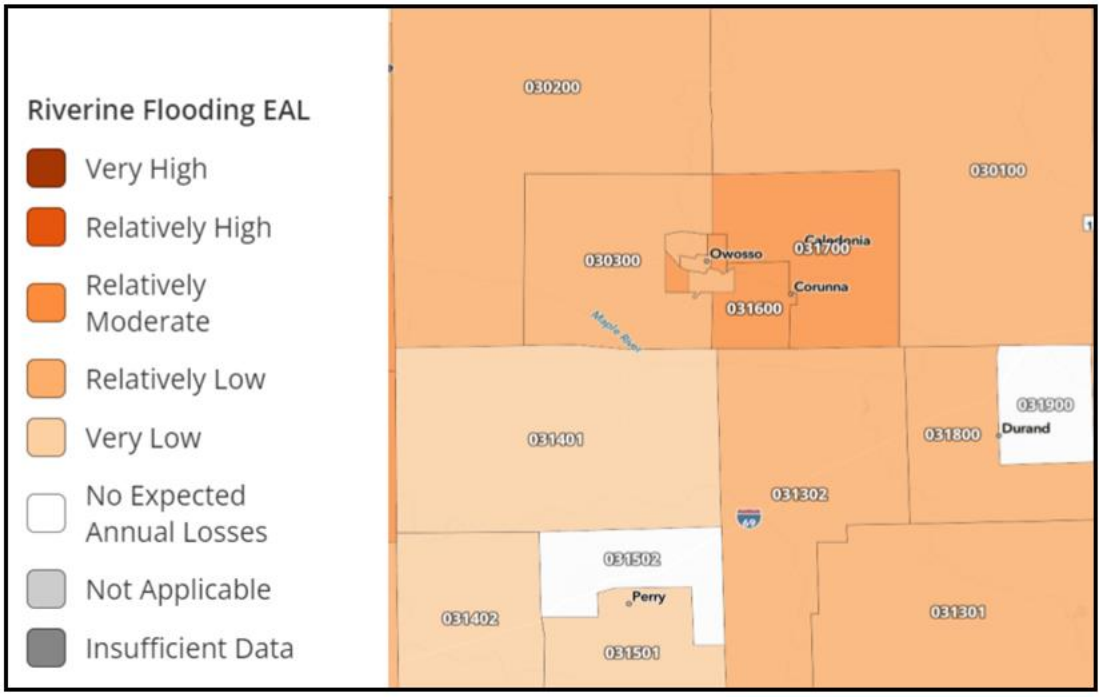
Map 45: FEMA NRI Jurisdictional Riverine Flood Risk



Source: FEMA NRI

As part of the NRI, EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following map indicates the EAL for flooding for participating jurisdictions within Shiawassee County:

Map 46: FEMA NRI Jurisdictional Flood EAL



Source: FEMA NRI

The following table indicates the FEMA NRI and EAL analysis for flood for each participating Shiawassee County jurisdiction:

Table 41: Shiawassee County FEMA EAL and NRI for Flood

Jurisdiction	EAL	Risk Index
Shiawassee County	Relatively Low	Relatively Low
City of Durand	No Expected Annual Losses	No Expected Annual Losses
City of Laingsburg	Very Low	Very Low
City of Owosso	Relatively Low	Relatively Moderate
City of Perry	Very Low	Very Low
Township of Owosso	Relatively Low	Relatively Moderate

A GIS analysis of FEMA's identified SFHAs allowed for an understanding of the valuation of potentially at-risk structures. Please note that no school facilities were identified in SFHAs.

Table 42: Shiawassee County Riverine Flood Vulnerable Structures

Residential	Commercial	Governmental	Industrial
$990,234,000	$609,554,000	$22,663,000	$56,488,000

Note: Calculations completed based on 2017-dollar valuations

Mapping for jurisdictional facilities in identified flood plains is included above.

4.10.8 National Flood Insurance Program Communities

The NFIP is a federal program, managed by FEMA, that exists to provide flood insurance for property owners in participating communities, to improve floodplain management practices, and to develop maps of flood hazard areas. The following table presents NFIP participating communities.

Table 43: Shiawassee County NFIP Communities

Community	Initial Flood Hazard Boundary Map Identified	Initial Flood Insurance Rate Map Identified	Current Effective Map Date
Shiawassee County	-	-	-
City of Corunna	9/19/1975	1/17/1986	9/29/2011
City of Durand	-	-	-
City of Laingsburg	-	9/29/2011	NSFHA
City of Owosso	9/26/1975	03/01/1982	9/29/2011
City of Perry	-	-	-
Township of Bennington	-	9/29/2011	9/29/2011 (M)
Township of Burns	-	12/19/1996	9/29/2011 (M)
Township of Caledonia	1/3/1975	5/17/1982	9/29/2011
Township of Hazelton	-	11/5/1997	9/29/2011
Township of New Haven	7/25/1975	4/1/1988	9/29/2011 (M)
Township of Owosso	-	10/20/1999	09/29/2011
Township of Rush	08/08/1975	02/01/1986	9/29/2011 (M)
Township of Shiawassee	10/10/1975	07/03/1986	9/29/2011 (M)
Township of Venice	-	9/29/2011	9/29/2011 (M)
Township of Vernon	-	09/29/2011	09/29/2011

Note: (M): No Elevation Determined - All Zone A, C and X
Note: NSFHA: No Special Flood Hazard Area

Additionally, the NFIP's Community Rating System (CRS) incentive rewards communities for the work they do managing their floodplains. Eligible communities that qualify for this voluntary program go above the minimum NFIP requirements and can offer their citizens discounted flood insurance in both SFHAs areas and non-SFHA areas. No Shiawassee jurisdictions currently participate in the CRS program.

4.10.9 FEMA Flood Policy Data

Shiawassee County flood policy information was sourced from FEMA's Flood Insurance Data and Analytic, Shiawassee County, and the State of Michigan. The number of flood insurance policies in effect may not include all structures at risk to flooding, and some properties are under-insured. The flood insurance purchase requirement is for flood insurance in the amount of federally backed mortgages, not the entire value of the structure. Additionally, contents coverage is not required. The following table shows the details of NFIP policy statistics for Shiawassee County.

Table 44: Shiawassee Policy and Loss Statistics

Jurisdiction	Number of Policies in Force	Total Coverage
City of Corunna	21	$3,195,800
City of Owosso	75	$7,323,700
Township of Burns	3	$562,500
Township of Caledonia	45	$4,979,700
Township of Hazelton	1	$350,000
Township of New Haven	1	$70,000
Township of Owosso	3	$586,500
Township of Rush	1	$183,000

Table 44: Shiawassee Policy and Loss Statistics

Jurisdiction	Number of Policies in Force	Total Coverage
Township of Vernon	1	$140,000

Source: FEMA Flood Insurance Data and Analytic, Shiawassee County, State of Michigan

Data concerning policies and total coverage for Shiawassee County was not presented in the last version of this LHMP, and historic data concerning coverage was unavailable through FEMA. As such direct trends in coverage could not be calculated. However, data concerning NFIP polices and coverage for the State of Michigan for the latest 12-month rolling period indicates that coverage has been declining throughout the state.

4.10.10 Repetitive Loss Structures

A high priority for Shiawassee County is the reduction of losses to Repetitive Loss (RL) and Severe Repetitive Loss (SRL) structures. The NFIP defines a RL property as:

- Any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. At least two of the claims must be more than 10 days apart.

The definition of severe repetitive loss as applied to this program was established in section 1361A of the National Flood Insurance Act, as amended, 42 U.S.C. 4102a. An SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both of the above, at least two of the referenced claims must have occurred within any ten-year period and must be greater than ten days apart.

Shiawassee County has no identified as RL or SRL properties.

4.11 Severe Weather

4.11.1 Hazard Description

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

This plan defines severe thunderstorms as a combination of the following severe weather effects as defined by NOAA and the National Weather Service (NWS).

- **Hail:** Precipitation in the form of irregular pellets or balls of ice more than 5 mm in diameter, falling from a cumulonimbus cloud.
- **Lightning:** A visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground or between the ground and a cloud.
- **Thunderstorm Winds:** The same classification as high or strong winds but as Companies a thunderstorm. It is also referred to as a straight-line wind to differentiate from rotating or tornado associated wind. Additionally, these winds can rapidly create dust storms that severely impact visibility.

Severe thunderstorms have been so consistent throughout modern history that much of the vulnerability is mitigated. However, this section is not concerned with everyday wind, lightning in the sky, or mild precipitation. This section is concerned with common storm elements when they behave such that they pose a threat to property and life.

4.11.2 – Location and Extent

Severe weather can rapidly descend on an area, but in many cases are predictable. Most weather forecasts focus on more than just temperature but on quickly changing conditions that may lead to the onset of severe storms. All of Shiawassee County is susceptible to severe thunderstorms.

The NWS classifies thunderstorms, often the generator of hail, lightning and high winds, using the following categories.

- **Marginal:** Isolated severe thunderstorms, limited in duration and/or coverage and/or intensity
- **Slight:** Scattered severe storms possible, short-lived and/or not widespread, isolated intense storms possible
- **Enhanced:** Numerous severe storms possible, more persistent and/or widespread, a few intense
- **Moderate:** Widespread severe storms likely, long-lived, widespread and intense
- **High:** Widespread severe storms expected, long-lived, very widespread and particularly intense

Additionally, the combination of hot and humid weather conditions can cause a specific type of severe thunderstorm known as a derecho. A derecho is a widespread, long-lived windstorm associated with rapidly moving thunderstorms. Derechos are generally defined by the following parameters:

- Wind gusts of at least 58 mph or greater along most of its length
- Wind damage extends in a line greater than 240 miles

Derechos can produce destruction similar to tornadoes.

In the United States, hail causes billions of dollars in damage to property, crops and livestock each year. Because of the large agricultural industry in Shiawassee County, crop damage and livestock losses due to hail are a concern. Vehicles, roofs of buildings and homes, and landscaping are the other things most commonly damaged by hail. Hail has been known to cause injury and the occasional fatality to humans, often associated with traffic accidents.

Based on information provided by the National Weather Service concerning size, the following table describes potential damage impacts of the various sizes of hail.

Table 45: Hail Size Comparison and Damage Descriptions

Diameter (inches)	Size Description	Potential Damage Impacts
1/4	Pea Size	No damage
1/2	Mothball, peanut, USB Plug	Slight damage to vegetation
3/4	Penny Size	Increased damage to crops and vegetation
7/8	Nickel Size	Severe damage to crops and vegetation, damage begins to glass and plastic
1	Quarter Size	Increased glass damage, damage begins to bodies of vehicles
1 1/4	Half Dollar Size	Large scale glass damage, begin roof damage, risk of injury to exposed persons
1 1/2	Ping Pong Ball Size	Large scale glass damage, begin roof damage, increased risk of injury to exposed persons
1 3/4	Golf Ball Size	Severe roof damage, risk of serious injuries to exposed persons
2	Lime or medium sized Hen Egg	Potential structural damage, risk of very severe injuries to exposed persons
2 1/2	Tennis Ball Size	Extensive structural damage, risk of very severe injuries or death to exposed persons

Source: National Weather Service

A recent report by the Insurance Information Institute says lightning strikes caused $1,300,000,000 in damage across the United States in 2021. There is currently no scale to indicate the severity of a lightning strike, but data from NOAA indicates that there approximately 25 million cloud-to-ground lightning strikes per year in the United States.

To measure wind speed and its correlating potential for damage, experts use the Beaufort scale as shown below.

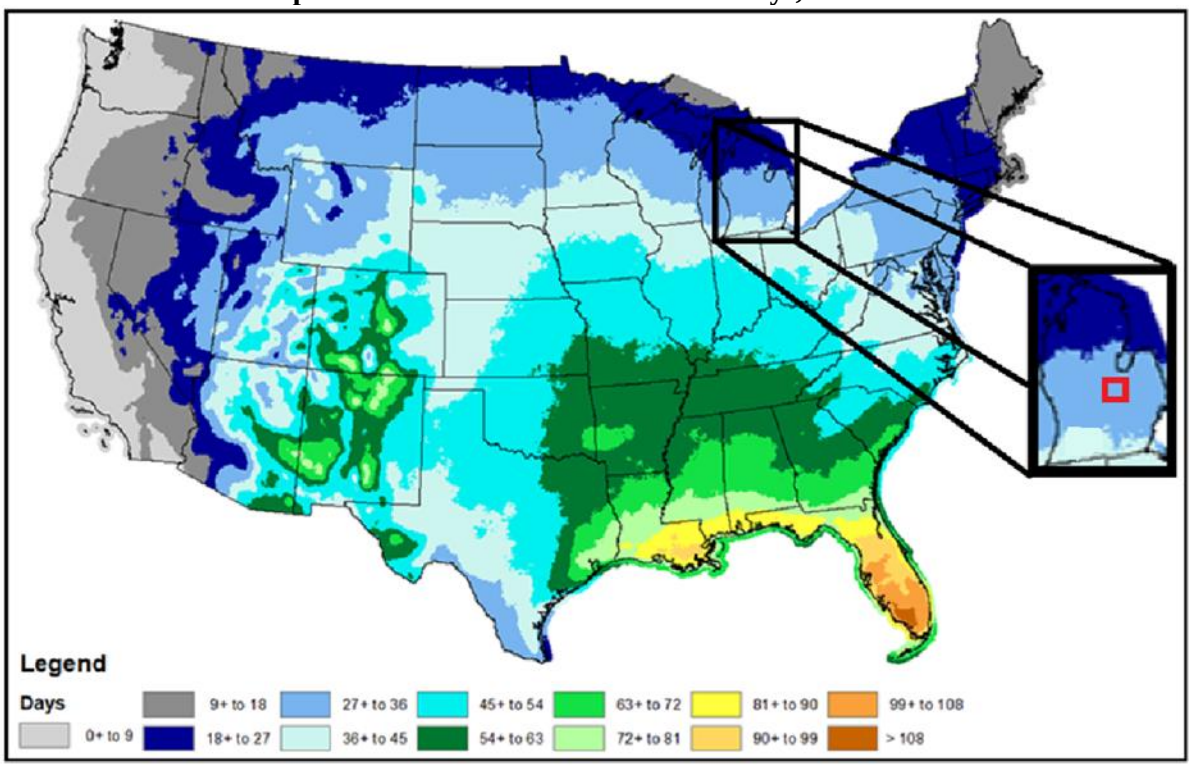
Table 46: Beaufort Scale

Beaufort Number	Wind Speed (mph)	Effects on Land
0	Under 1	Calm, smoke rises vertically
1	1-3	Smoke drift indicates wind direction, vanes do not move
2	4-7	Wind felt on face, leaves rustle, vanes begin to move
3	8-12	Leaves, small twigs in constant motion. Light flags extended.
4	13-18	Dust, leaves and loose paper raised up; small branches move
5	19-24	Small trees begin to sway
6	25-31	Large branches of trees in motion, whistling heard in wires
7	32-38	While trees in motion, resistance felt in walking against the wind
8	39-46	Twigs and small branches broken off trees
9	47-54	Slight structural damage occurs, slate blown from roofs
10	55-63	Seldom experienced on land, trees broken, structural damage occurs
11	64-72	Very rarely experienced on land, usually with widespread damage
12	73 or higher	Violence and destruction

Source: NOAA

The widespread and frequent nature of severe weather makes hail, lightning, and high wind a relatively common occurrence for Shiawassee County. The following map, from NOAA, indicates annual mean thunderstorm days from 1993 to 2018

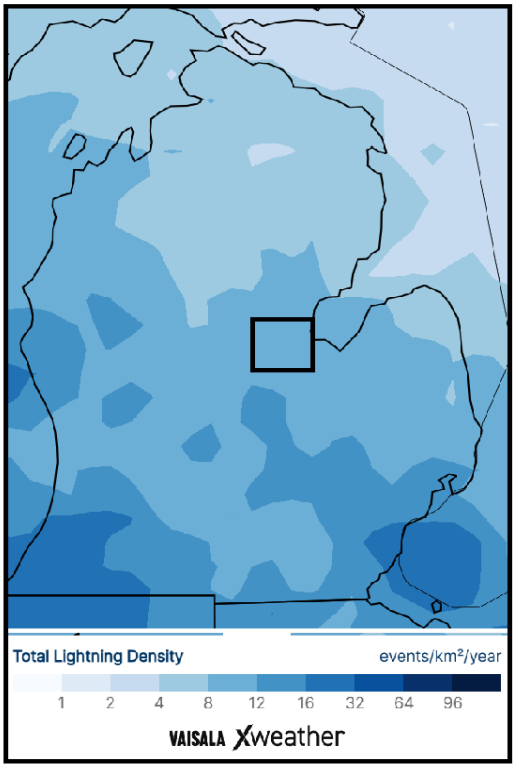
Map 47: Annual Mean Thunderstorm Days, 1993-2018



Source: NOAA

The following map, from Vaisala, indicates the average annual light events per square kilometer per year for Shiawassee County.

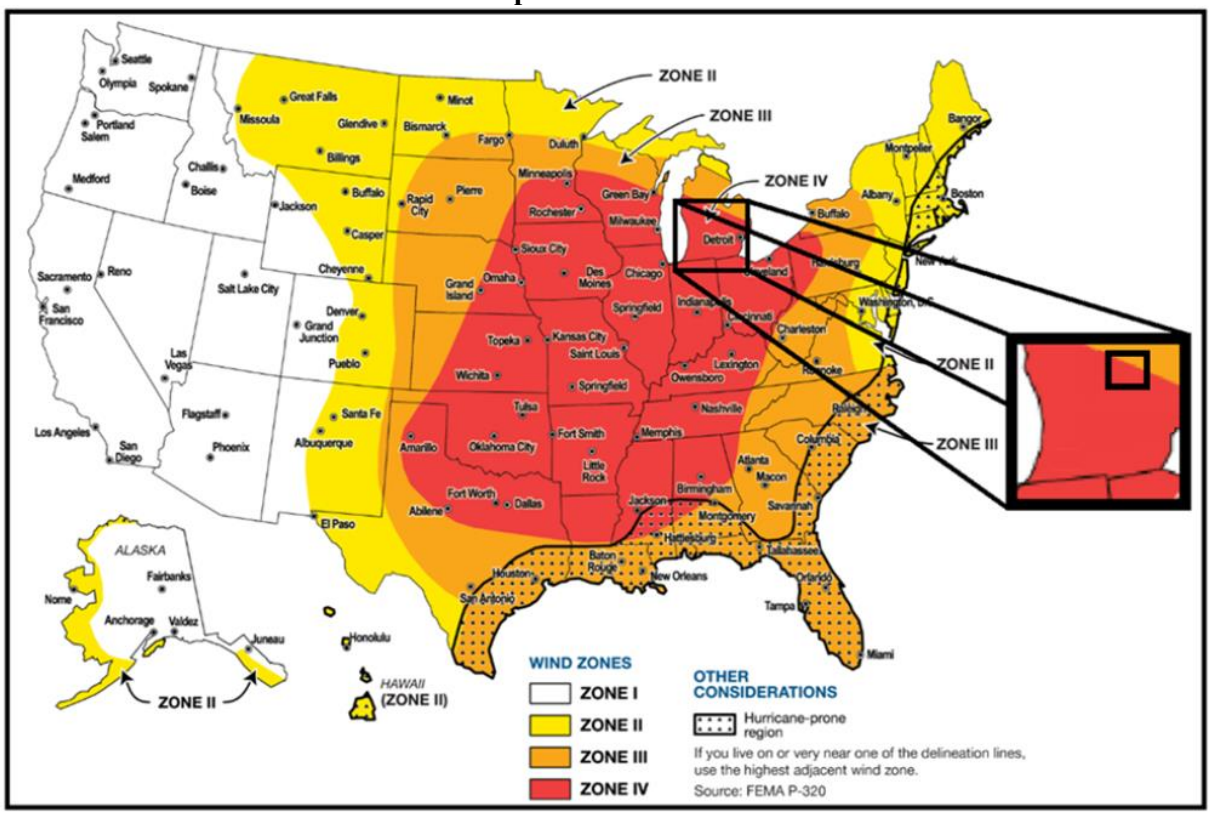
Map 48: Average Annual Lightning Events per Square Kilometer per Year, 2016 - 2022



Source: Vaisala

The following map illustrates wind zones for the United States. As indicated on the map, Shiawassee County is in zone IV, the highest category, with up to 250 miles per hour possible.

Map 49: Wind Zones



Source: National Institute of Standards and Technology

4.11.3 Previous Occurrences

Historical events of significant magnitude or impact can result in a Presidential Disaster Declaration. The following table details Disaster Declarations for Shiawassee County for severe weather events from 1953 - 2023:

Table 47: Shiawassee County Presidentially Declared Disasters

Designation	Declaration Date	Incident Type	Assistance	Mitigation Grants
DR-1527-MI	06/30/2004	Severe Storms	$41,320,558	-
DR-1226-MI	06/24/1998	Severe Storms	-	-
DR-495-MI	03/19/1976	Severe Storms	-	-

Source: FEMA

The following table presents NCEI identified severe weather events and the resulting damage totals in Shiawassee County from 1950 to 2023. Please note that as severe weather events tend to cover larger areas occurrence data is being presented as representative of all participating jurisdictions.

Table 48: Shiawassee County NCEI Severe Thunderstorm Events, 1950-2023

Event Type	Number of Days with Events	Property Damage	Deaths and Injuries
Hail	43	$2,800,000	0
Lightning	6	$225,000	1
Thunderstorm Winds	134	$1,596,000	0

Source: NCEI

The following provides both local accounts and NCEI descriptions of notable recorded events:

- **July 26, 2007, Durand:** Extreme intensity of large hail pounded areas in a 3-mile radius around the city of Durand. Severe hail the size of golf balls fell for nearly an hour. Hundreds of homes and vehicles suffered significant damages totaling nearly 5 million dollars in this area alone. Damages estimated at 2.8 million.

4.11.4 Probability of Future Events

Predicting the probability of severe weather occurrences is tremendously challenging due to the large number of factors involved and the random nature of formation. Data from the NCEI indicates that Shiawassee County, can expect on a yearly basis, relevant to severe weather events:

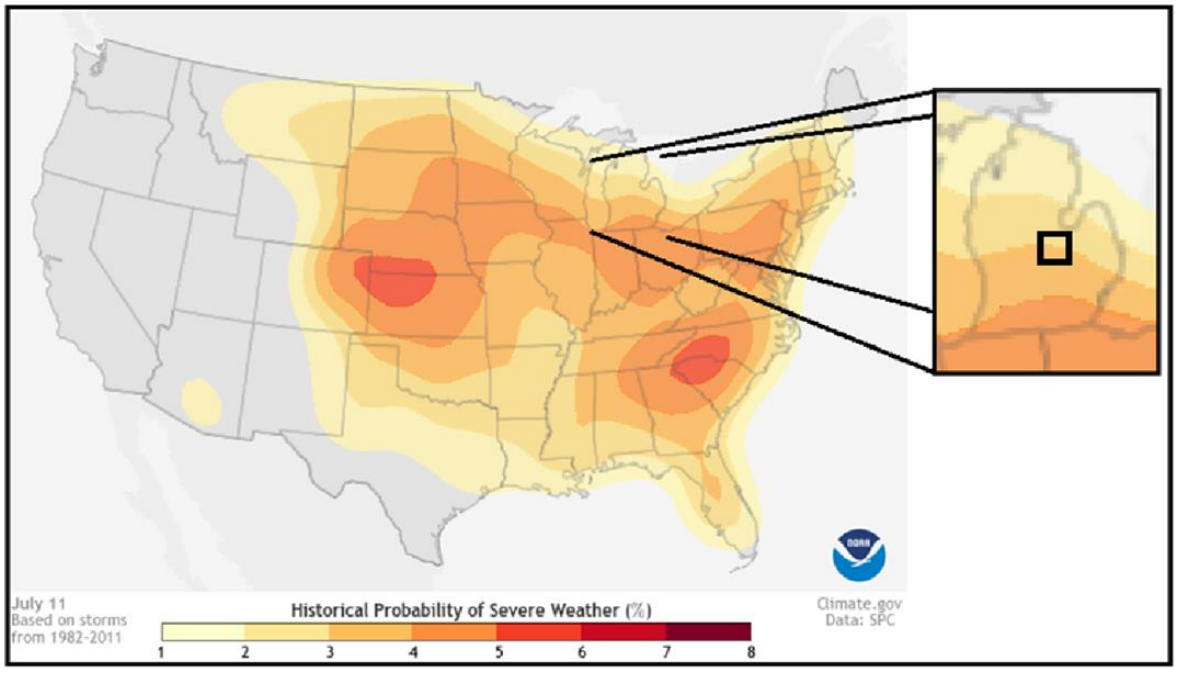
Table 49: Shiawassee County and Participating Jurisdictions Severe Weather Probability Summary

Data	Days
Number of Days with NCEI Reported Event (1950-2023)	183
Average Events per Year	3

Source: NCEI

Data from NOAA indicates that Shiawassee County can expect between 27 to 36 weather events per year. Additionally, the following map from NOAA provides a probability snapshot for the probability of a severe weather event on a summer day.

Map 50: Historic Probability of a Severe Weather Summer Event in Shiawassee County



Source: NOAA

4.11.5 Projected Changes in Location, Intensity, Frequency, and Duration

Climate change can have several impacts on severe weather, although the precise details can vary depending on regional climate patterns and other factors. In general, it is believed that climate change can alter the timing and seasonality of severe weather. In some cases, this may mean more severe weather occurring earlier or later in the year.

Climate change can lead to increased temperatures and moisture levels in the atmosphere, which can provide favorable conditions for the development of severe weather. This can result in a higher frequency of severe weather events and an increase in their intensity. As a result of increased temperatures, warmer air can hold more moisture, leading to increased rainfall during severe weather. This can elevate the risk of flash flooding, particularly in areas prone to heavy

precipitation. Changes in atmospheric circulation patterns associated with climate change can lead to stronger winds, which can result in more powerful gusts, increasing the risk of wind damage and downed trees and power lines.

Climate change can influence the conditions necessary for hail formation. Warmer temperatures at the surface and greater instability in the atmosphere can contribute to larger and more damaging hailstones. Additionally, changes in atmospheric conditions can affect the frequency and distribution of lightning strikes associated with thunderstorms. More lightning can increase the risk of wildfires in dry regions.

It is important to note that while there is evidence linking climate change to changes in weather patterns that can influence severe weather, predicting specific events remains challenging. Climate models provide valuable insights into long-term trends, but individual thunderstorm events are influenced by a complex interplay of factors.

As indicated in the data above, Shiawassee County and all participating jurisdictions have been seeing generally declining populations. A declining population could decrease population risks to severe weather by nature of their being fewer citizens to negatively impact.

Shiawassee County's current land-use regulations require the consideration of building codes during the development review process. A building-by-building structural review, including roof profile, type and strength of windows, and foundation systems would need to be considered to determine structural risk. However, enforced building codes can ensure that newly built and renovated structures can withstand all but the most extreme weather incidents.

The agriculture base of Shiawassee County is increasingly vulnerable to the effects of severe weather. Future development of agricultural resources would tend to increase the risk and impact of an event. As indicated in the data above, Shiawassee County is seeing an increase in the market value of agricultural goods sold, and thus a potential greater future vulnerability.

4.11.6 Vulnerability and Impact

Data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to severe weather events:

Table 50: Shiawassee County Severe Thunderstorm Impact Summary

Data	Recorded Impact
Deaths or Injuries (1950-2023)	1
Average Number of Deaths or Injuries	<1
Total Reported NCEI Property Damage (1950-2023)	$4,621,000
Average Property Damage per Year	$87,189

Source: NCEI

Please note that damages and injuries, as represented above, are not broken down into participating jurisdictions due to the random and widespread nature of occurrence.

Data from HAZUS was used to provide a county building stock valuation. This data was then compared to NCEI structural damage figures to determine the percentage of impacted building within the county for the period of 2003-2022 for each severe storm component. Data was only available at a county level.

Table 51: Shiawassee County Severe Storm Percentage Loss Data

Hazard	HAZUS Valuation	NCEI Structure Damage, 1950-2023	Percentage of Building Valuation Damaged
Hail	$11,130,400,000	$2,800,000	0.03%
Lightning	$11,130,400,000	$225,000	0.002%
Wind	$11,130,400,000	$1,596,000	0.01%

Source: NCEI and Shiawassee County

Severe weather can have a wide range of effects on people, often posing significant risks to life, property, and general well-being. In the absence of proper shelter, hail, lightning, and high winds can cause serious injury. In general, if potentially exposed persons take shelter in a solid, well-constructed structure protection from these severe weather components would be provided. However, old or poorly constructed facilities may be more prone to damage, potentially increasing the impact on economically disadvantaged populations. Some of the potential effects of severe weather on people may include:

- Death and Injury: Severe weather can produce lightning and wind driving debris. Both of these elements can cause injuries or fatalities.
- Power Outages: Lightning strikes, strong winds, and falling trees can lead to power outages, disrupting daily life, and potentially affecting essential services, such as medical equipment and refrigeration.
- Mental Health Impact: Severe weather can be frightening and stressful, leading to anxiety and post-traumatic stress disorder in some individuals. The emotional toll of property damage and loss can also be significant.
- Displacement: People may need to evacuate their homes or be temporarily displaced due to storm damage, requiring emergency shelter and support.
- Economic Costs: Severe thunderstorms result in economic costs, including repair and recovery expenses, insurance claims, and potential loss of income due to property damage or work disruptions.
- Public Safety Response: Severe weather can strain public safety resources, including emergency services, law enforcement, and medical facilities.

Data from the FEMA Hazus system indicates the total value of property within Shiawassee County is $11,130,400,000, all of which is vulnerable to severe weather. All facilities within Shiawassee County can be impacted by severe weather, including critical facilities. However, the location and construction of the facility will have a significant impact on the vulnerability. In general, older structures would be at higher risk of negative impacts. Some of the potential impacts include:

- Electrical Infrastructure Damage: Severe thunderstorms can damage electrical infrastructure, including power lines, transformers, and substations. This can result in widespread power outages, affecting homes, businesses, hospitals, and other critical facilities.
- Communication Disruptions: Thunderstorms can disrupt telecommunications infrastructure, including cell towers, data centers, and communication networks. This can impact emergency communication and coordination efforts.
- Transportation Disruptions: Heavy rain, strong winds, and flooding can damage roads, bridges, and transportation networks. This can lead to transportation disruptions, accidents, and delays, affecting the movement of goods and people.
- Airport Closures: Thunderstorms can force the closure of airports due to safety concerns, affecting air travel and cargo shipments.
- Water and Wastewater Systems: Severe storms can overwhelm water treatment plants and wastewater facilities, leading to contamination and water supply disruptions. Flooding can also damage water infrastructure.
- Critical Facilities: Hospitals, emergency response centers, and other critical facilities may be affected by power outages, flooding, and damage to infrastructure. This can impact the ability to provide essential services during and after the storm.
- Energy Generation: Thunderstorms can disrupt energy generation facilities, such as wind farms and solar installations, and damage conventional power plants. This can affect the availability of electricity.
- Safety Risks: Damage to infrastructure can pose safety risks to workers and the public. Fallen power lines, damaged buildings, and debris can be hazardous.

Severe weather can pose various risks to the environment. These risks can have both short-term and long-term impacts on natural ecosystems. Severe weather can produce heavy rainfall over a short period of time, leading to flash floods

and riverine flooding. This can result in soil erosion, damage to aquatic habitats, and the displacement of aquatic organisms. Large hailstones can damage crops, vegetation, and natural habitats. Hail can strip leaves from trees and plants, reducing their ability to photosynthesize and grow. It can also damage wildlife habitats. Severe thunderstorms often produce strong straight-line winds. These winds can uproot trees, damage forests, and disrupt animal habitats. They can also scatter debris and cause structural damage to buildings, which can lead to further environmental issues if hazardous materials are released. Lightning is a common occurrence in severe weather and can spark wildfires. These wildfires can have significant ecological impacts, including habitat destruction, loss of wildlife, and changes in the local ecosystem.

Hail events can cause significant agricultural impacts. The following map from the United States Department of Agriculture details total agricultural losses, by county, due to hail events from 1989 to 2021:

Map 51: Agricultural Losses Due to Hail Events, 1989 to 2021

Source: USDA

Severe weather can pose various risks to government operations, facilities, and assets. These risks can have significant economic and operational consequences, and can include:

- Structural Damage: High winds, hail, and tornadoes associated with severe weather can cause significant damage to government buildings and infrastructure. This can result in costly repairs and disruptions to government operations.
- Power Outages: Severe weather can lead to power outages by damaging electrical infrastructure such as power lines and substations. Government buildings may lose power, affecting critical operations and services.
- Flooding: Heavy rainfall during severe weather can lead to flooding, which can damage government buildings and disrupt operations. Flood damage may require extensive repairs and cleanup.
- Communication Disruptions: Lightning strikes can damage communication equipment, including telephone lines and computer systems. This can hinder communication between government agencies and the public.
- Transportation Disruptions: Severe weather can make roads impassable due to flooding or fallen trees. This can impact the ability of government employees to commute to work and can disrupt the delivery of goods and services.

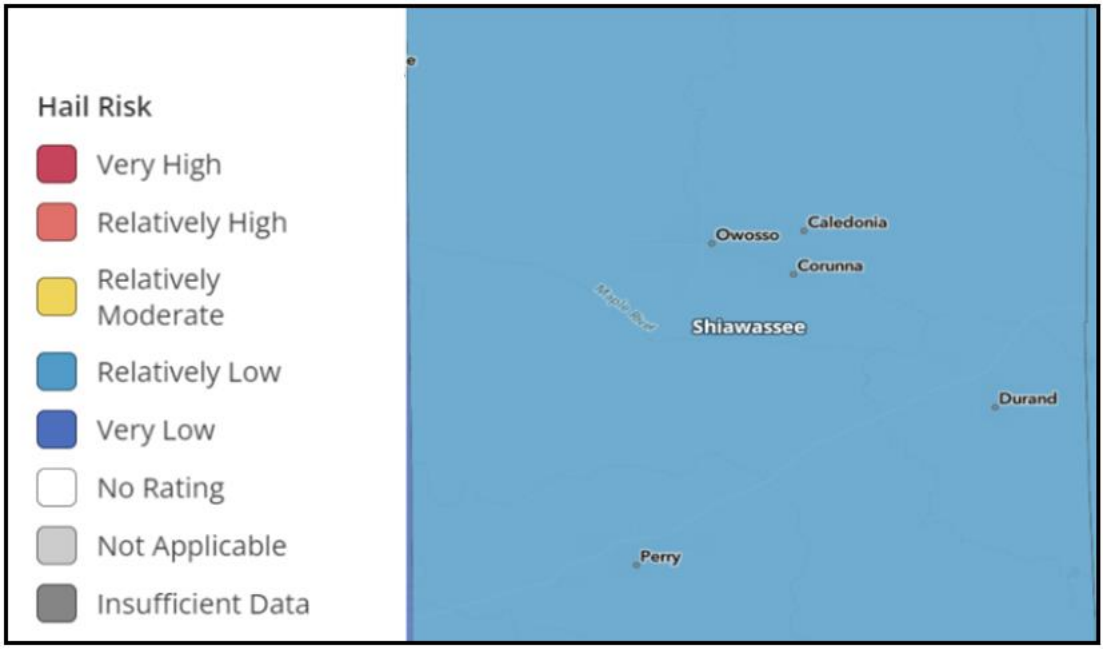
- Emergency Response: Severe weather may require the activation of emergency response plans. This can strain resources and personnel, especially if the storms lead to widespread damage or evacuations.
- Loss of Records and Data: Flooding or equipment damage can result in the loss of important records and data stored in government buildings. This can have legal and operational implications.
- Budgetary Impact: The costs associated with repairing and restoring government buildings and infrastructure after severe weather can strain budgets.

Structural vulnerability to hail is determined by construction and exposure. Metal siding and roofing is better able to stand up to the damage of a hailstorm than other materials, such as glass. Additionally, this damage can also impact personal vehicles, causing an economic impact. The vulnerability of infrastructural damage caused by wind is based largely on building construction and standards. Other factors, such as location, condition, and maintenance of trees also play a significant role in determining vulnerability.

Data from the FEMA Hazus system indicates the total value of government property within Shiawassee County is $142,910,000, all of which is vulnerable to severe thunderstorms.

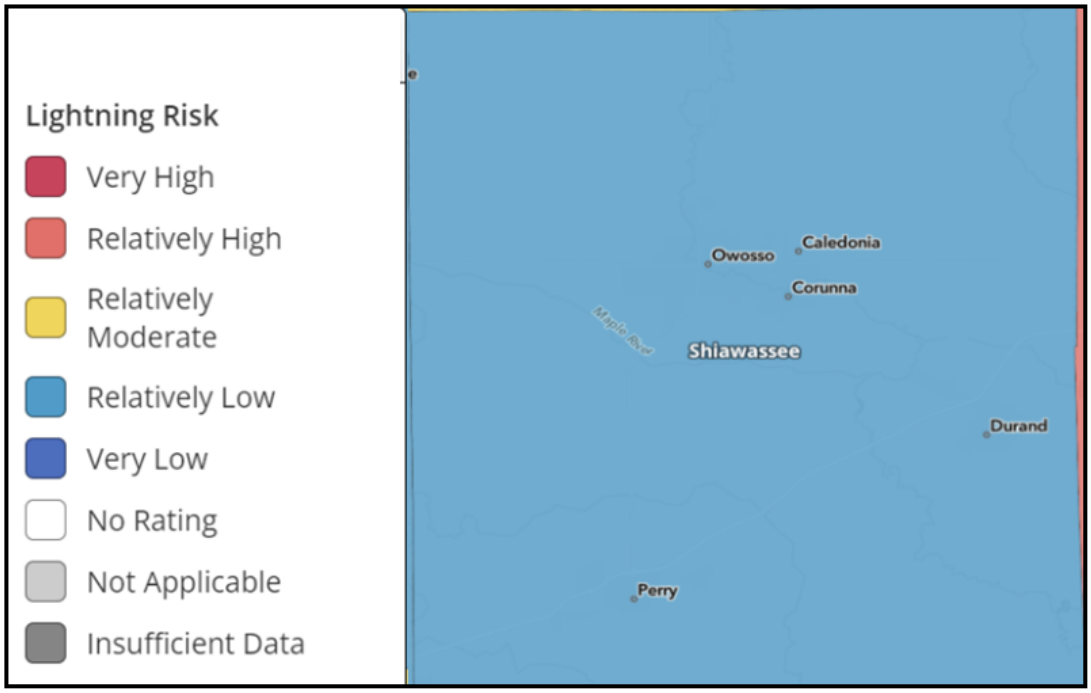
Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following maps were created indicating the potential risk to Shiawassee County from hail, lighting, and strong wind, the components of severe thunderstorms:

Map 52: FEMA NRI Hail Risk



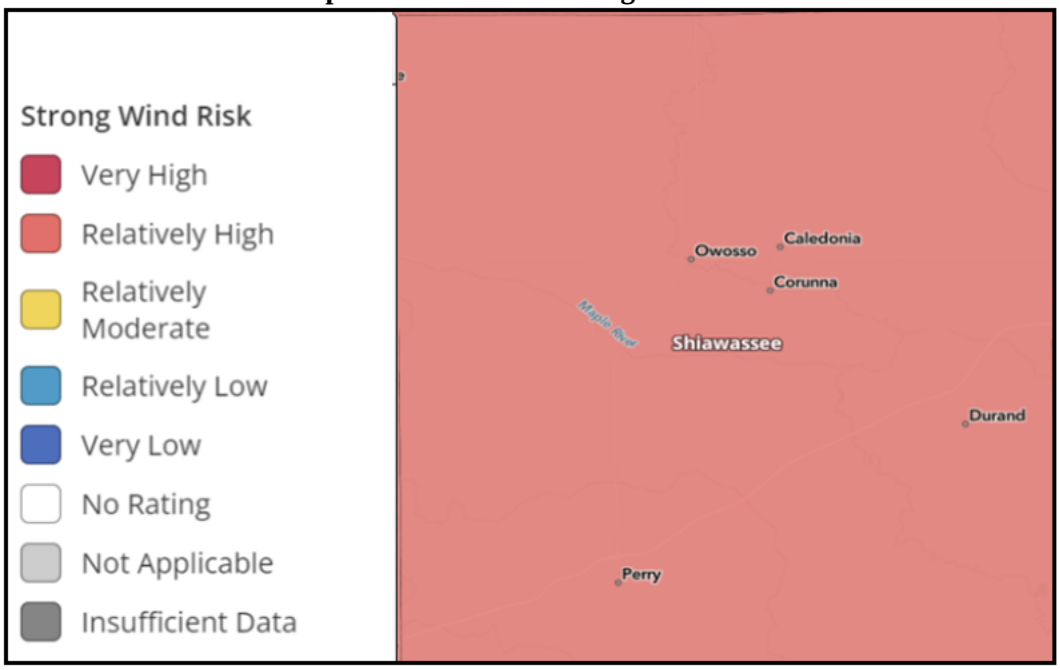
Source: FEMA NRI

Map 53: FEMA NRI Lightning Risk



Source: FEMA NRI

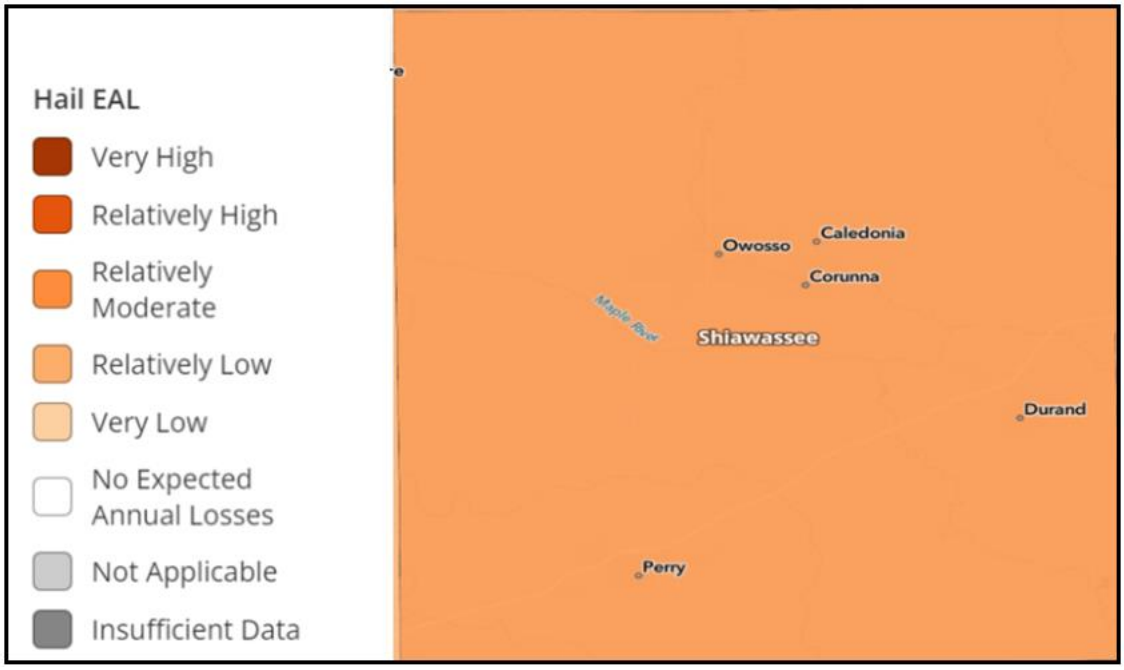
Map 54: FEMA NRI Strong Wind Risk



Source: FEMA NRI

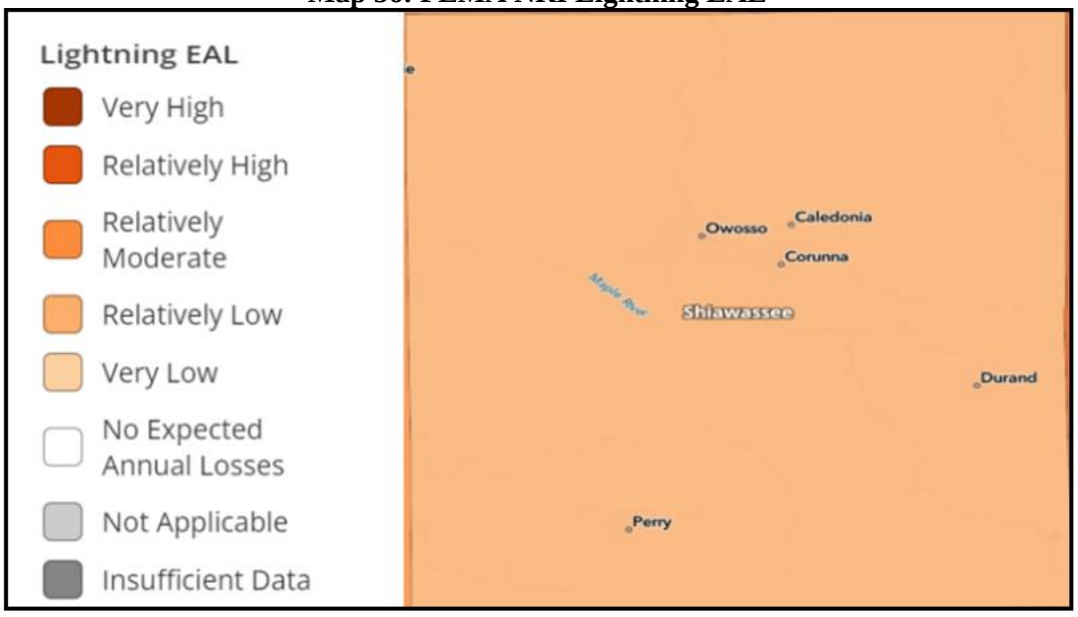
As part of the NRI, EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following maps indicate the EAL for hail, lightning, and strong wind for Shiawassee County:

Map 55: FEMA NRI Hail EAL



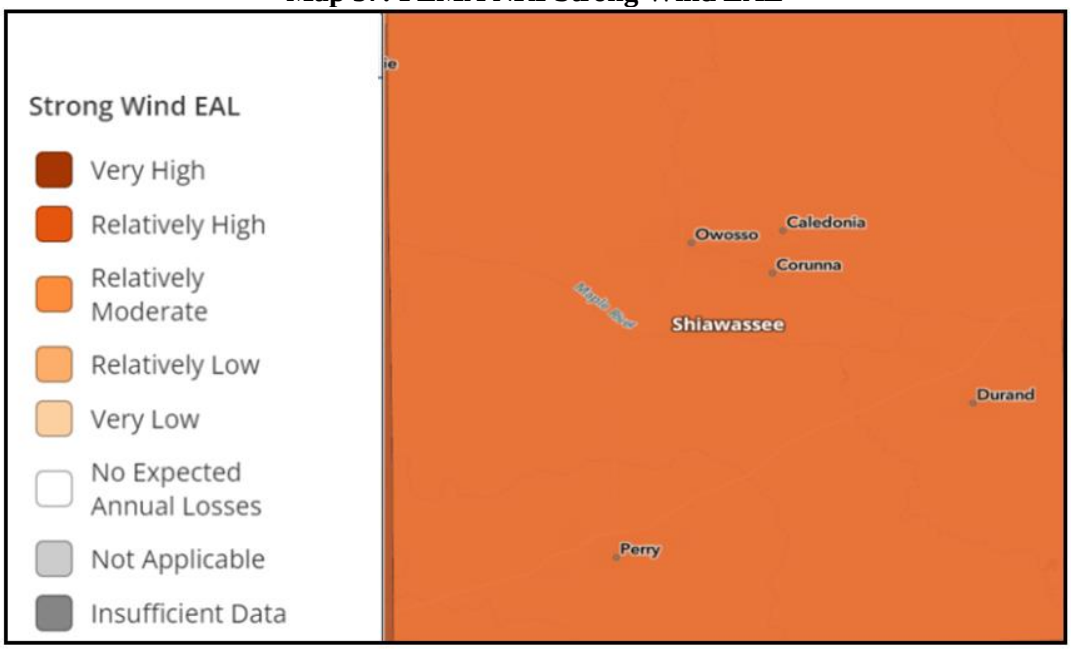
Source: FEMA NRI

Map 56: FEMA NRI Lightning EAL



Source: FEMA NRI

Map 57: FEMA NRI Strong Wind EAL



Source: FEMA NRI

Potentially Vulnerable Community Lifelines

Severe weather can have significant impacts on electrical utilities, leading to disruptions in power supply and potential damage to infrastructure. Severe weather can affect electrical utilities in the following ways:

- Lightning Strikes: Lightning is a common occurrence in severe weather and poses a substantial risk to electrical infrastructure. Lightning strikes can damage power lines, transformers, substations, and other critical components, leading to power outages.
- Wind Damage: High winds associated with severe weather can cause trees, branches, and other debris to fall onto power lines. This can result in downed power lines, structural damage to utility poles, and disruptions in electrical service.
- Hailstorms: Severe weather may produce hail, which can damage power lines, transformers, and other equipment. Hailstones can also lead to short circuits and insulation damage on electrical components.
- Power Surges: Lightning strikes, strong winds, and other storm-related events can lead to power surges in the electrical grid. These surges can damage electronic devices, appliances, and utility equipment connected to the power supply.

Location information concerning electrical generating stations and high-capacity transmission lines may be found in Map 31, page 63.

The cost to replace electrical lines can vary widely based on several factors, including the type of electrical lines, the distance of the replacement, local labor and material costs, the complexity of the project, and any specific requirements or challenges involved. Additionally, costs can be significantly different for residential, commercial, or industrial projects. Additionally, urban and rural locations may have varying cost factors. As a rough estimate, the cost to replace electrical lines can range from a few thousand dollars to several thousand dollars per mile.

Communications systems within Shiawassee County may have an increased vulnerability to severe weather events. Of particular concern is 911 and the dispatch system. Shiawassee County and all jurisdictions are served by the Shiawassee County Consolidated Dispatch Authority, a public authority formed under the Urban Cooperation Act of 1967. The

Shiawassee County Consolidated Dispatch Authority is the sole public safety answering point in Shiawassee County, providing direct dispatching for:

- Law Enforcement
- Emergency Medical Services
- Fire

Severe weather can disrupt this vital communications system, affecting reliability and functionality. Some of the key vulnerabilities include:

- Physical Infrastructure Damage: High winds, heavy rainfall, and other severe weather conditions can cause physical damage to communication infrastructure such as cell towers, antennas, cables, and data centers. This damage can result in network outages and disruptions.
- Power Outages: Severe weather often lead to power outages, which can affect the operation of communication networks. Without a stable power supply, cell towers, data centers, and other critical components may become non-functional, leading to service interruptions.
- Lightning Strikes: Lightning poses a threat to communication infrastructure. Direct strikes or induced surges can damage electronic equipment, leading to the need for repairs or replacements and causing downtime.
- Signal Interference: Severe weather can create electromagnetic interference that disrupts radio signals used in wireless communication. This interference can lead to poor signal quality, dropped calls, and slower data speeds.
- Loss of Backhaul Connectivity: Severe weather events can damage the backhaul infrastructure that connects various communication nodes. This backbone infrastructure is crucial for transmitting data between local and regional networks, and any disruption can impact overall network performance.
- Communication Tower Instability: High winds and extreme weather conditions can compromise the stability of communication towers. If towers are not designed to withstand severe weather, they may collapse, leading to network outages.
- Network Congestion: In the event of a disaster, communication networks may experience a surge in usage as people attempt to contact emergency services, friends, and family. This increased demand can lead to network congestion, making it difficult for users to connect.

The cost to repair the Shiawassee County communications network can vary widely depending on the extent of the damage, the size of the network, and the specific technologies involved. Repair costs may include expenses for labor, equipment replacement or repair, materials, and any additional resources required to restore the network to full functionality. The following data, from the U.S. Department of Homeland Security Cybersecurity and Infrastructure Security Agency, indicates cost ranges for communications system components:

Table 52: Summary of Communication System Component Costs

Components	Examples	Cost	Expected Lifespan
Infrastructure	Towers, shelters, commercial and backup power equipment,	$$$–$$$$$	20–25 years
Fixed Station Equipment	Antennas, repeaters, towers on wheels, consoles, mobile stations, servers, computers, physical and electronic security elements (e.g., fencing, cameras, monitors, environmental conditions)	$$-$$$	3-15 years
Devices	Handheld portable radios, cellular phones, satellite phones, mobile data devices	$-$$	2-10 years
Accessories	Holsters, chargers, speakers, lapel microphone extensions, Bluetooth, vehicle kits, aircards, intercoms	$	2-10 years

Table 52: Summary of Communication System Component Costs

Components	Examples	Cost	Expected Lifespan
Features	Encryption to protect against security risks, ruggedization to ensure reliant services, Over-the-Air-Programming, automatic roaming	$-$$$	-
Software and Data Storage	Global information system, emergency notifications, monitoring, call answering, database access, Automatic Vehicle Locator	$-$$	-

Source: U.S. Department of Homeland Security Cybersecurity and Infrastructure Security Agency

Hospitals and urgent care facilities may see an increase in severe thunderstorm related injuries during an event, however it is considered unlikely that this increase will impact or overload capacity. Location information concerning hospital and urgent care facilities may be found in Map 42, page 82.

Consequence Analysis

This consequence analysis lists the potential impacts of a hazard on various elements of community and state infrastructure. The impact of each hazard is evaluated in terms of disruption of operations, recovery challenges, and overall wellbeing to all Shiawassee County residents and first responder personnel. The consequence analysis supplements the hazard profile by analyzing specific impacts.

Table 53: Severe Thunderstorm Consequence Analysis

Subject	Potential Impacts
Impact on the Public	Thunderstorms can cause extensive property damage, loss of utility service, and injury to the public. Those most at-risk are low-income and homeless individuals without proper shelter.
Impact on Responders	First responders may be unable to access roadways due to flooding, trees, or debris. Exposure to lightning, flooding, and high winds may cause injuries to first responders. Vehicles and resources may be damaged, leading to impaired response activities. In addition, road conditions may become hazardous as a result of the by-products
Continuity of Operations	Local jurisdictions maintain continuity plans which can be enacted as necessary based on the situation. Severe thunderstorms may impact an agency's ability to maintain continuity of operations due to power outages, flooding, and wind damage. If the activation of alternate facilities was required, travel may be difficult as well as computer/network access due to long-term power outages caused by thunderstorms.
Delivery of Services	Delivery of services may be impaired by flooding, obstruction, and damage to roadways and resources. The ability to deliver goods and services will be impacted locally, regionally, or statewide depending on the magnitude of the event. Goods, equipment, and vehicles may become damaged during transport.
Property, Facilities, and Infrastructure	Power lines and power generators are most at risk from thunderstorms and impacts could result in isolated power outages or full-scale blackouts. Building and vehicle damage can occur from hail and other debris created by thunderstorms. Properties and critical facilities also may face foundational and physical damage due to flooding, lightning strike, or excessive winds, delaying response and recovery operations.
Impact on Environment	Waste and debris from damage treatment infrastructure or hazardous materials facilities could contaminate sources of water and food. Debris can impact and contaminate wildlife and natural areas. Lightning strikes may also ignite fires, leading to destruction of agricultural crops, critical ecosystems, and natural habitats.
Economic Conditions	Flooding, high winds, lightning, and hail can stress state and local resources. Even if some of the costs can be recouped through federal reimbursements (federal disaster declaration), there is a fiscal impact on the local government.
Public Confidence in Governance	Ineffective thunderstorm response can decrease the public's confidence in the ability to respond and govern. Governmental response across local, state, regional, and federal

Table 53: Severe Thunderstorm Consequence Analysis

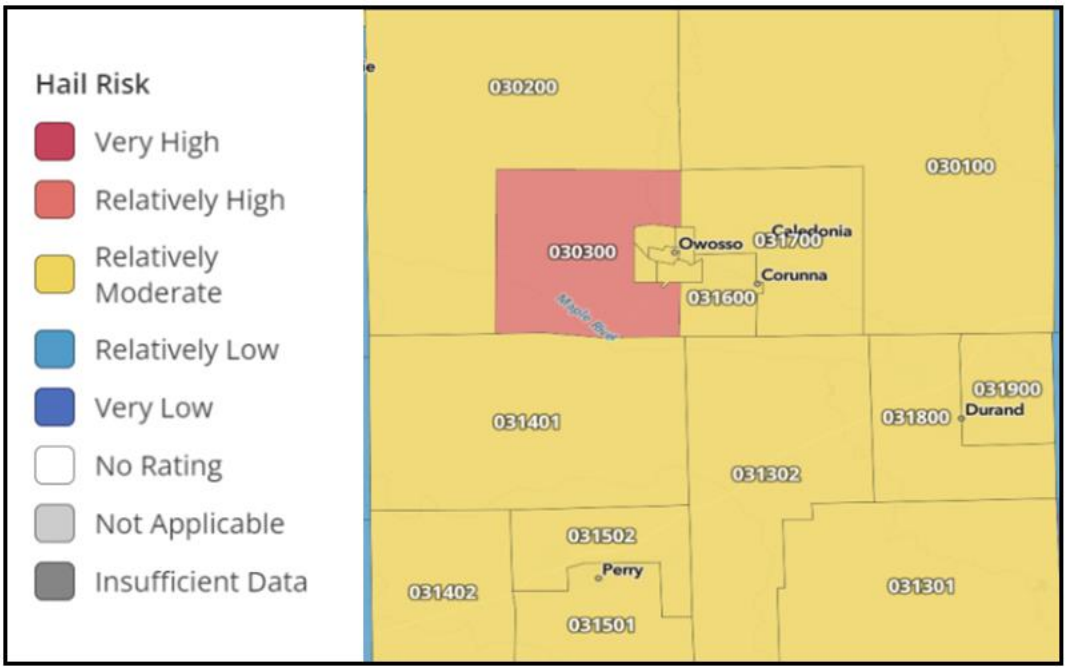
Subject	Potential Impacts
	levels require direct actions that must be immediate and effective to maintain public confidence.

4.11.7 Jurisdictional Risk and Vulnerability

To help understand the risk and vulnerability to severe thunderstorms of participating jurisdictions mapping from the FEMA NRI was run on a census tract level. As the NRI does not generate mapping for individual jurisdictions, census tract analysis is the closest analogue available to understand individual jurisdiction conditions.

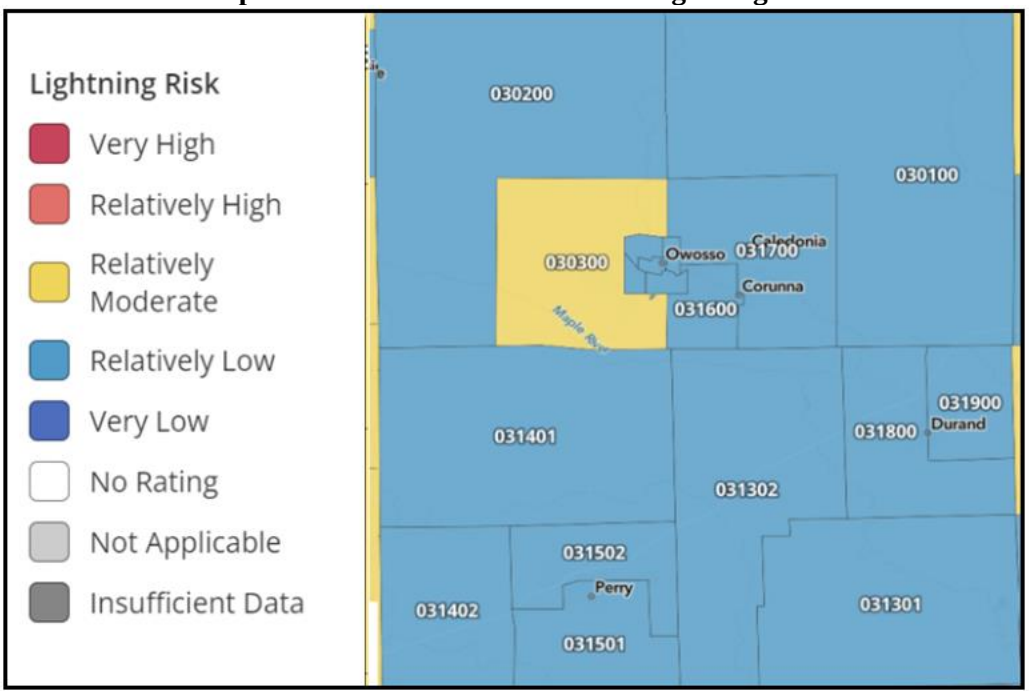
Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following map was created indicating the potential risk to participating jurisdictions from hail, lightning, and strong wind, the components of strong thunderstorms:

Map 58: FEMA NRI Jurisdictional Hail Risk



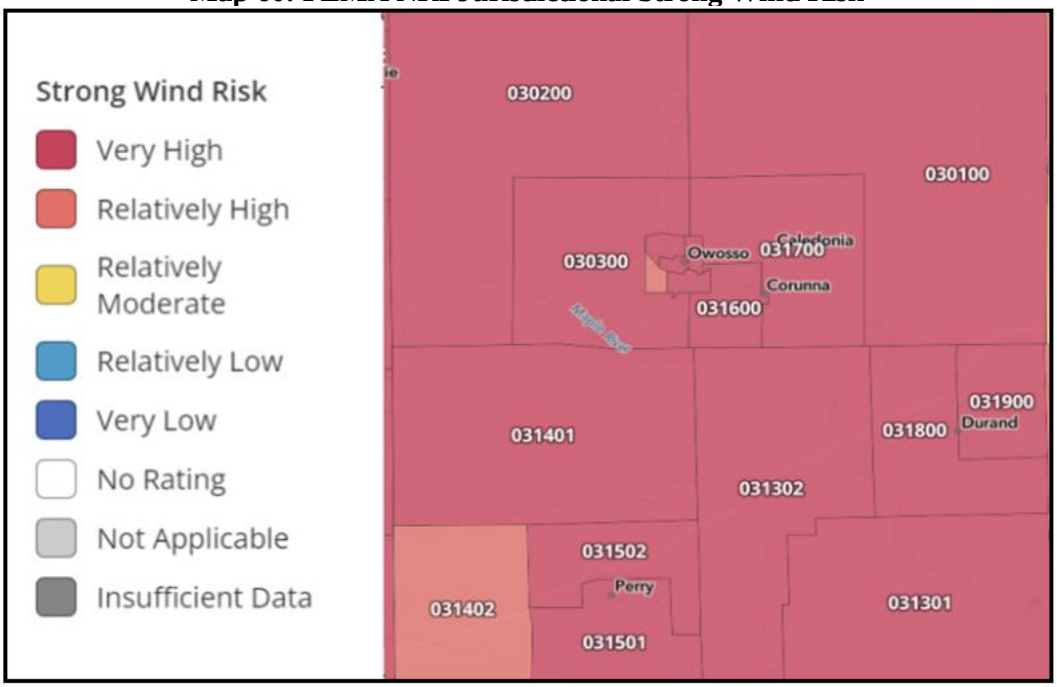
Source: FEMA NRI

Map 59: FEMA NRI Jurisdictional Lightning Risk



Source: FEMA NRI

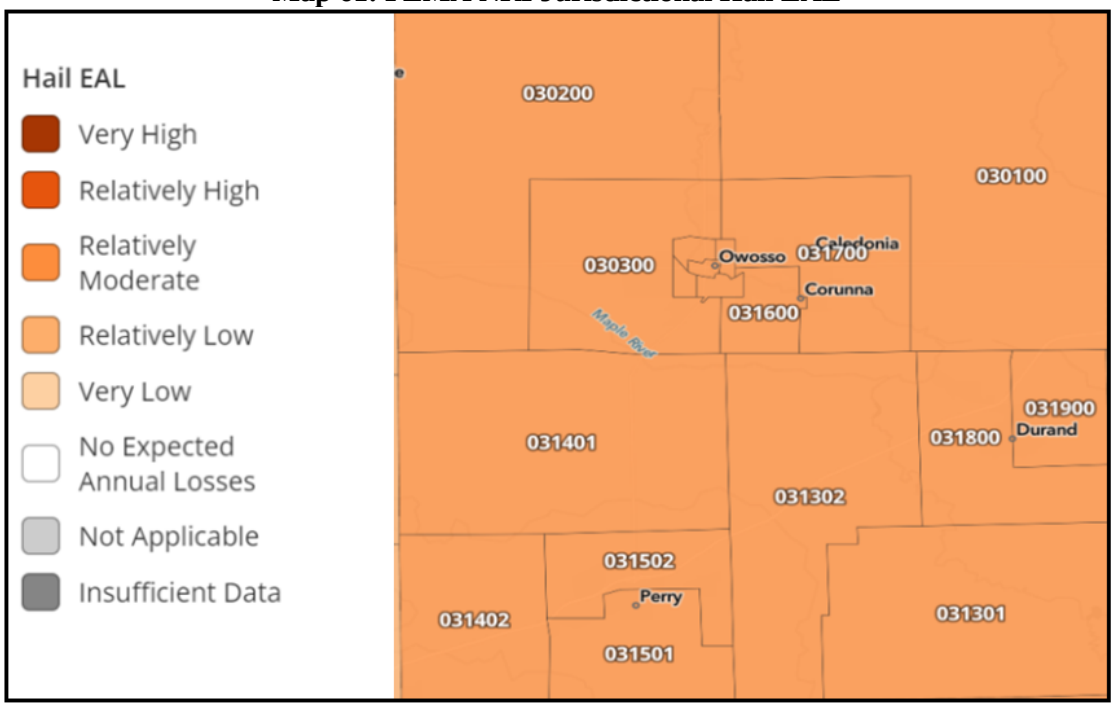
Map 60: FEMA NRI Jurisdictional Strong Wind Risk



Source: FEMA NRI

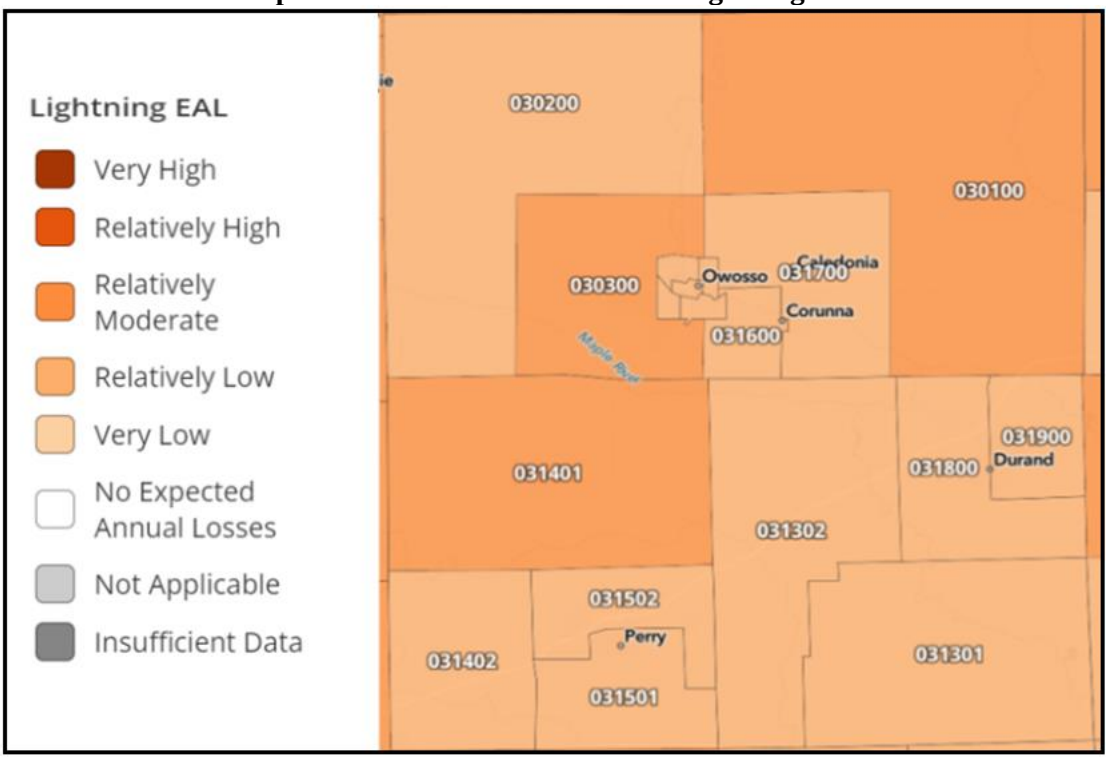
As part of the NRI, EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following map indicates the EAL for hail, lightning, and strong wind, the components of severe thunderstorms, for participating jurisdictions within Shiawassee County:

Map 61: FEMA NRI Jurisdictional Hail EAL



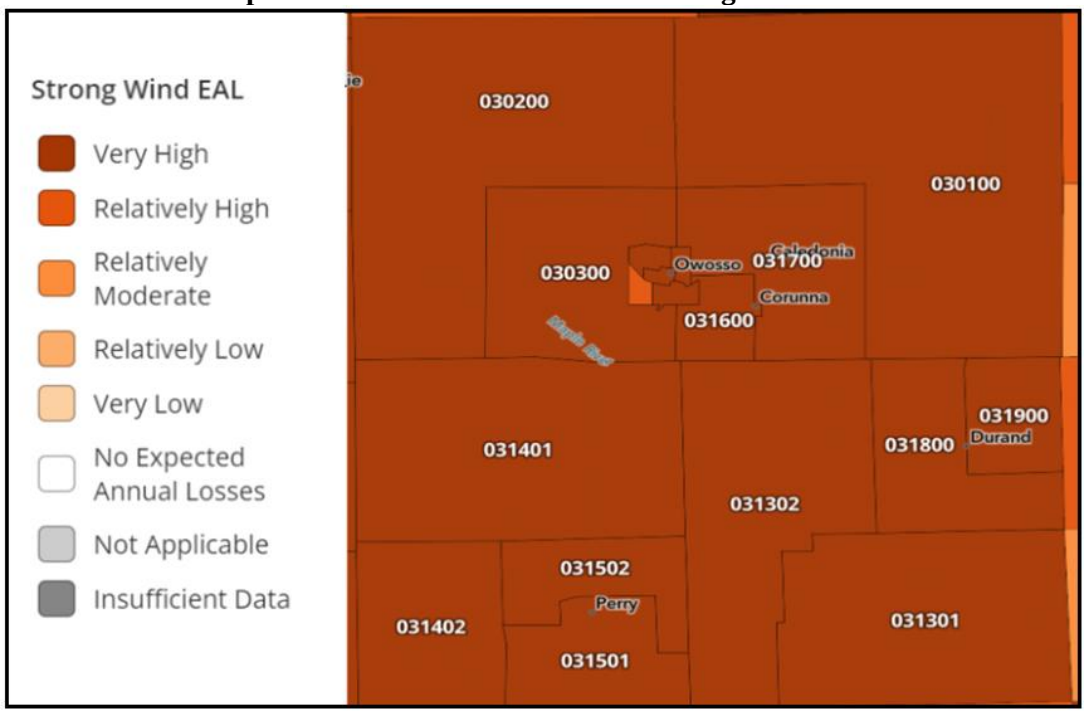
Source: FEMA NRI

Map 62: FEMA NRI Jurisdictional Lightning EAL



Source: FEMA NRI

Map 63: FEMA NRI Jurisdictional Strong Wind EAL



Source: FEMA NRI

The following table indicates the FEMA NRI and EAL analysis for the components of severe thunderstorms (hail, lightning, and strong winds) for each participating Shiawassee County jurisdiction:

Table 54: Shiawassee County FEMA EAL and NRI for Hail

Jurisdiction	EAL	Risk Index
Shiawassee County	Relatively Moderate	Relatively Moderate
City of Durand	Relatively Moderate	Relatively Moderate
City of Laingsburg	Relatively Moderate	Relatively Moderate
City of Owosso	Relatively Moderate	Relatively Moderate
City of Perry	Relatively Moderate	Relatively Moderate
Township of Owosso	Relatively Moderate	Relatively Moderate

Source: FEMA NRI

The following table indicates the FEMA NRI and EAL analysis for drought for each participating Shiawassee County jurisdiction:

Table 55: Shiawassee County FEMA EAL and NRI for Lightning

Jurisdiction	EAL	Risk Index
Shiawassee County	Relatively Low	Relatively Low
City of Durand	Relatively Low	Relatively Low
City of Laingsburg	Relatively Moderate	Relatively Low
City of Owosso	Relatively Low	Relatively Low
City of Perry	Relatively Low	Relatively Low
Township of Owosso	Relatively Low	Relatively Low

Source: FEMA NRI

Table 56: Shiawassee County FEMA EAL and NRI for Strong Winds

Jurisdiction	EAL	Risk Index
Shiawassee County	Very High	Very High
City of Durand	Very High	Very High
City of Laingsburg	Very High	Very High
City of Owosso	Very High	Very High
City of Perry	Very High	Very High
Township of Owosso	Very High	Very High

Source: FEMA NRI

Lower income communities, including communities with a large percentage of mobile homes, may suffer disproportionate impacts from severe storm events, especially strong winds. Data concerning mobile homes may be found in Section 3.6, pages 20.

Since severe storms threaten the entire planning area equally, all structures are considered exposed and vulnerable to severe thunderstorms.

4.12 Severe Winter Storms

4.12.1 Hazard Description

A winter storm encompasses multiple effects caused by winter weather. Included are strong winds, ice storms, heavy or prolonged snow, sleet, and extreme temperatures. Winter storms can be increasingly hazardous in areas and regions that only see winter storms intermittently.

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

- **Ice Storm:** An ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater.
- **Heavy Snow:** This generally means snowfall accumulating to 4" or more in depth in 12 hours or less; or snowfall accumulating to 6" or more in depth in 24 hours or less.
- **Winter Storm:** Hazardous winter weather in the form of heavy snow, freezing rain, or heavy sleet. It may also include extremely low temperatures and increased wind.
- **Cold Wave/Extreme Cold:** As described by NWS, a cold wave is a rapid fall in temperature within a 24-hour period requiring substantially increased protection to agriculture, industry, commerce, and social activities. As evidenced by past incidents across the U.S., extreme cold can cause impact to human life and property.

4.12.2 – Location and Extent

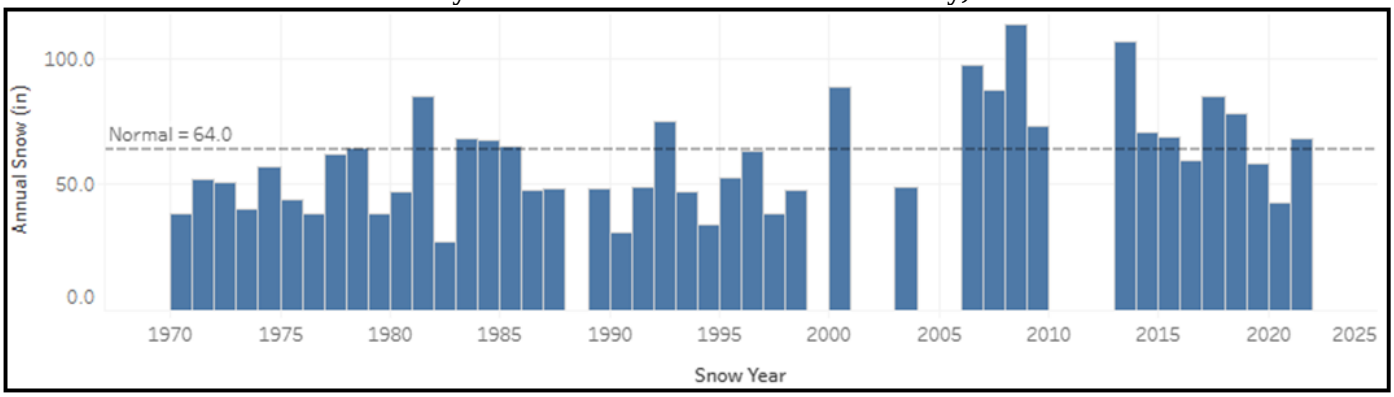
Severe winter storms occur regularly throughout Shiawassee County and its participating jurisdictions, and often affect the entire planning area. These events occur on a large geographic scale, often affecting multiple counties, regions, and states.

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

Severe winter storms can range from moderate snow over a few hours to blizzard conditions with high winds, freezing rain or sleet, heavy snowfall with blinding wind-driven snow and extremely cold temperatures that last several days.

Th Midwest Region Climate Center maintains a snow collection point in Shiawassee County. Historically, data from the station indicates that Shiawassee County and its participating jurisdictions will typically see an average of 64 inches of snowfall each year.

Chart 16: Yearly Snowfall Totals for Shiawassee County, 1970 – 2022 -



Source: Midwest Regional Climate Center

The Northeast Snowfall Impact Scale is a scale used to assess and rank the impact of snowfall events in the northeastern United States. It was developed by NOAA to provide a standardized way of measuring the societal and economic impacts of snowstorms in this region. The scale takes into account factors such as snowfall amount, population density, and the area affected by the storm to determine its impact. The NESIS scale has five categories, each with its own associated impacts:

Table 65: Northeast Snowfall Impact Scale

Category	Description	Impacts
1	Notable	Light to moderate snowfall. Limited impacts on transportation and daily life. Typically localized to small areas.
2	Significant	Moderate to heavy snowfall. Widespread impacts on transportation, including delays and disruptions. Some school and business closures. Widespread power outages are rare.
3	Major	Heavy snowfall, often exceeding one foot or more. Significant transportation disruptions, including major highway closures. Widespread school and business closures. Power outages may occur, especially in areas with wet, heavy snow.
4	Crippling	Extreme snowfall, often exceeding two feet or more. Severe and prolonged transportation disruptions, including highway closures. Widespread school and business closures for an extended period. Widespread and prolonged power outages, especially in areas with ice accumulation.
5	Extreme	Exceptional snowfall, often exceeding three feet or more. Complete paralysis of transportation systems, including major highways and airports. Extended school and business closures. Widespread and prolonged power outages with significant damage to the electrical infrastructure.

Source: NOAA

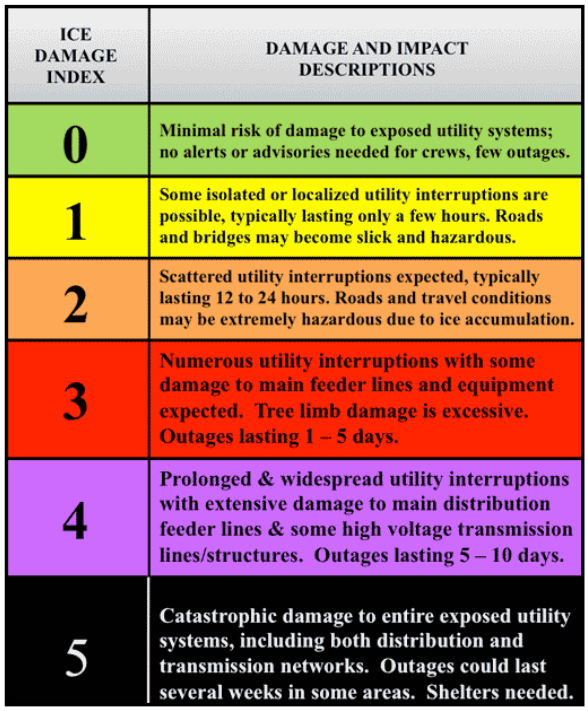
The scale provides valuable information for emergency management, public safety agencies, and the public to understand the potential impacts of a snowstorm and to prepare accordingly. It helps to quantify and communicate the severity of winter weather events, especially in regions where snowfall can have a major impact on daily life and the economy.

Ice storms are characterized by the accumulation of freezing rain or freezing drizzle, which coats surfaces with a layer of ice. These storms can have significant impacts on transportation, infrastructure, and the environment. Ice storms occur when there's a layer of warm air above a layer of cold air near the surface. Precipitation falls as rain in the warm

layer and then freezes upon contact with surfaces at or below freezing temperatures in the cold layer. The most common type of precipitation during an ice storm is freezing rain. This is rain that falls as a liquid but freezes upon contact with cold surfaces, forming a layer of ice.

The Sperry–Piltz Ice Accumulation Index is an ice accumulation and ice damage prediction index that, when combined with NWS data, predicts the projected footprint, total ice accumulation, and resulting potential damage from approaching ice storms.

Figure 3: Sperry–Piltz Ice Accumulation Index



Source: Sperry–Piltz Ice Accumulation Index

4.12.3 Previous Occurrence

The following table presents NCEI identified blizzard, ice storm, and winter storm events and the resulting damage totals in Shiawassee County from 1950 to 2023. Please note that as these storm events tend to cover larger areas occurrence data is being presented as representative of all participating jurisdictions.

Table 66: Shiawassee County NCEI Winter Storm Events, 1950 - 2023

Event Type	Number of Events	Property Damage	Deaths and Injuries
Blizzard	1	$0	0
Ice Storm	6	$3,000,000	0
Winter Storm	3	$0	0

Source: NCEI

It is worth noting that damage estimates indicated by the NCEI are often artificially low. This underreporting is a result of the way the events are reported to the NCEI, often by the local and/or NWS office. When reporting an event oftentimes the NWS office does not have access to the actual damage assessment resulting from that event. As such, the report often details a very low amount or zero-dollar amount for damages. Additionally, deaths and injuries may be underreported as they may be a result of a concurrent event, such as a person driving unsafely during heavy rain and passing away.

4.13.4 Probability of Future Events

Predicting the probability of winter storm occurrences is tremendously challenging due to the large number of factors involved and the random nature of formation. Data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to winter storm events:

Table 67: Shiawassee County Winter Storm Probability Summary

Data	Events
Number of Days with NCEI Reported Event (1950-2023)	10
Average Events per Year	<1

Source: NCEI

Additional data from NOAA and the NWS indicate that Shiawassee County can expect an average annual snowfall of between 64 inches per year.

4.12.5 Projected Changes in Location, Intensity, Frequency, and Duration

Climate change can lead to greater variability in precipitation patterns. In Shiawassee County, this may result in more erratic and intense winter storms with periods of heavy snowfall followed by rain or freezing rain. These mixed precipitation events can make winter storms more challenging to predict and can lead to a greater risk of ice accumulation. Additionally, Shiawassee County may experience milder winters as average temperatures rise due to climate change. While this could lead to a decrease in the frequency of traditional snowstorms, it may also increase the likelihood of winter storms that produce mixed precipitation, including freezing rain and sleet. Warmer temperatures can lead to a higher snowfall threshold, meaning that storms that would have produced snow in the past may now bring more rain or a mix of precipitation types. This can affect the accumulation of snow in the state. Changes in atmospheric circulation patterns associated with climate change can influence the tracks of winter storms. This could lead to a shift in the amounts of heavy snowfall, ice, and other winter weather hazards.

As indicated in the data above, Shiawassee County and all participating jurisdictions have been seeing generally static or declining populations. A static or declining population could decrease population risks to winter storms by nature of their being fewer citizens to negatively impact.

Shiawassee County's current land-use regulations require the consideration of building codes during the development review process. A building-by-building structural review, including roof profile and strength would need to be to determine structural risk to snow and ice loads. However, enforced building codes can ensure that newly built and renovated structures can better withstand the loads.

The agriculture base of Shiawassee County is increasingly vulnerable to the effects of winter storms. Future development of agricultural resources would tend to increase the risk and impact of an event. As indicated in the data above, Shiawassee County is seeing a continuing projected increase in agricultural activities and thus a potential greater future vulnerability.

4.12.6 Vulnerability and Impact

Data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to Winter Storm events:

Table 68: Shiawassee County Winter Storm Impact Summary

Data	Recorded Impact
Number of Deaths or Injuries (1950-2023)	0
Average Number of Deaths or Injuries	0
Total Reported NCEI Property Damage (1950-2023)	$3,000,000
Average Property Damage per Year	$41,096

Source: NCEI

All of Shiawassee County is vulnerable to winter and ice storms. Based on the non-geographic specific aspect of this hazard, i.e., no one area is at a greater risk, all of the planning area's structural inventory and population is vulnerable.

Extremely cold temperatures are a threat to anyone exposed to them. Extreme cold can cause frostbite and hypothermia. Bitterly cold temperatures can also burst water and create an excessive demand on providers to deliver energy for household heating. There are also fire dangers associated with home heating. Heavy snow and/or ice can paralyze communities. Roads can become hazardous which may cause accidents, disrupted flow of supplies, and challenges in the delivery of emergency and medical services. Additional impacts on people and the community may include:

- Injuries and Fatalities: Slippery sidewalks, roads, and driveways can lead to slip and fall accidents, vehicle crashes, and pedestrian injuries. Exposure to extreme cold temperatures can cause frostbite, hypothermia, and cold-related illnesses, which can be life-threatening.
- Power Outages: Heavy snow, ice, and freezing rain can bring down power lines and disrupt electricity supply. Power outages can lead to heating and lighting challenges, particularly in extreme cold conditions.
- Transportation Disruptions: Winter storms can make roads and highways treacherous, leading to travel delays, accidents, and stranded motorists. Public transportation services may be disrupted, affecting commuters and essential travel.
- Stranded or Isolated Communities: Severe winter weather can leave communities isolated and cut off from emergency services and supplies. Residents may need to shelter in place or rely on local resources until conditions improve.
- Health Risks: Exposure to extreme cold can lead to a range of health risks, including frostbite, hypothermia, and cold-related illnesses. Individuals with pre-existing health conditions may face exacerbated risks.
- Increased Heating Costs: Cold weather can result in higher heating costs, which can be a financial burden for many households. Low-income individuals and families may struggle to afford adequate heating.
- Disruption of Essential Services: Severe winter weather can disrupt essential services such as healthcare, emergency response, and utilities. Hospitals may face increased patient volumes due to weather-related injuries and illnesses.

Severe winter storms can have significant and wide-ranging impacts on critical facilities and infrastructure. The extent of the impact depends on the severity of the storm, the preparedness of the facilities and infrastructure, and the effectiveness of response and recovery efforts, and may include:

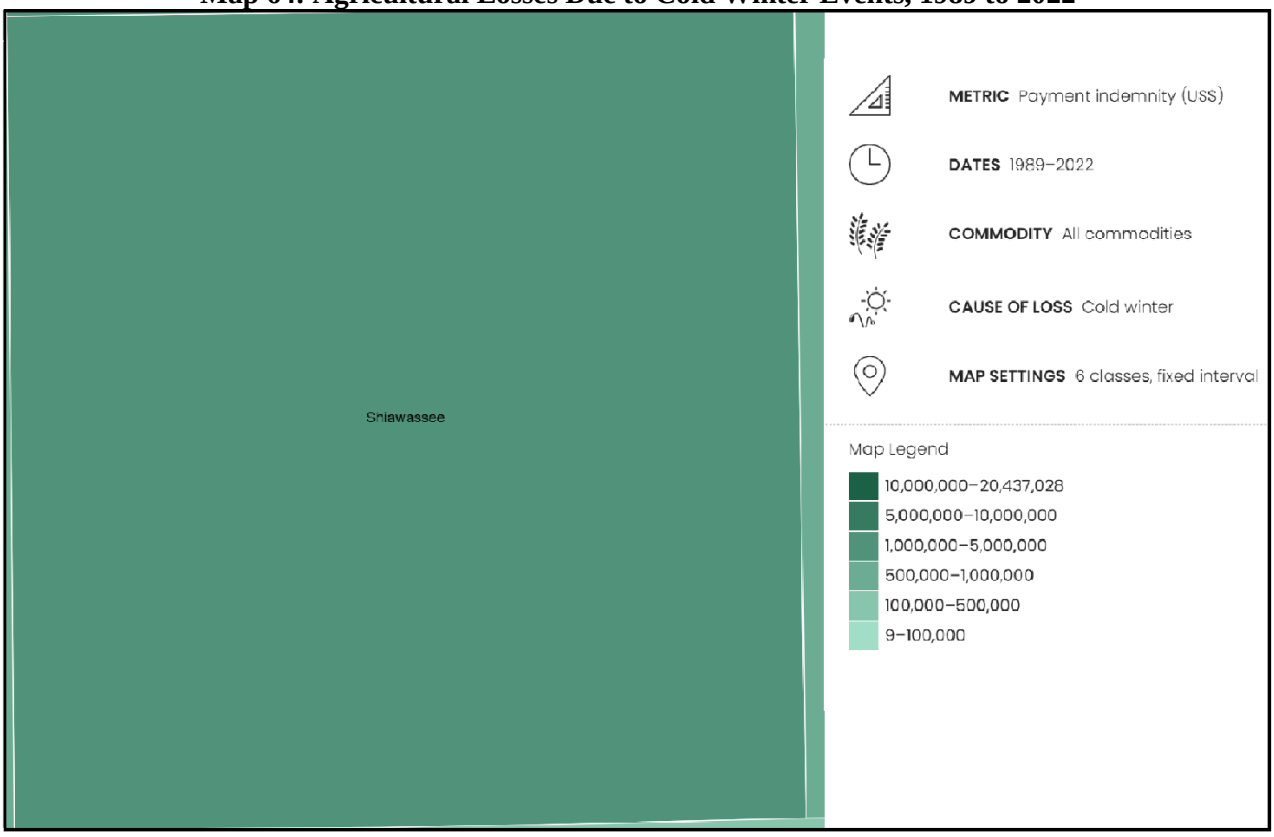
- Power Outages: Severe winter storms can cause power outages by bringing down power lines, causing ice accumulation on electrical infrastructure, or overloading the electrical grid due to increased demand for heating. Critical facilities such as hospitals, emergency response centers, and data centers may rely on backup generators to maintain essential operations during outages.
- Communication Disruptions: Ice and freezing rain can damage communication infrastructure, including cell towers, telephone lines, and data centers, leading to disruptions in phone and internet services. This can hinder emergency communication and coordination, affecting critical response efforts.
- Transportation Disruptions: Snow and ice accumulation on roads, runways, and railways can disrupt transportation networks, leading to travel delays, accidents, and closures. Critical facilities may face challenges in receiving essential supplies and personnel during and after the storm.
- Healthcare System Strain: Hospitals and healthcare facilities may experience increased demand for medical services due to storm-related injuries and illnesses, including those related to slips and falls, traffic accidents, and cold exposure.
- Water Supply Interruptions: Freezing temperatures can cause water pipes to burst, leading to water supply interruptions and damage to water infrastructure. Critical facilities such as hospitals and emergency response centers rely on a continuous supply of clean water for various purposes, including patient care and firefighting.
- Wastewater Systems: Cold temperatures can affect wastewater treatment plants, leading to potential operational disruptions and contamination risks.
- Fuel Supply Disruptions: Snow and ice can disrupt fuel supply chains, leading to shortages of gasoline, diesel, and heating oil. Critical facilities may rely on fuel for backup power generators and heating systems.

- Property Damage: Severe winter storms can result in property damage, including roof collapses due to heavy snow accumulation, ice damming, and frozen pipes.

Severe winter storms can have various impacts on the environment, particularly in regions prone to cold and snowy winters. These impacts can affect ecosystems, wildlife, and natural resources and can include habitat disruption, reduction of food sources, changes in migration patterns, and damage to foliage (especially if a spring storm). Additionally, the use of salt and de-icing chemicals on roads and sidewalks can have negative environmental impacts. These chemicals can find their way into nearby water bodies, leading to water pollution and harm to aquatic ecosystems. Snowmelt can also introduce pollutants from roadways and urban areas into rivers and streams, leading to reduced water quality. Elevated sediment levels and changes in water temperature can also affect aquatic life.

Severe winter storm conditions can cause significant agricultural impacts. The following map from the United States Department of Agriculture details total agricultural losses, by county, due to freeze events from 1989 to 2022:

Map 64: Agricultural Losses Due to Cold Winter Events, 1989 to 2022



Source: USDA

Severe winter storms can pose risks to local operations and can disrupt government functions and strain resources. Some of the risks to operations and facilities include:

- Transportation Disruptions: Snow and ice accumulation on roads and highways can hinder transportation, making it difficult for agencies and personnel to travel and respond to emergencies. RIDOT must allocate resources to plow and salt roads, clear snow and ice, and repair potholes caused by freezing and thawing. These efforts are costly and resource intensive.
- School Closures: Winter storms often lead to school closures, which can affect state-run education programs and services. Agencies may need to coordinate with school districts to ensure the safety of students.

- Emergency Response and Public Safety: Winter storms can result in increased demands for emergency services, including responses to traffic accidents, medical emergencies, and stranded motorists. State and local agencies must allocate additional resources to address these needs.
- Economic Impact: Winter storms can result in economic losses due to reduced economic activity, transportation disruptions, property damage, and increased spending on emergency response and recovery efforts.
- Emergency Shelter Operations: Local jurisdictions may need to operate or coordinate emergency shelters during winter storms to provide shelter and resources to vulnerable populations, including those experiencing homelessness.
- Resource Allocation: Agencies must allocate resources, including personnel, equipment, and stockpiled supplies, to support emergency response efforts and maintain public services.
- Communication Challenges: Winter storms can disrupt communication networks, hindering the ability of agencies to communicate internally and with the public. This can impact emergency notifications and coordination efforts.
- Budgetary Impact: The costs associated with snow removal, road maintenance, emergency response efforts, and infrastructure repair can strain state budgets.
- Governance and Administrative Challenges: State government offices and facilities may experience closures or reduced staffing during severe winter weather, affecting administrative functions, regulatory processes, and public services.

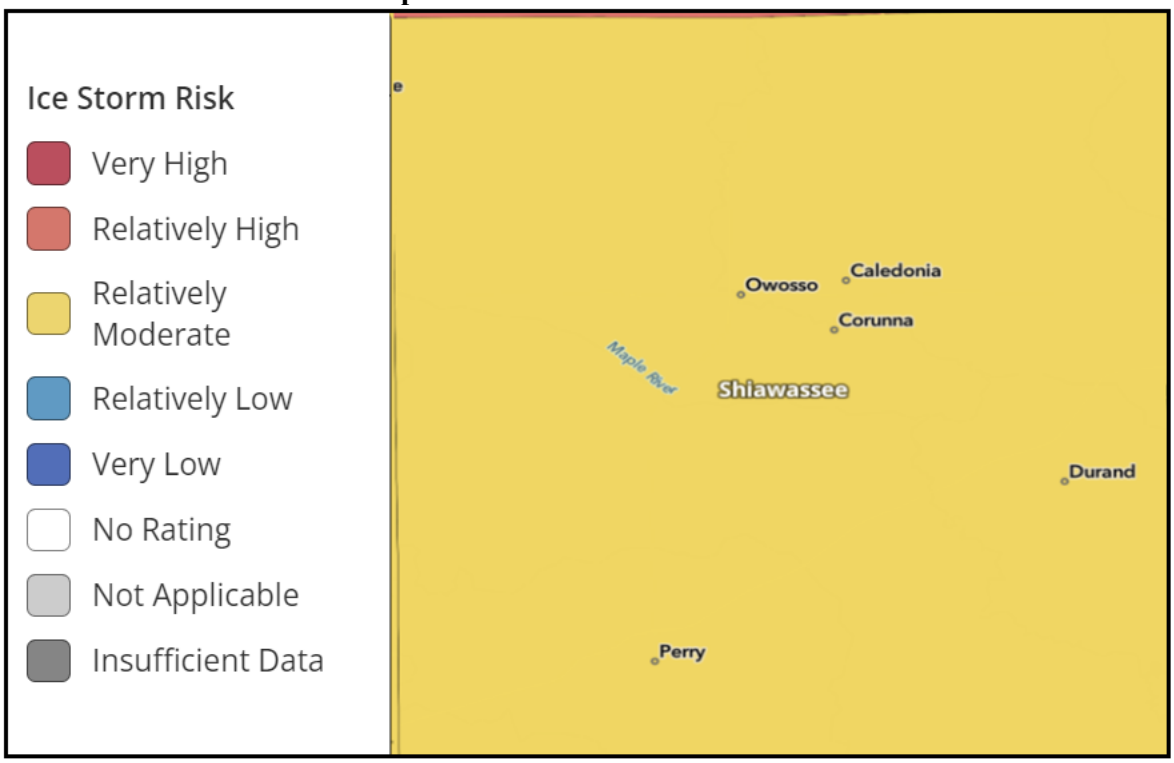
Severe winter storms can have significant impacts on government facilities and assets. These impacts may include:

- Property Damage: Ice accumulation on buildings and structures can lead to structural damage, including roof collapses and damage to exterior elements. Frozen pipes and water mains can cause interior damage.
- Communication Challenges: Ice accumulation on communication infrastructure, such as antennas and transmission towers, can disrupt communication services, affecting the ability of government agencies to convey critical information.
- Infrastructure Maintenance Challenges: The need for snow and ice removal, as well as the maintenance of roads and public spaces, can be challenging during severe winter weather. This requires additional resources and coordination.

Data from the FEMA Hazus system indicates the total value of government property within Shiawassee County is $258,661,000, all of which is vulnerable to tornadoes.

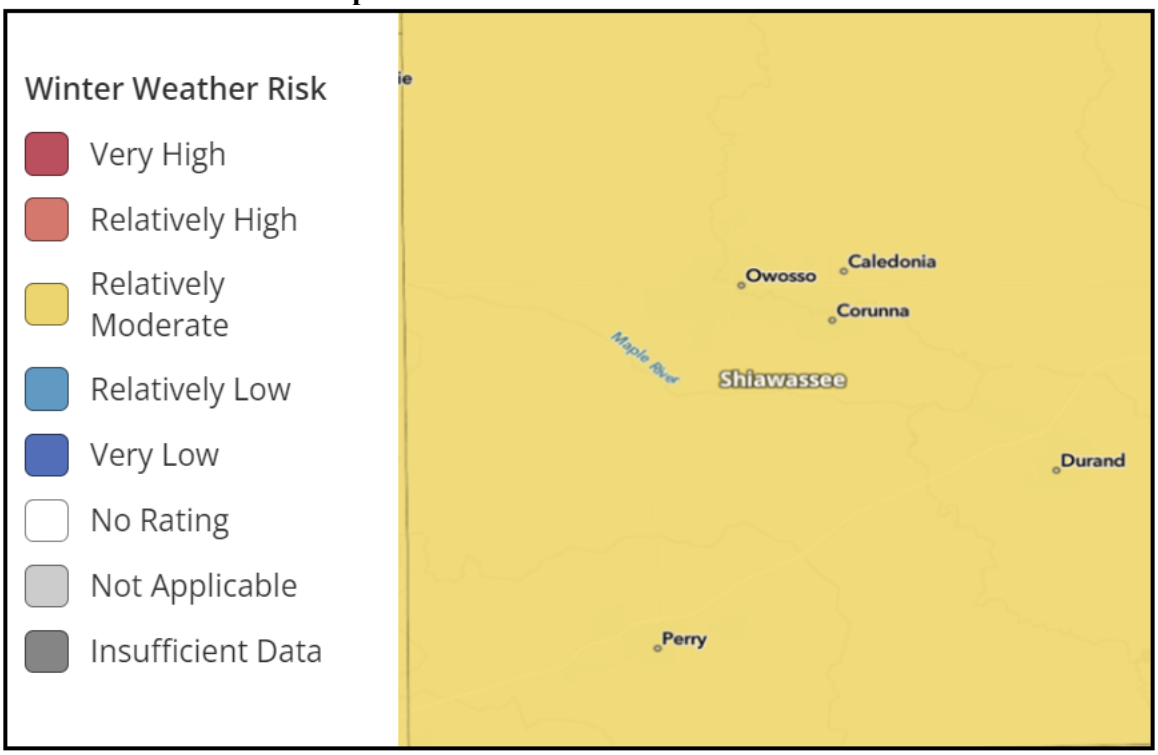
Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following maps were created indicating the potential risk to Shiawassee County from ice storms and winter weather for Shiawassee County:

Map 65: FEMA NRI Ice Storm Risk



Source: FEMA NRI

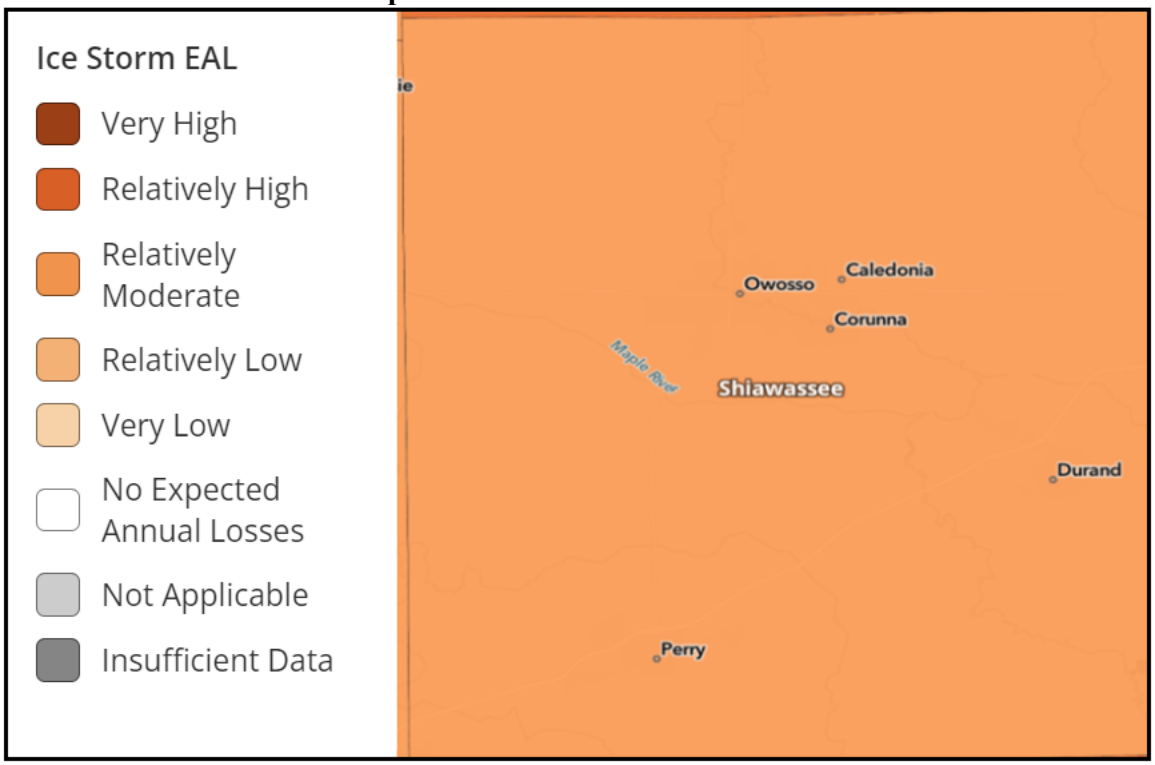
Map 66: FEMA NRI Winter Weather Risk



Source: FEMA NRI

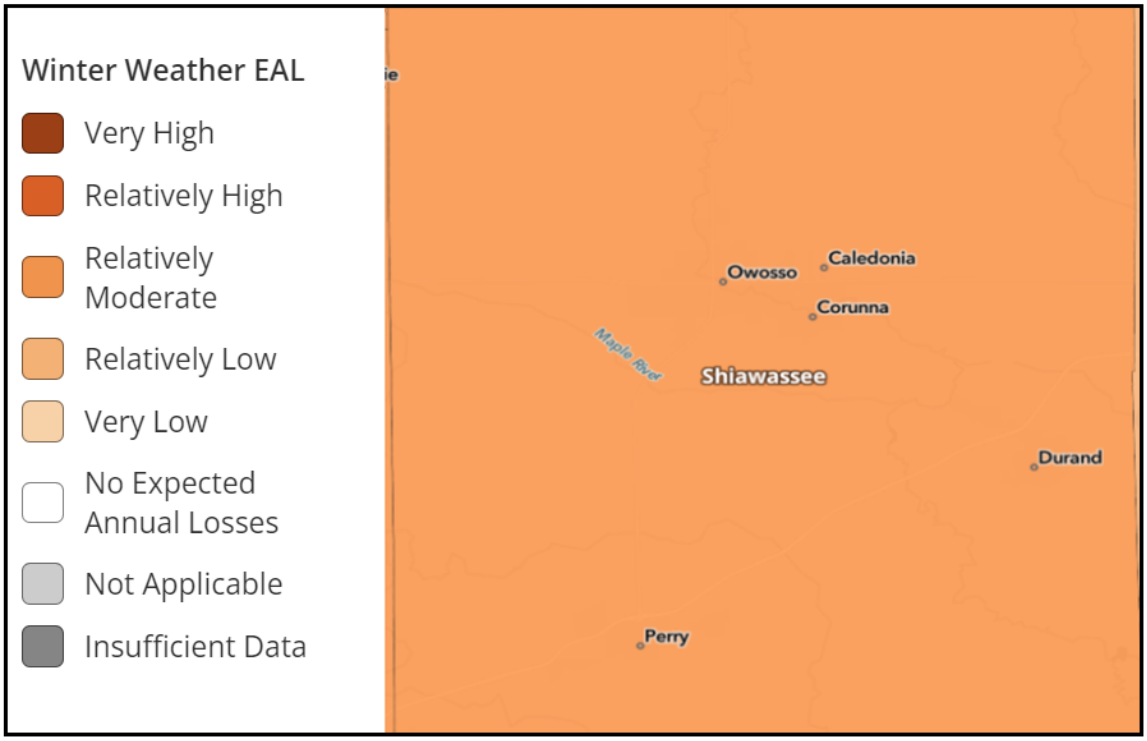
EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following maps indicate the EAL for ice storms and winter weather for Shiawassee County:

Map 67 : FEMA NRI Ice Storm EAL



Source: FEMA NRI

Map 68: FEMA NRI Winter Weather EAL



Source: FEMA NRI

Potentially Vulnerable Community Lifelines

Extreme cold temperatures often associated with severe winter weather can impact various community lifelines, critical systems and services that communities rely on for their functioning. Vulnerabilities arise due to the stress that winter weather places on infrastructure, resources, and operational processes.

Severe winter storms can have significant impacts on road infrastructure, creating challenging conditions for transportation and necessitating proactive measures for maintenance and safety. Winter storms can impact road infrastructure:

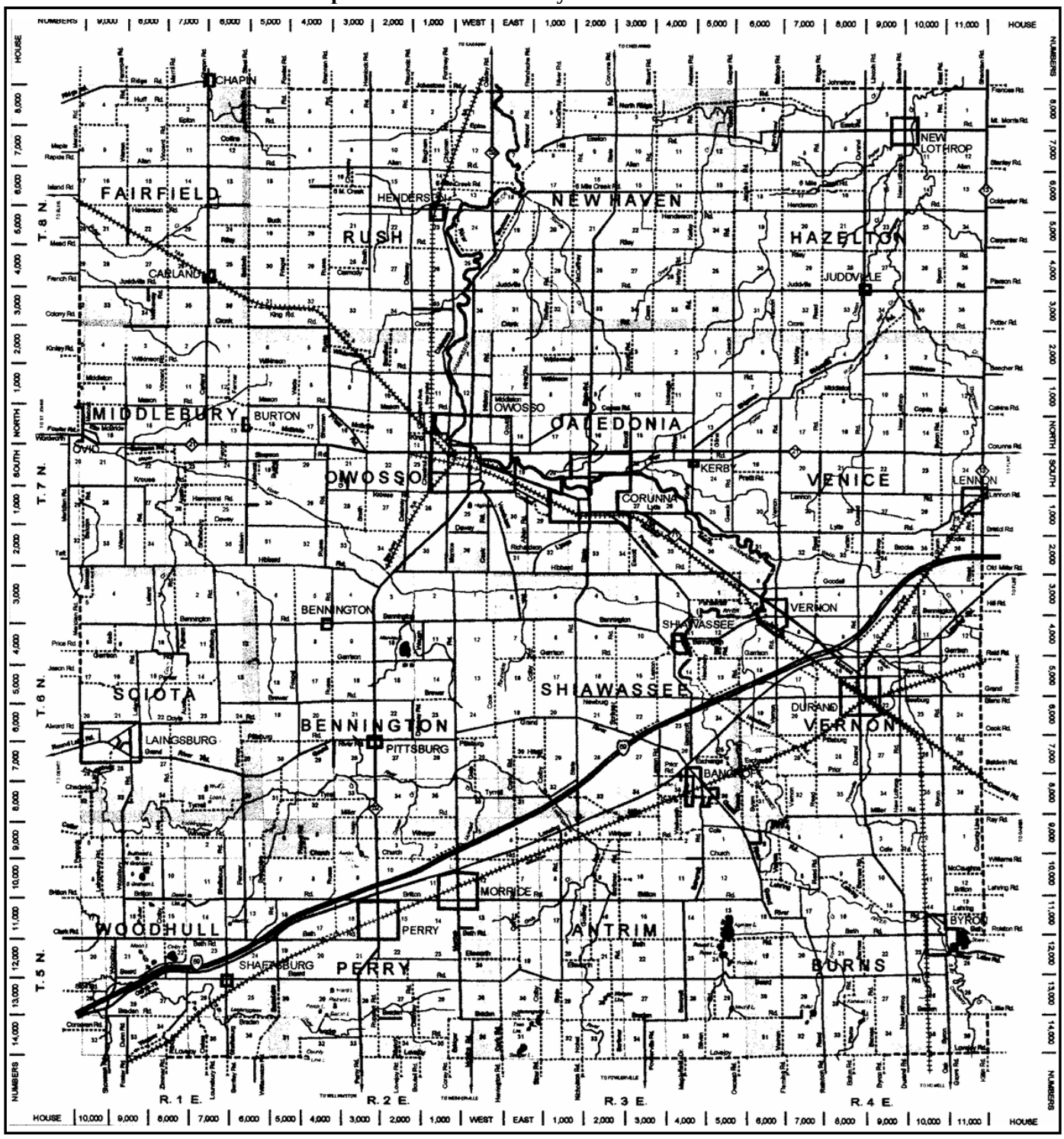
- Snow Accumulation: Snowfall can accumulate on road surfaces, creating slippery and hazardous conditions for drivers. Accumulated snow can reduce road visibility and make travel difficult.
- Ice Formation: Freezing temperatures can lead to the formation of ice on roadways, increasing the risk of accidents and making roads slippery. Black ice, which is nearly invisible, poses a particular hazard.
- Snowdrifts: Strong winds during winter storms can lead to the formation of snowdrifts on roads, especially in open areas. These drifts can obstruct visibility and impede traffic flow.
- Road Surface Damage: The freeze-thaw cycle, where melted snow refreezes, can lead to the formation of ice patches and potholes on road surfaces. This cycle can contribute to the deterioration of road infrastructure over time.
- Freeze-Thaw Cycling: Alternating freezing and thawing can cause the expansion and contraction of water within pavement cracks, leading to the formation and enlargement of potholes.
- Snowplow and Deicing Operations: Snowplows and deicing operations are necessary to clear roads and improve driving conditions. However, the use of salt and chemicals for deicing can contribute to corrosion and deterioration of road surfaces and infrastructure.
- Infrastructure Stress: Bridges and overpasses are particularly susceptible to ice formation due to the lack of ground contact. Winter storms can stress these structures, potentially leading to structural issues over time.

The Shiawassee County Road Department's policy for prioritizing snow removal is based on traffic volume, speed limits and road surface types. Preference is given in the following order:

- State trunklines
- Primary roads
- Major local roads
- Residential / subdivision streets

The following map details all roads within Shiawassee County that may be impacted by severe winter storms:

Map 69: Shiawassee County Road Infrastructure



Source: Shiawassee County

Severe winter storms can impact electrical utilities in various ways, potentially leading to disruptions in service. These impacts include:

- Power Outages: High temperatures can strain electrical systems, leading to increased demand for cooling systems like air conditioners. This heightened demand can overload power grids, resulting in power outages.

- Equipment Failure: Electrical equipment, such as cables and switches, may experience higher resistance and increased stress during extreme heat, increasing the likelihood of equipment failures.
- Reduced Efficiency in Power Plants: Power generation facilities may experience reduced efficiency during heatwaves due to elevated ambient temperatures. This can affect the output of power plants and potentially lead to supply shortages.
- Icing on Power Lines: Ice accumulation on power lines can lead to increased weight, potentially causing lines to sag or break. This can result in power outages and safety hazards.

Location information concerning electric generation stations and high-capacity transmission lines may be found in Map 31, page 63.

Severe winter storms can significantly impact emergency response infrastructure, creating challenges for first responders and organizations involved in managing and mitigating the effects of severe weather events. Winter storms can impact emergency response through:

- Transportation Disruptions: Snow and ice accumulation on roads can hinder the ability of emergency vehicles to navigate and reach affected areas promptly. Hazardous road conditions may result in delays in response times.
- Road Closures: Winter storms can lead to the closure of roads due to snow accumulation, ice, and hazardous conditions. This can limit access for emergency vehicles and impede the evacuation of residents.
- Communication Disruptions: Snow and ice can disrupt communication networks, affecting the ability of emergency responders to coordinate and communicate effectively. Downed power lines and damage to communication infrastructure contribute to these disruptions.
- Power Outages: Severe winter weather, including ice storms, can lead to power outages. Emergency response facilities, such as command centers and fire stations, may lose power, affecting their operational capabilities.
- Exposure: Emergency responders face increased health and safety risks in winter conditions. Exposure to extreme cold, snow, and ice can impact the well-being of responders and affect their ability to provide effective assistance.
- Resource Allocation Challenges: Winter storms often require the allocation of additional resources, including personnel, equipment, and supplies, to address immediate needs. This can strain emergency response organizations and impact their ability to respond to other concurrent incidents.
- Logistical Challenges: Snow accumulation and icy conditions may create logistical challenges for the transportation of supplies, equipment, and personnel to affected areas, hindering the overall effectiveness of emergency response efforts.
- Increased Demand for Services: Winter storms can result in an increased demand for emergency services, including medical assistance, search and rescue operations, and responses to accidents. Emergency response organizations may need to manage a higher volume of incidents simultaneously.

Location information concerning fire stations and law enforcement centers may be found in Maps 43 and 44, pages 82 and 83.

While hospitals and urgent care facilities may see an increase in winter storm related injuries and conditions during an event, it is considered unlikely that this increase will impact or overload capacity. Location information on hospitals and urgent care facilities may be found in Map 42, page 82.

Consequence Analysis

This consequence analysis lists the potential impacts of a hazard on various elements of community and state infrastructure. The impact of each hazard is evaluated in terms of disruption of operations, recovery challenges, and overall wellbeing to all Shiawassee County residents and first responder personnel. The consequence analysis supplements the hazard profile by analyzing specific impacts.

Table 69: Severe Winter Weather Consequence Analysis

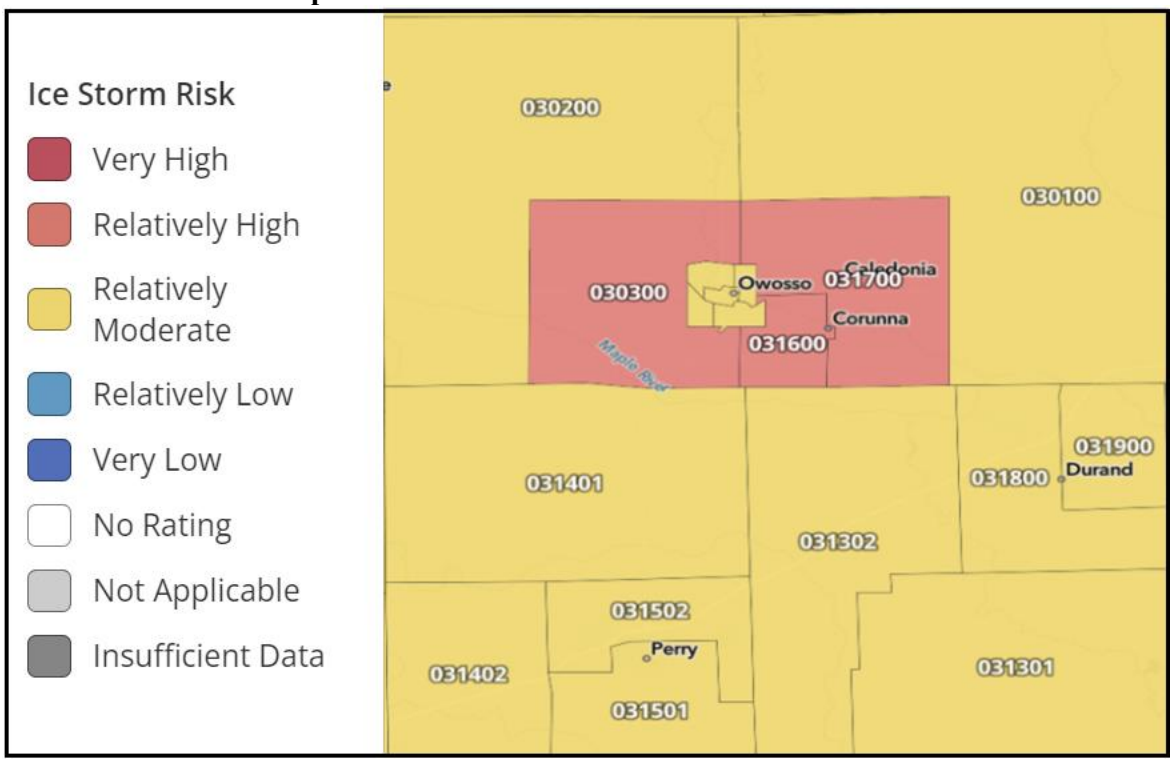
Subject	Potential Impacts
Impact on the Public	Freezing temperatures coupled with heavy snow accumulation can cause dangerous travel conditions, leading to accidents and road closures. Downed power lines can lead to a loss of electricity and heat, with the young and the elderly especially vulnerable. Extremely cold temperatures may lead to hypothermia and death.
Impact on Responders	Dangerous road conditions create a transportation challenge for first responders. First responders will need to control their own exposure to the elements for prolonged periods of time and will need to continuously seek heat and shelter to stay warm. Equipment may also be damaged or destroyed due to cold temperatures, heavy wind, ice, and heavy snow fall, which may lead to a decrease in response capabilities.
Continuity of Operations	Local jurisdictions maintain continuity plans which can be enacted as necessary. Severe winter weather may impact an agency's ability to maintain operations due to power outages and transportation difficulties. If the activation of alternate facilities was required, travel may be difficult. Additionally, computer/network and other communication access may be impacted due to power outages.
Delivery of Services	The ability to deliver services can be impacted locally, regionally, or statewide depending on the severity of the severe winter weather event. Dangerous road conditions may lead to roadway and bridge closures, as well as transit service disruptions. Businesses and places of commerce may completely shut down, which leads to the disruption of goods and services.
Property, Facilities, and Infrastructure	Transportation, governmental operations, and communications may be heavily disrupted. Roads and bridges may be heavily impacted by severe winter weather, and may be completely obstructed by downed trees, powerlines, and snow accumulation. Snow and ice can impact access to homes and critical facilities such as hospitals, schools, and supermarkets. Power loss can lead to disruption of critical infrastructure and technology.
Impact on Environment	Heavy snow and ice accumulation can weigh down and damage vegetation, tree limbs, and power lines. Flooding may also occur after the rapid melting of a heavy snowfall, causing bodies of water to flood, damaging the surrounding areas. Exposure to extreme winter weather may result in animal death. Chemicals used to treat roadways may contaminate natural environments and water reservoirs if used in large quantities.
Economic Conditions	Severe winter weather poses a fiscal impact on the governments, even if some of those costs can be recouped through federal grant reimbursements. Local, county, and state resources may be drained by a severe winter weather event.
Public Confidence in Governance	The public's confidence in governance is affected by immediate local and state response through direct and effective actions. Efficiency in response and recovery operations is critical in keeping public confidence high.

4.12.7 Jurisdictional Risk and Vulnerability

To help understand the risk and vulnerability to severe thunderstorms of participating jurisdictions mapping from the FEMA NRI was run on a census tract level. As the NRI does not generate mapping for individual jurisdictions, census tract analysis is the closest analogue available to understand individual jurisdiction conditions.

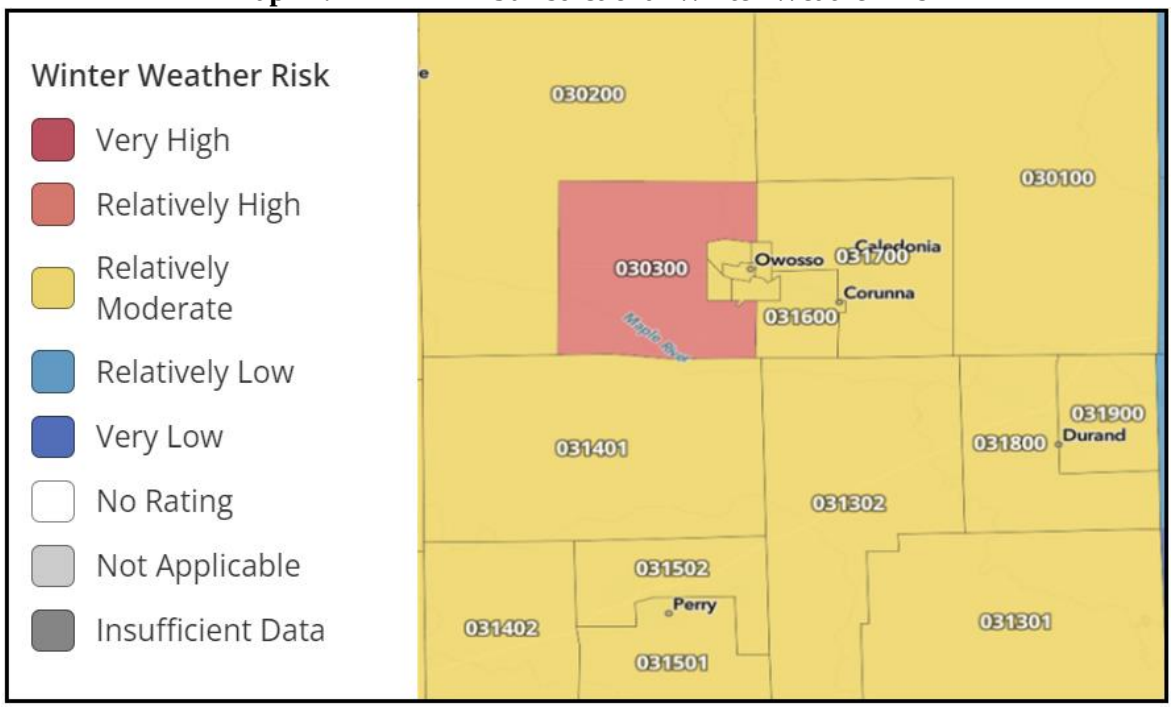
Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following map was created indicating the potential risk to participating jurisdictions from ice storms and winter weather:

Map 70: FEMA NRI Jurisdictional Ice Storm Risk



Source: FEMA NRI

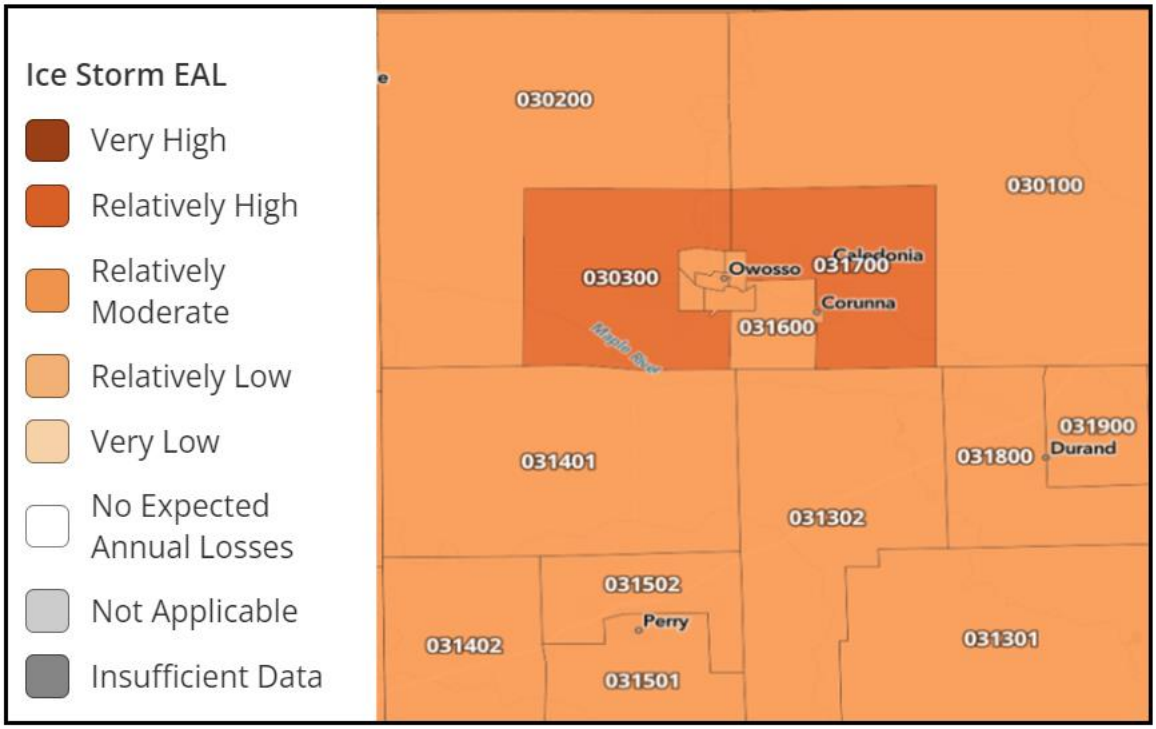
Map 71: FEMA NRI Jurisdictional Winter Weather Risk



Source: FEMA NRI

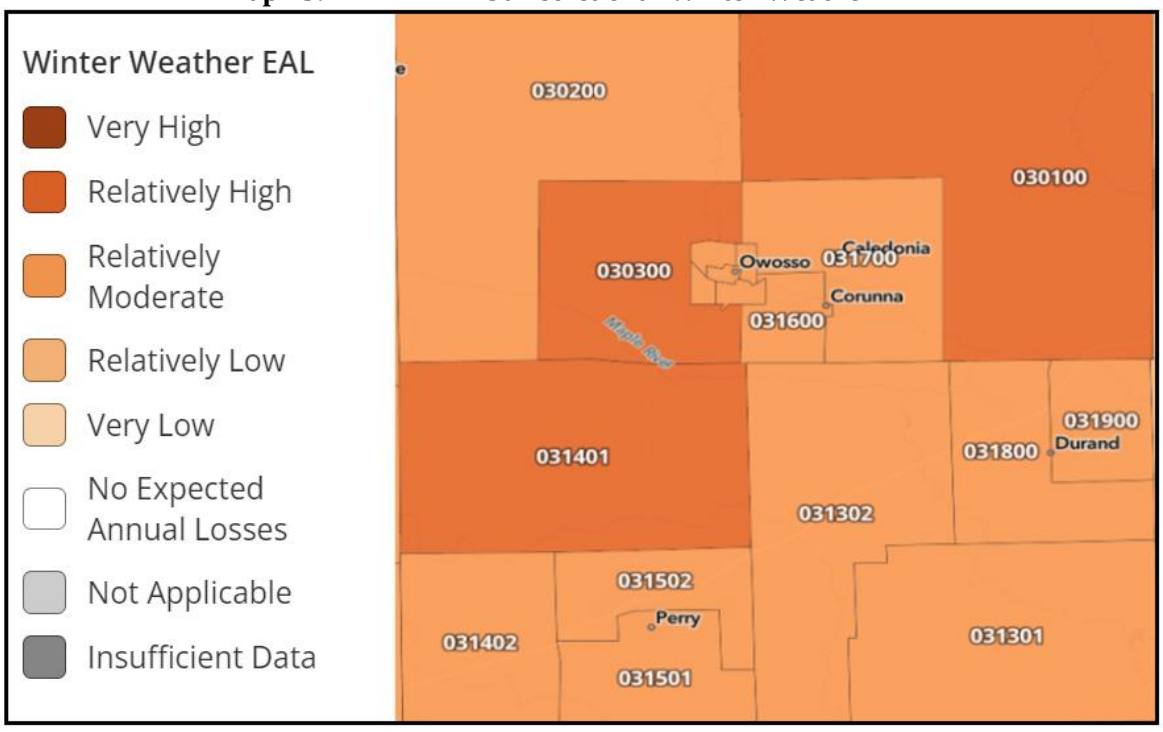
As part of the NRI, EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following map indicates the EAL for ice storms and winter weather for participating jurisdictions within Shiawassee County:

Map 72: FEMA NRI Jurisdictional Ice Storm EAL



Source: FEMA NRI

Map 73: FEMA NRI Jurisdictional Winter Weather EAL



Source: FEMA NRI

The following table indicates the FEMA NRI and EAL analysis for winter weather for each participating Shiawassee County jurisdiction:

Table 70: Shiawassee County FEMA EAL and NRI for Winter Weather

Jurisdiction	Ice Storm EAL	Ice Storm Risk Index	Winter Sorm EAL	Winter Storm Risk Index
Shiawassee County	Relatively Low	Relatively Moderate	Relatively Low	Relatively Moderate
City of Durand	Relatively Low	Relatively Moderate	Relatively Low	Relatively Moderate
City of Laingsburg	Relatively Low	Relatively Moderate	Relatively Moderate	Relatively Moderate
City of Owosso	Relatively Low	Relatively Moderate	Relatively Low	Relatively Moderate
City of Perry	Relatively Low	Relatively Moderate	Relatively Low	Relatively Moderate
Owosso Township	Relatively Low	Relatively Moderate	Relatively Low	Relatively Moderate

Source: FEMA NRI

Of particular concern, socially vulnerable and at-risk populations that may have difficulty with poverty or extremes in age may have an increased susceptibility to the impacts of this hazard. These populations suffer a disproportionate impact due to:

- Inadequate access to heating
- Constrained financial resources
- Age related sensitivity

Data concerning vulnerable population may be found in Section 3.4, page 14.

Since winter storms threaten the entire planning area equally, all structures are considered exposed and vulnerable. Data from the FEMA Hazus system indicates the total value of property within Shiawassee County is $11,130,400.

4.13 Tornado

4.13.1 Hazard Description

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

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

4.13.2 – Location and Extent

Tornadoes can strike anywhere in Shiawassee County or its participating jurisdictions placing the entire planning area at risk. A tornado may arrive with a squall line or cold front and touch down quickly. Smaller tornadoes can strike without warning. Other times tornado watches and sirens will alert communities of high potential tornado producing weather or an already formed tornado and its likely path.

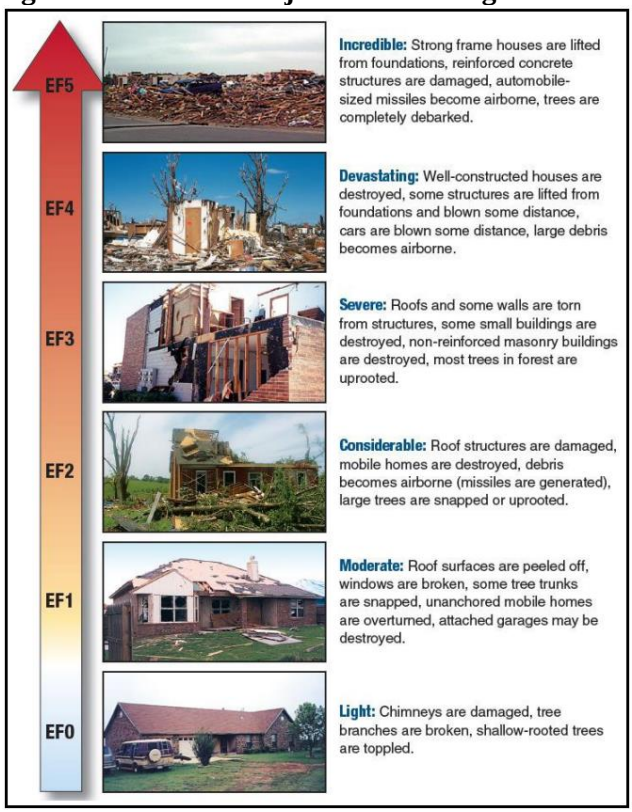
Since 2007, the United States uses the Enhanced Fujita (EF) Scale to categorize tornadoes. The scale correlates wind speed values per F level and provides a rubric for estimating damage.

Table 57: Enhanced Fujita Scale

Scale	Wind Speed (mph)	Relative Frequency	Potential Damage
EF0	65-85	53.5%	Light. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.
EF1	86-110	31.6%	Moderate. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	10.7%	Considerable. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes complete destroyed; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	3.4%	Severe. Entire stores of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	0.7%	Devastating. Well-constructed houses and whole frame houses completely leveled; cars thrown, and small missiles generated.
EF5	>200	<0.1%	Explosive. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 300 ft.; steel reinforced concrete structure badly damaged; high rise buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA Storm Prediction Center

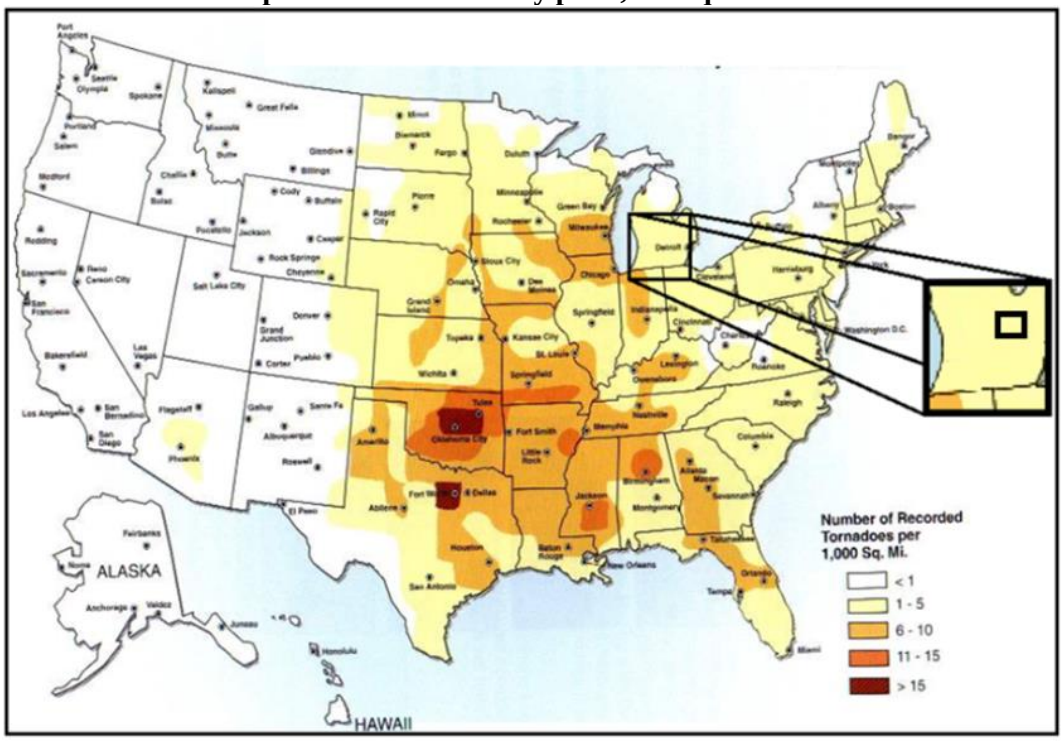
Figure 4: Enhanced Fujita Scale Damage Estimates



Source: FEMA

The following map, from FEMA, indicates that Shiawassee County can expect, on average, one to five tornadoes per 1,000 square miles, a moderate category.

Map 74: Tornado Activity per 1,000 Square Miles



Source: FEMA

4.13.3 Previous Occurrences

Historical events of significant magnitude or impact can result in a Presidential Disaster Declaration. The following table details Disaster Declarations for Shiawassee County for tornado events from 1953-2023:

Table 58: Shiawassee County Presidentially Declared Disasters

Designation	Declaration Date	Incident Type	Assistance	Mitigation Grants
DR-190-MI	04/14/1965	Tornado	-	-

Source: FEMA

The following table presents NCEI identified tornado events and the resulting damage totals in Shiawassee County from 2003 to 2022. with the years 2003 and 2022 being full dataset years. Please note that as tornadoes events tend to cover larger areas occurrence data is being presented as representative of all participating jurisdictions.

Table 59: Shiawassee County NCEI Tornado Events, 1950-2023

Number of Days with Event	Property Damage	Deaths and Injuries	Highest Rated Tornado	Number of EF2 or Greater Tornadoes
27	$17,875,000	16	F4	7

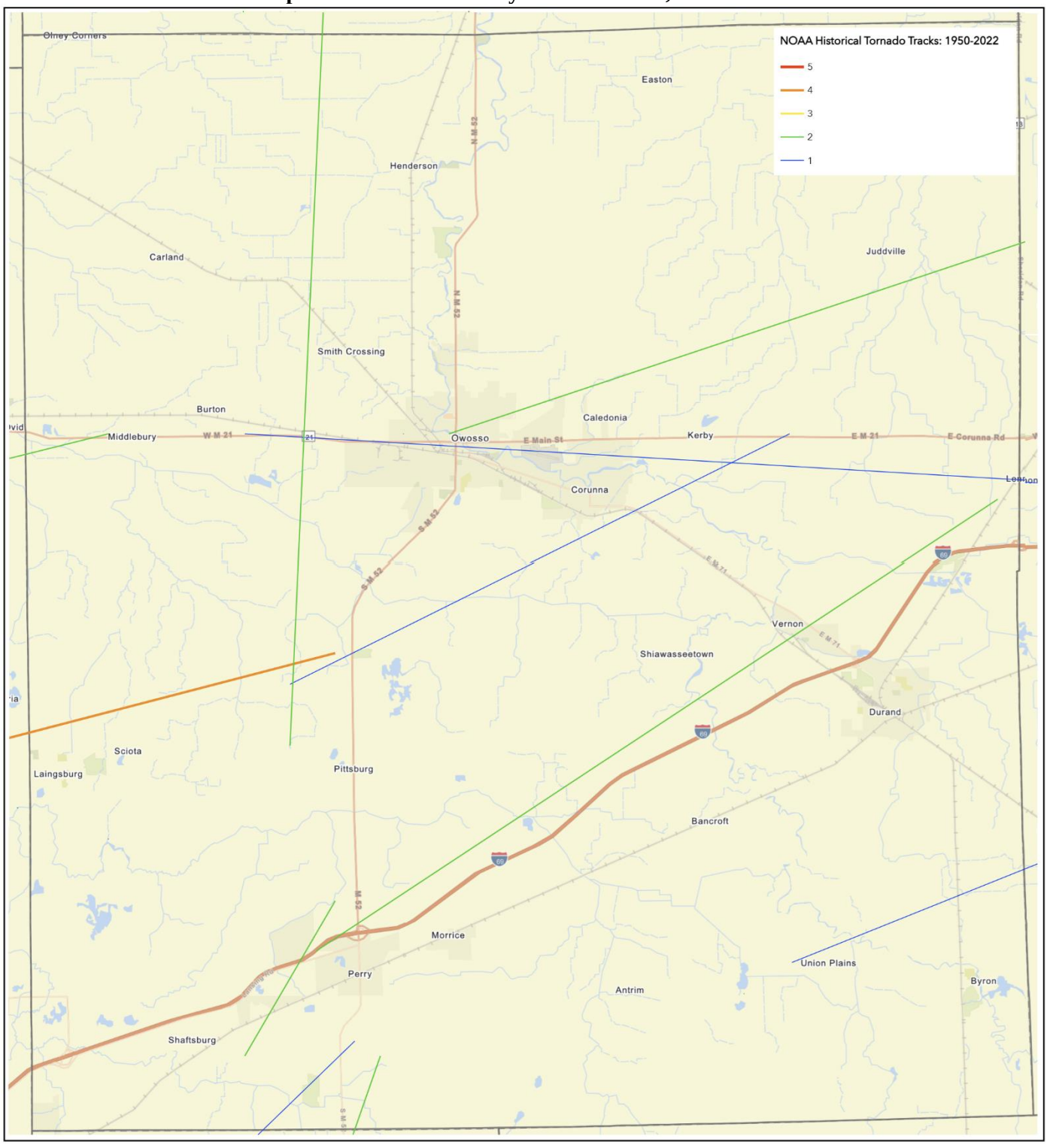
Source: NCEI

The following provides both local accounts and NCEI descriptions of notable recorded events:

- **April 21, 1976, Shiawassee County:** Tornado touched down in Maplewood Creek and proceeded north northeast crossing Northridge Road where it damaged a home, destroyed a pole, barn, two garages and a chicken coop. Damages were estimated at $2,500,000.
- **April 28, 1986, Shiawassee County:** A tornado destroyed 8 barns, 4 houses and 1 business along Brewer Road west of Reuss Road, south of Bennington. A tornado continued northward, blew a truck off the road, and rolled over 3 times south of Brant. Damages were estimated at $2,500,000.
- **March 14, 2019, Shiawassee County:** A large powerful low-pressure system moved up across the central Plains with weather ranging from blizzard to tornadoes. The Shiawassee Emergency Manager reported 135 structures, 94 homes, 4 businesses, 16 barns and 22 RVs were damaged or destroyed in the wake of the storms. Damages are estimated at $9,750,000.

NOAA has been tracking tornadoes in Shiawassee County for decades. This following map, which contains data from 1950 to 2022, pinpoints where tornadoes have touched down and traces its path.

Map 75: Shiawassee County Tornado Paths, 1950 to 2022



Source: FEMA RAPT

4.13.4 Probability of Future Events

Predicting the probability of tornado occurrences is tremendously challenging due to the large number of factors involved and the random nature of formation. Data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to tornado events:

Table 60: Shiawassee County Tornado Probability Summary

Data	Events
Number of Days with NCEI Reported Event (1950-2023)	27
Average Events per Year	<1
Strongest EF Rated Tornado	F4

Source: NCEI

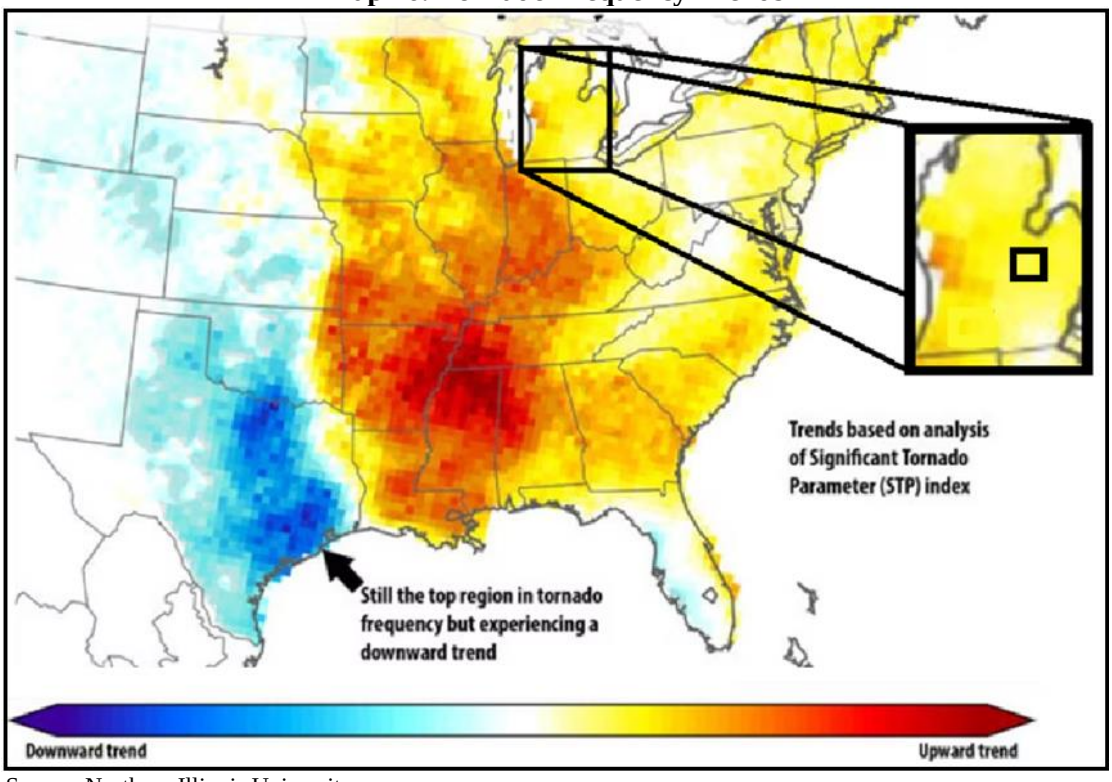
4.13.5 Projected Changes in Location, Intensity, Frequency, and Duration

The relationship between climate change and tornadoes is complex, and while there is ongoing research in this area, it is not fully understood. Tornadoes are small-scale, short-lived weather phenomena that can be influenced by a variety of atmospheric factors, including temperature, humidity, wind patterns, and atmospheric instability. Climate change can influence some of these factors, which may, in turn, affect tornado activity. Tornadoes typically form when warm, moist air near the surface clashes with cooler, drier air aloft, creating atmospheric instability. Climate change can alter temperature and humidity patterns, potentially affecting the conditions necessary for tornado formation. Additionally, climate change can lead to more extreme and variable weather patterns. While this may not necessarily increase the overall number of tornadoes, it could lead to more unpredictable and severe tornado events when they do occur. Some research suggests that climate change could lead to longer tornado seasons, with tornadoes occurring outside of their typical timeframes.

It's important to emphasize that while there may be some links between climate change and tornado activity, these links are not fully understood, and it is difficult to attribute specific tornado events to climate change. Tornadoes are influenced by a complex interplay of factors, and any changes in tornado patterns may vary by region.

Research conducted by the National Severe Storms Lab looked at to help determine future tornado probability. Significant Tornado Parameters are a measurement of the major parameters of tornado conditions, including wind speed and direction, wind at differing altitudes, unstable air patterns, and humidity. The following map, generated by Northern Illinois University and compiled from Significant Tornado Parameter data, indicates that Shiawassee County may see an increasing number of tornadoes.

Map 76: Tornado Frequency Trends



Source: Northern Illinois University

As indicated in the data above, Shiawassee County and all participating jurisdictions have been seeing generally static or declining populations. A static or declining population could decrease population risks to tornadoes by nature of their being fewer citizens to negatively impact.

Shiawassee County's current land-use regulations require the consideration of building codes during the development review process. A building-by-building structural review, including roof profile, type and strength of windows, and foundation systems would need to be considered to determine structural risk. However, enforced building codes can ensure that newly built and renovated structures can better withstand tornado events.

The agriculture base of Shiawassee County is increasingly vulnerable to the effects of tornadoes. Future development of agricultural resources would tend to increase the risk and impact of an event. As indicated in the data above, Shiawassee County is seeing a continuing projected increase in agricultural activities and thus a potential greater future vulnerability.

4.13.6 Vulnerability and Impact

Data from the NCEI indicates that Shiawassee County can expect on a yearly basis, relevant to tornado events:

Table 61 : Shiawassee County Tornado Impact Summary

Data	Recorded Impact
Deaths or Injuries (1950-2023)	16
Average Number of Deaths or Injuries	<1
Total Reported NCEI Property Damage (1950-2023)	$17,875,000
Average Property Damage per Year	$244,863

Source: NCEI

Data from HAZUS was used to provide a county building stock valuation. This data was then compared to NCEI structural damage figures to determine the percentage of impacted buildings within the county for the period of 1950-2022 for tornadoes. Data was only available at a county level.

Table 62: Shiawassee County HAZUS and NCEI Tornado Percentage Loss Data

Hazard	HAZUS Building Valuation	NCEI Structure Damage, 1950-2023	Percentage of Building Valuation Damaged
Tornado	$11,130,400,000	$17,875,000	0.2%

Source: FEMA HAZUS

While difficult to quantify, as the impacts of future tornadoes will be determined by many factors, the impacts of a tornado may be widespread. An EF4 or EF5 tornado has the potential to level facilities. A lesser magnitude tornado can rip off roofs and walls while launching airborne missiles born from debris. In the absence of proper shelter tornadoes can cause serious injury. In general, if potentially exposed persons take shelter in a solid, well-constructed shelter protection from tornadoes would be provided. However, old or poorly constructed facilities may be more prone to damage, potentially increasing the impact on economically disadvantaged populations.

Tornadoes can have significant and often devastating impacts on people and communities. These impacts can vary depending on the tornado's intensity, size, path, and may include:

- Injuries and Fatalities: Tornadoes can cause a wide range of injuries, from minor cuts and bruises to severe trauma. Flying debris, structural damage, and the force of the wind can lead to injuries or fatalities among those directly affected by the tornado. Prompt medical care is essential to treat injuries effectively and save lives.
- Mental Health Effects: Tornadoes can be extremely traumatic events, causing psychological distress and emotional trauma for survivors. Individuals may experience post-traumatic stress disorder, anxiety, depression,

and grief. Mental health support and counseling services are often needed to help survivors cope with these emotional challenges.
- Displacement: People may need to evacuate their homes or be temporarily displaced due to tornado damage, requiring emergency shelter and support.

After a tornado, health risks may arise due to contaminated water, debris, and unsafe conditions. Inadequate sanitation and exposure to harsh weather can exacerbate health issues. Children, the elderly, and individuals with disabilities or limited mobility may face additional challenges in evacuating to safety and accessing needed resources.

Tornadoes can have significant and wide-ranging impacts on facilities, critical facilities, and critical infrastructure. These risks can have significant economic and operational consequences, and can include:

- Critical Facility Damage: Hospitals and healthcare facilities may be damaged or rendered inoperable during tornadoes, affecting the ability to provide medical care during a disaster. Fire stations, police stations, and emergency operation centers may be damaged or destroyed, impacting the ability of first responders to coordinate disaster response efforts. Damage to emergency shelters and housing facilities can disrupt services which are critical for providing temporary shelter to displaced individuals and families.
- Infrastructure Damage: High winds and blowing debris can cause considerable damage to infrastructure. This can result in costly repairs and disruptions to daily lives for an extended period.
- Power Outages: Tornadoes can cause power outages by bringing down power lines and damaging electrical infrastructure. Critical facilities such as hospitals, emergency response centers, and data centers may rely on backup generators to maintain essential operations during outages.
- Communication Disruptions: Tornadoes can damage communication infrastructure, including cell towers, telephone lines, and data centers, leading to disruptions in phone and internet services. This can hinder emergency communication and coordination, affecting critical response efforts.
- Transportation Disruptions: Debris and fallen trees on roads, runways, and railways can disrupt transportation networks, leading to travel delays, accidents, and closures. Critical facilities may face challenges in receiving essential supplies and personnel during and after the storm.
- Healthcare System Strain: Hospitals and healthcare facilities may experience increased demand for medical services due to storm-related injuries and illnesses.
- Water and Wastewater System Interruptions: Tornadoes can damage water treatment plants, pumping stations, and water distribution systems. This can lead to a loss of clean drinking water and sanitation services, posing health risks to affected communities. Damage to wastewater treatment facilities and sewer systems can result in the release of untreated sewage, creating environmental hazards and public health concerns.
- Property Damage: Tornadoes can result in property damage, up to and including complete structural collapse.

Tornadoes can have significant impacts on the environment. These impacts are often destructive and can affect ecosystems, wildlife, natural resources, and even the local climate. Tornadoes can disrupt natural habitats by uprooting or damaging trees, destroying vegetation, and altering landscapes. This can affect the habitat suitability for wildlife and plant species. Tornadoes can harm or displace wildlife, resulting in injury or death. Nesting birds, burrowing mammals, and other species can be particularly vulnerable. As tornadoes can transport plant seeds, insects, and other organisms over long distances, in the aftermath it is possible for invasive species to take root in new areas, especially those impacted by wildfires caused by downed utility lines.

Tornadoes can have significant and wide-ranging impacts on local operations. Some of the key impacts of tornadoes on operations may include:

- Emergency Response and Public Safety: Tornadoes can lead to a surge in emergency calls for services related to accidents, injuries, and damaged structures. Agencies involved in emergency response must mobilize additional resources to handle these demands.

- Emergency Operations Centers: Tornadoes often require the activation of state Emergency Operations Centers to coordinate emergency response efforts. These centers serve as hubs for communication, resource allocation, and decision-making during disasters.
- Emergency Shelters and Services: Tornadoes may require the establishment of emergency shelters and services for displaced residents. Agencies must coordinate the setup and operation of these facilities.
- Education Disruption: Tornadoes can lead to school closures, affecting education programs and services. Agencies may need to coordinate with school districts to ensure the safety of students.
- Budgetary Impact: The costs associated with emergency response efforts, disaster recovery, and infrastructure repair can strain state budgets.
- Resource Allocation: State governments must allocate resources, including personnel, equipment, and stockpiled supplies, to support emergency response and recovery efforts.
- Communication Challenges: Tornadoes can disrupt communication networks, hindering the ability of government agencies to communicate internally and with the public. This can impact emergency notifications and coordination efforts.
- Administrative and Governance Challenges: State government offices and facilities may experience closures or reduced staffing during tornadoes, affecting administrative functions, regulatory processes, and public services.
- Economic Impact: The destruction of infrastructure and businesses can have significant economic consequences for the state and local communities, including job losses and reduced economic activity.
- Public Services: Tornadoes can disrupt the delivery of public services, including transportation, utilities, and social services, affecting the well-being of residents.

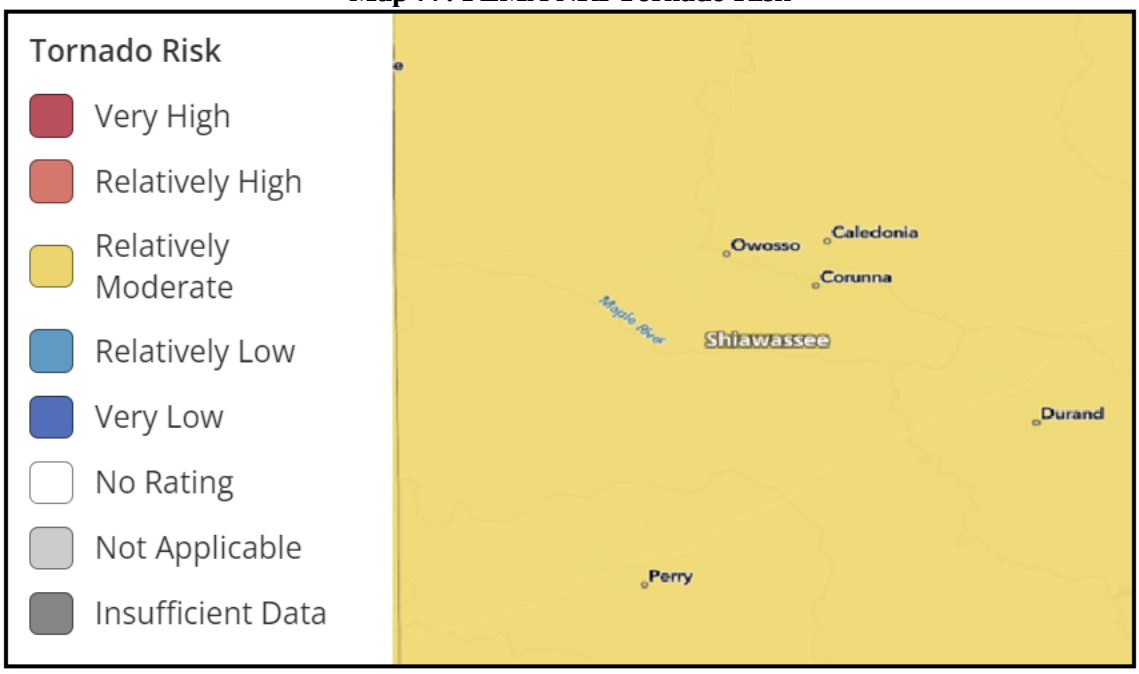
Tornadoes can have severe and destructive impacts on government facilities and assets, affecting operations, and potential impacts may include:

- Structural Damage: Tornadoes can cause significant structural damage to government buildings. Roofs may be torn off, walls may collapse, and windows may shatter.
- Communication Infrastructure Damage: Tornadoes can damage communication infrastructure, such as cell towers, antennas, and communication lines, affecting the ability of government agencies to coordinate emergency response efforts.
- Infrastructure Damage: Tornadoes can block roads, damage bridges, and disrupt transportation networks.

Data from the FEMA Hazus system indicates the total value of government property within Shiawassee County is $142,910,000, all of which is vulnerable to tornadoes.

Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following map was created indicating the potential risk to Shiawassee County from tornadoes:

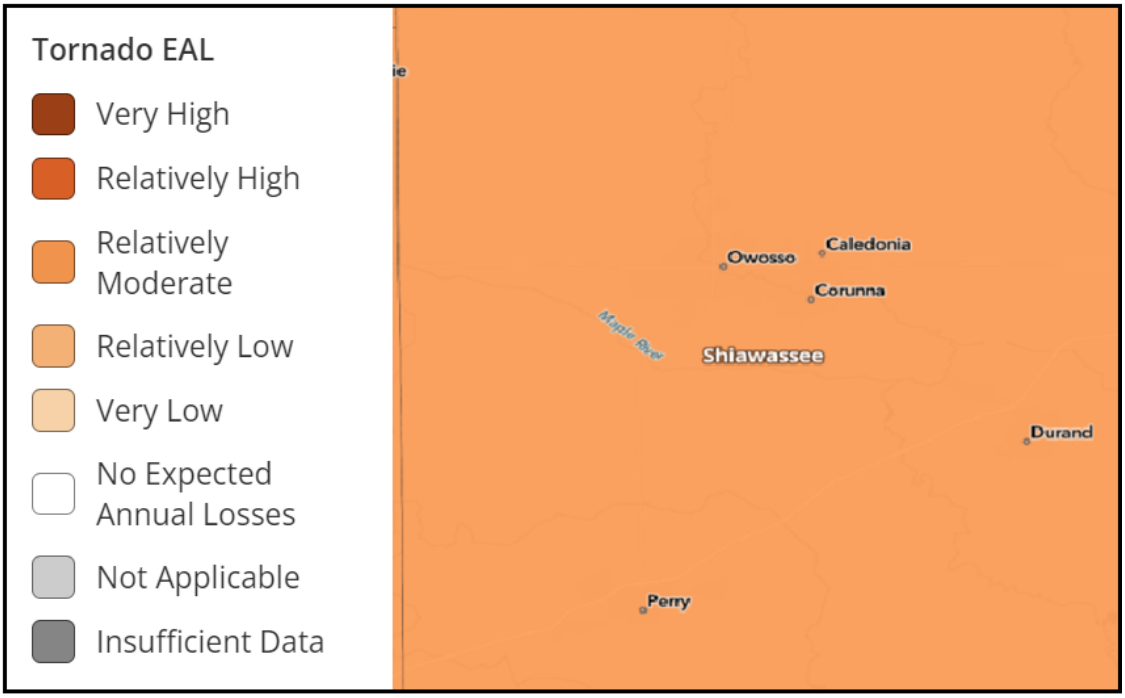
Map 77: FEMA NRI Tornado Risk



Source: FEMA NRI

EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following map indicate the EAL for tornadoes for Shiawassee County:

Map 78: FEMA NRI Tornado EAL



Source: FEMA NRI

Potentially Vulnerable Community Lifelines

Tornadoes can have significant impacts on electrical utilities, leading to disruptions in power supply and potential damage to infrastructure. The high winds associated with smaller tornadoes can cause trees, branches, and other debris

to fall onto power lines. Higher intensity tornadoes can destroy transmission infrastructure. This can result in downed power lines, structural damage to utility poles, and disruptions in electrical service.

Data concerning electrical generating stations and high-capacity transmission lines may be found in Map 31, page 63.

The cost to replace electrical lines can vary widely based on several factors, including the type of electrical lines, the distance of the replacement, local labor and material costs, the complexity of the project, and any specific requirements or challenges involved. Additionally, costs can be significantly different for residential, commercial, or industrial projects. Additionally, urban and rural locations may have varying cost factors. As a rough estimate, the cost to replace electrical lines can range from a few thousand dollars to several thousand dollars per mile.

Communications systems within Shiawassee County may have an increased vulnerability to tornado events. Of particular concern is 911 and the dispatch system. Shiawassee County and all jurisdictions are served by the Shiawassee County Consolidated Dispatch Authority, a public authority formed under the Urban Cooperation Act of 1967. The Shiawassee County Consolidated Dispatch Authority is the sole public safety answering point in Shiawassee County, providing direct dispatching for:

- Law Enforcement
- Emergency Medical Services
- Fire

Tornadoes can disrupt this vital communications system, affecting reliability and functionality. Some of the key vulnerabilities include:

- Structural Damage to Communication Towers: Tornadoes can cause direct structural damage to communication towers, including cellular, television, radio, and microwave towers. Toppled or damaged towers can disrupt signal transmission and reception.
- Power Outages: Tornadoes often cause power outages by damaging electrical infrastructure. Communication facilities, including cell towers and data centers, rely on a stable power supply. Power failures can lead to service interruptions.
- Fiber Optic Cable Damage: Flying debris and tornado-related destruction can damage underground and aerial fiber optic cables. Severed cables can disrupt data transmission and internet connectivity.
- Microwave Link Disruptions: Tornadoes can interfere with microwave communication links, which are used for long-distance communication. High winds and debris can disrupt the line of sight needed for these links.
- Equipment Damage: Communication equipment located outdoors, such as antennas, dishes, and amplifiers, can be damaged by tornadoes, affecting the performance of communication systems.
- Loss of Communication Nodes: Tornadoes can damage communication nodes, exchanges, and network switching centers. Loss of these critical components can lead to widespread service disruptions.
- Cellular Network Congestion: In the aftermath of a tornado, there is often an increased demand for cellular communication as individuals seek information and contact loved ones. This surge in demand can lead to network congestion and reduced service quality.

The cost to repair the Shiawassee County communications network can vary widely depending on the extent of the damage, the size of the network, and the specific technologies involved. Data concerning potential repair cost mat be found in Table 52, page 101.

Tornadoes can significantly impact emergency response infrastructure, creating challenges for first responders and organizations involved in managing and mitigating the effects of severe weather events. Tornadoes can impact emergency response through:

- Transportation Disruptions: Debris on roads can hinder the ability of emergency vehicles to navigate and reach affected areas promptly. Hazardous road conditions may result in delays in response times.
- Road Closures: Tornadoes can lead to the closure of roads due to debris accumulation and hazardous conditions. This can limit access for emergency vehicles and impede the evacuation of residents.
- Communication Disruptions: Tornadoes can disrupt communication networks, affecting the ability of emergency responders to coordinate and communicate effectively. Downed power lines and damage to communication infrastructure contribute to these disruptions.
- Power Outages: Tornadoes downing power lines can lead to power outages. Emergency response facilities, such as command centers and fire stations, may lose power, affecting their operational capabilities.
- Resource Allocation Challenges: Tornadoes often require the allocation of additional resources, including personnel, equipment, and supplies, to address immediate needs. This can strain emergency response organizations and impact their ability to respond to other concurrent incidents.
- Logistical Challenges: Tornadoes may create logistical challenges for the transportation of supplies, equipment, and personnel to affected areas, hindering the overall effectiveness of emergency response efforts.
- Increased Demand for Services: Tornadoes can result in an increased demand for emergency services, including medical assistance, search and rescue operations, and responses to accidents. Emergency response organizations may need to manage a higher volume of incidents simultaneously.

Location information concerning fire stations and law enforcement centers may be found in Maps 43 and 44, pages 82 and 83.

While hospitals and urgent care facilities may see an increase in tornado related injuries during an event, it is considered unlikely that this increase will impact or overload capacity. Location information on hospitals and urgent care facilities may be found in Map 42, page 82.

Consequence Analysis

This consequence analysis lists the potential impacts of a hazard on various elements of community and state infrastructure. The impact of each hazard is evaluated in terms of disruption of operations, recovery challenges, and overall wellbeing to all Shiawassee County residents and first responder personnel. The consequence analysis supplements the hazard profile by analyzing specific impacts.

Table 63: Tornado Consequence Analysis

Subject	Potential Impacts
Impact on the Public	High wind speeds can cause automobiles to become airborne, destroy homes, and turn debris into projectiles, which may cause injury or death. An increased demand for medical treatment for traumatic injuries caused by the tornado would be anticipated. Significant portions of the population may be displaced by the destruction and those individuals may not have access to personal documents or medical records.
Impact on Responders	First responders may be injured as the tornado passes, resulting in employee absenteeism that impacts the overall capacity to respond to the event. The deposit of debris on major roadways, the location of the event, and/or damage to equipment or facilities may increase the response times. Exposed wires or hazardous materials may cause injury to first responders during search and rescue operations.
Continuity of Operations	Local jurisdictions maintain continuity plans which can be enacted as necessary based on the situation. Tornadoes may impact an agency's ability to maintain continuity of operations due to power or communications infrastructure impacts. If the activation of alternate facilities was required, travel may be difficult due to reduced transportation options, power outages, or damage to facilities.
Delivery of Services	Delivery of services may be impacted by dangerous conditions or disruption to transportation systems, causing food, water, and resource systems to be delayed or

Table 63: Tornado Consequence Analysis

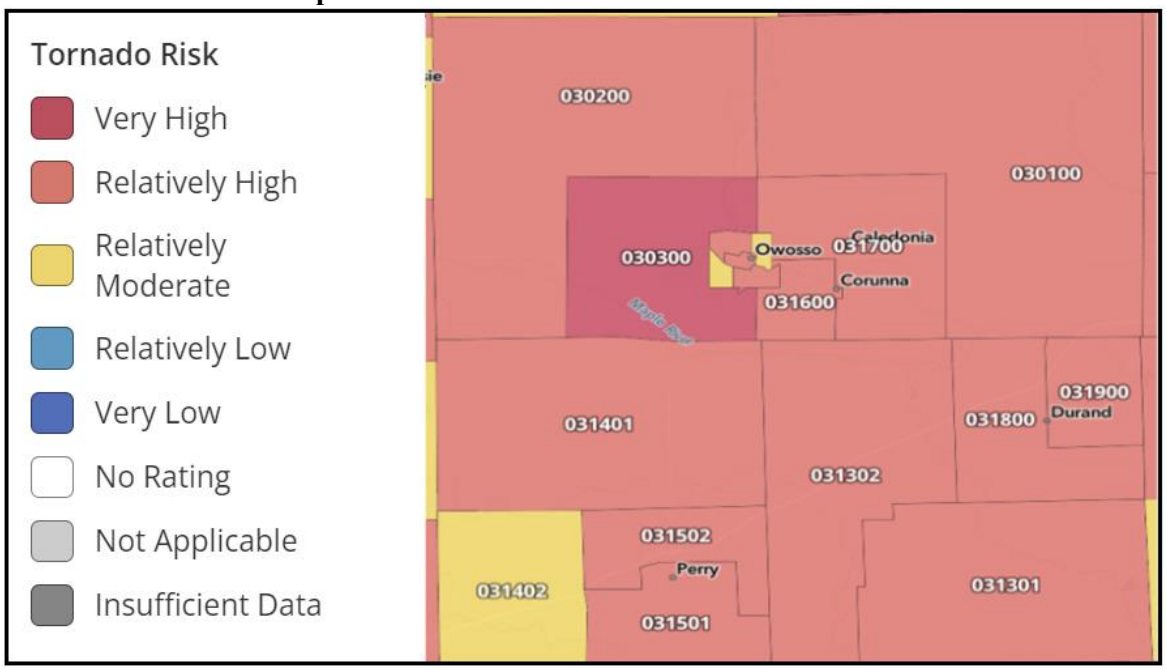
Subject	Potential Impacts
	halted. Waterway infrastructure may be damaged or malfunction, stopping barge and ship traffic. Goods may be damaged, destroyed, or carried off by high winds.
Property, Facilities, and Infrastructure	Damages from lower intensity tornadoes can range from chimney damage to uprooted shallow trees. A significant tornado (EF-2) would cause damage to roofs on frame houses, complete destruction of mobile homes and large trees and utility lines snapping. A devastating tornado (EF-4) would result in well-constructed houses being leveled, weak foundations blown away, and cars thrown away. Communications or power infrastructure may be damaged or destroyed.
Impact on Environment	Tornadoes may cause significant damage to the environment by exposing hazardous materials, causing contamination of water or food sources, or uprooting vegetation. Animals may be injured by flying debris or being lifted by the tornado. Agricultural crops may be lost due to contamination or being uprooted.
Economic Conditions	Tornadoes pose a fiscal impact on the local governments, even if some of those costs can be recouped through federal grant reimbursements. Fiscal resources may be drained by the occurrence of a tornado.
Public Confidence in Governance	The public's confidence in governance is affected by immediate local and state response through direct and effective actions. Efficiency in response and recovery operations is critical in keeping public confidence high.

4.13.7 Jurisdictional Risk and Vulnerability

To help understand the risk and vulnerability to severe thunderstorms of participating jurisdictions mapping from the FEMA NRI was run on a census tract level. As the NRI does not generate mapping for individual jurisdictions, census tract analysis is the closest analogue available to understand individual jurisdiction conditions.

Using the FEMA NRI, and consisting of three input components (expected annual loss, social vulnerability, and community resilience), the following map was created indicating the potential risk to participating jurisdictions from tornadoes:

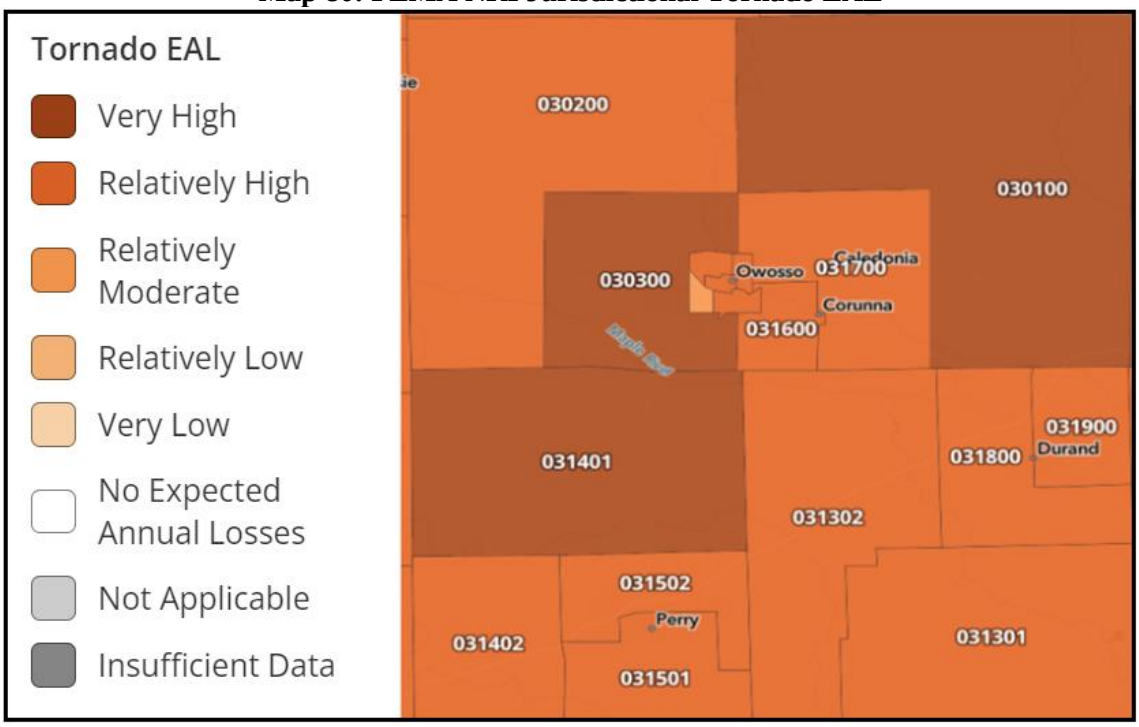
Map 79: FEMA NRI Jurisdictional Tornado Risk



Source: FEMA NRI

As part of the NRI, EAL represents the average economic loss in dollars resulting from natural hazards each year and is proportional to a community's risk. The following map indicates the EAL for tornadoes for participating jurisdictions within Shiawassee County:

Map 80: FEMA NRI Jurisdictional Tornado EAL



Source: FEMA NRI

The following table indicates the FEMA NRI and EAL analysis for tornadoes for each participating Shiawassee County jurisdiction:

Table 64: Shiawassee County FEMA EAL and NRI for Tornadoes

Jurisdiction	Tornado EAL	Tornado Risk Index
Shiawassee County	Relatively High	Relatively High
City of Durand	Relatively High	Relatively High
City of Laingsburg	Very High	Relatively High
City of Owosso	Relatively High	Relatively High
City of Perry	Relatively High	Relatively High
Township of Owosso	Relatively High	Relatively High

Source: FEMA NRI

Lower income communities, including communities with a large percentage of mobile homes, may suffer disproportionate impacts from tornado events. Data concerning mobile homes may be found in Section 3.6, pages 20.

Since tornadoes threaten the entire planning area equally, all tribal, municipal, and school district structures are considered exposed and vulnerable. Data from the FEMA Hazus system indicates the total value of property within Shiawassee County is $11,130,400,000

Section 5 –Capability Assessment

5.1 Introduction

This capability overview for Shiawassee County documents programs, policies, and funding mechanisms for participating jurisdictions. All listed capabilities documented in the previous LHMP were reviewed for relevance and updated to reflect the current environment, as necessary. Additionally, any programs, policies, or funding mechanisms that are no longer applicable, are outdated, or are no longer in existence have been removed. As part of this process, updated jurisdictional capability profiles were sent for review and, if necessary, further revision.

This section of the plan discusses the current capacity of regional communities to mitigate the effects of identified hazards. A capability assessment is conducted to determine the ability of a jurisdiction to execute a comprehensive mitigation strategy, and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs or projects.

A capability assessment helps to determine which mitigation actions are practical based on a jurisdiction's fiscal, staffing and political resources, and consists of:

- An inventory of relevant plans, ordinances, or programs already in place
- An analysis capacity to carry them out.

A thoughtful review of jurisdictional capabilities will assist in determining gaps that could limit current or proposed mitigation activities, or potentially aggravate a jurisdiction's vulnerability to an identified hazard. Additionally, a capability assessment can detail current successful mitigation actions that should continue to receive support.

The capability of each participating jurisdiction varies based largely on the size and financial capabilities. While all jurisdictions have the capability needed to conduct mitigation planning, many rely on the technical expertise of both Shiawassee County and the State of Michigan to apply for mitigation grant funding and oversee mitigation projects. Additionally, further augmenting local emergency management capabilities, the State of Michigan aids with state and federal mitigation and emergency management initiatives and available funding opportunities.

Technical capabilities for each participating jurisdiction vary widely and are generally based on financial capabilities. In general, more urban, or larger jurisdictions have a greater range of technical capabilities and staffing related to planning, engineering, and mapping, while smaller counties and jurisdictions lack these capabilities.

The following table details local departments and positions and their roles in supporting hazard mitigation planning:

Table 71: Local Jurisdiction Department and Positions Supporting Mitigation Planning

Department or Position	Description	Role in Mitigation
Building Officials	Implements and enforces building codes and zoning ordinances.	Ensures construction standards are consistently applied.
Emergency Management Director	Directs local response, recovery, and mitigation programs.	Develops Local Emergency Operations Plan, Continuity Plans, and Hazard Mitigation Plans, helping to minimize loss of life and property damage.
NFIP/CRS Coordinators	Oversees compliance with the NFIP and CRS and addresses flood determinations, mapping issues, and construction standards within Special Flood Hazard Areas.	Reviews floodplain/building permits for structures within floodplains and inspects developments to determine compliance with the community development standards and NFIP requirements. Explains floodplain

Table 71: Local Jurisdiction Department and Positions Supporting Mitigation Planning

Department or Position	Description	Role in Mitigation
		development requirements to community leaders, citizens, and the general public.
Planning Boards	Recommends land use regulations	Coordinates with the NFIP Coordinator and the Hazard Mitigation Committee through the mitigation planning process and the implementation of the plans.
Public Works Departments	Responsible for municipal drainage and storm water management systems.	Provides for the ongoing maintenance and upgrading of local storm water systems to help reduce flood risks.
Town/Township/City Council	Approves subdivision, zoning and land ordinances and bylaws and facilitates capital improvements budget and plan.	Provide leadership and approval for local hazard mitigation plans, projects, grants, and programs.

5.2 Regulation of Development

The regulation of development plays a crucial role in helping a community become more resilient in the face of various hazards. Effective regulation of development contributes to community resilience through:

- Risk Reduction: Regulations guide land use and construction practices, ensuring that they provide strong protection against hazards.
- Public Safety: Building codes and land-use regulations establish minimum safety standards for construction, including structural integrity, fire resistance, and the use of resilient materials.
- Infrastructure Resilience: Regulations may require infrastructure improvements, such as the construction of resilient roads, bridges, utility systems, and drainage systems. This strengthens a community's ability to withstand hazards, ensures the continued operation of critical services, and aids in recovery.
- Floodplain Management: Regulations in flood-prone areas can mandate elevation requirements for new construction, ensuring that structures are built above the base flood elevation. This minimizes flood damage, reduces the need for costly post-disaster repairs, and protects property values.
- Land Use Planning: Effective land-use planning helps communities avoid inappropriate development in areas at high risk of hazards.
- Community Awareness: Public education and outreach can be incorporated into regulations, requiring communities to inform residents about local hazards, evacuation routes, and preparedness. Informed residents are more likely to take protective measures and respond effectively to disasters.

The following sections provide further detail on building codes, zoning ordinances, and floodplain management.

Building Codes

Pursuant to 1972 PA 230 (Stille-Derossett-Hale Single State Construction Code Act), adopted by the State of Michigan on November 5, 1974 and amended by 1999 PA 245, all communities in Michigan are subject to the State Construction Code. The State Construction Code is a compilation of the following:

- International Residential Code
- International Building Code
- International Mechanical Code
- International Plumbing Code
- National Electrical Code
- Michigan Uniform Energy Code

The State Construction Code establishes general minimum construction standards and is enforced through authorized local building inspection agencies and state inspectors. Building codes provide for:

- Life Safety: Building codes include provisions for fire safety, emergency egress, and the use of fire-resistant materials.
- Accessibility and Life Support: Building codes incorporate accessibility standards, ensuring that buildings are designed to accommodate all individuals. This is crucial during and after disasters when people with mobility issues may require assistance. Accessible features also benefit emergency responders and support recovery efforts.
- Retrofitting Existing Buildings: Building codes may require the retrofitting of older structures to meet modern safety standards.
- Public Awareness: Building codes promote public awareness of hazards and the importance of resilient construction. This can lead to informed decision-making by property owners, builders, and developers, resulting in safer structures.

Key hazard resistant building code provisions found in the Michigan Building Code include:

- Structural Design Requirements: Provides requirements for the structural design of buildings to ensure their resistance to various hazards, including earthquakes, high winds, and snow loads. These requirements are aimed at enhancing the overall structural integrity and safety of buildings.
- Wind Design Requirements: Provides specific provisions for wind design, considering the geographical location of the structure. Wind loads are calculated based on factors such as wind speed, exposure, and building height.
- Seismic Design Requirements: Incorporates seismic design provisions to address earthquake hazards. The code includes seismic design categories and requirements for the design and construction of buildings in seismic-prone regions.
- Flood-Resistant Design Requirements: Includes provisions related to flood-resistant design, particularly in areas prone to flooding. It may specify elevation requirements, construction materials, and other considerations to reduce the risk of flood damage. The vast majority of the regulations required by the NFIP are included within the International Building Code and the International Residential Code.
- Fire-Resistant Construction Requirements: Requirements for fire-resistant construction are included to mitigate the risk of fire hazards. This includes specifications for fire-resistant materials, assemblies, and building features.
- Material and Construction Standard Requirements: Establishes standards for building materials and construction methods to ensure the durability and safety of structures, considering various hazards.

All jurisdictional building code officials were invited to attend planning meetings and were encouraged to provide plan input and recommendations. The following table represents jurisdictional building code officials:

For specific information concerning the local application and enforcement of building codes it is essential to contact the local building department for the most accurate information. It is important to note that building codes are universally and evenly enforced across the state, and no obstacles to enforcing the hazard mitigation provisions in any codes have been identified.

Table 72: Shiawassee County Building or Development Stakeholders

Jurisdiction	Department	Name	Title
Shiawassee County	Community Development	Peter Preston	Director
City of Durand	Building and Zoning	Nate Charles	Director

Table 72: Shiawassee County Building or Development Stakeholders

Jurisdiction	Department	Name	Title
City of Laingsburg	Building and Zoning	Rob Kehoe	Building Official
City of Owosso	Building Department	Tanya S. Buckelew	Planning and Building Director
City of Perry	Building	Rob Kehoe	Building Inspector
Township of Owosso	NA	None	None

Zoning Ordinances

Zoning ordinances in Shiawassee County govern land use, development, and building requirements. These ordinances work by dividing the land into different zoning districts and establishing rules and guidelines for land use, building placement, density, and setback within the zoning districts. In general, zoning ordinances establish:

- **Zoning districts:** Areas designated for specific types of land use, such as residential, commercial, industrial, agricultural, mixed-use, or special districts.
- **Land usage within a zoning district:** Specifications as to which activities, buildings, and operations are permitted in each zoning district.
- **Enforcement:** Zoning ordinances are enforced by the local building department or zoning enforcement officers.

Zoning is the traditional, and most common, tool available to local jurisdictions to control the use of land. Zoning is used to promote health, safety, and the general welfare of the community. Zoning is used to dictate the type of land use and to set minimum specifications for use such as lot size, building height and setbacks, and density of population.

Zoning ordinances play a significant role in enhancing hazard resilience for communities and can help reduce vulnerability to various natural and man-made hazards by regulating land use and development practices. In Shiawassee County, locally instituted and enforced zoning ordinances provide for:

- Land Use Planning: Zoning ordinances designate land use zones within a community, ensuring that certain areas are reserved for particular uses. This can prevent the construction of critical infrastructure, homes, or businesses in high-risk zones, such as floodplains or wildfire-prone areas.
- Setback Requirements: Zoning ordinances often mandate specific setbacks, which are distances between structures and property lines or natural features. These setbacks can help prevent buildings from being too close to potential hazards, potentially reducing the risk of damage.
- Building Height and Design Standards: Zoning codes can establish building height limits to reduce exposure to certain hazards. Design standards, including materials and construction methods, can be specified to make structures more resilient.
- Floodplain Management: Many zoning ordinances incorporate floodplain regulations, which dictate where and how buildings can be constructed within flood-prone areas. These regulations may require buildings to be elevated, use flood-resistant materials, or include openings to allow floodwaters to pass through.
- Wildfire Mitigation Zones: In regions susceptible to wildfires, zoning ordinances can establish wildfire mitigation zones with specific requirements for defensible space, fire-resistant landscaping, and building materials to reduce the risk of wildfires spreading to structures.

Properly applied, zoning restriction and historic preservation are some of the most effective hazard mitigation tools available against a wide variety of hazards.

Floodplain Management Standards

Floodplain ordinances and management are one of the most effective hazard mitigation tools available against flooding. Local floodplain ordinances, required for NFIP participants, are often used to prevent inappropriate development in floodplains and to reduce flood hazards. In general, they allow the jurisdiction to:

- Minimize the extent of floods by preventing obstructions that inhibit water flow and increase flood height and damage.
- Prevent and minimize loss of life, injuries, and property damage in flood hazard areas.
- Promote the public health, safety and welfare of citizens in flood hazard areas.
- Manage planned growth.
- Grant permits for use in development within special flood hazard areas that are consistent with the community ordinance and the NFIP under 44 CFR 60.3.

The NFIP floodplain management regulations work alongside building codes by providing specific flood-related requirements that must be met in addition to general building code standards. For residential structures within both FEMA and State of Michigan regulated floodplains the State Construction Code requires that the lowest floor be elevated one foot above the base flood elevation. Requirements also dictate that utilities and mechanical equipment be elevated above the base flood elevation and/or protected from a 1%-annual-chance flood.

The floodplain development prevention ordinances outright prevent development in a 100- or 500-year floodplain. It is possible to appeal this limitation by applying a development certificate which requires an inspector to show that new development will not alter a floodplain creating a hazard risk for other existing developments as well as requiring the development to be built one foot above the base flood elevation.

The following table details the status of these codes and ordinances for participating jurisdictions:

Table 73: Jurisdictional Codes and Ordinances

Jurisdiction	Building Code	Floodplain Ordinance	Zoning Ordinance
Shiawassee County	x	x	x
City of Durand	x	x	x
City of Laingsburg	x	x	x
City of Owosso	x	x	x
City of Perry	x	x	x
Township of Owosso			

5.3 Jurisdictional Compliance with NFIP

All NFIP participating jurisdictions are required to meet the minimum standards set forth in the program. The jurisdictions' NFIP coordinator ensures all new construction projects are properly surveyed and receive an elevation certificate.

NFIP participants are committed to continued involvement and compliance. To help facilitate compliance, NFIP participating jurisdictions:

- Adopted floodplain regulations through local ordinance
- Enforces floodplain ordinances through building restrictions
- Regulates new construction in Special Flood Hazard Areas as outlined in their floodplain ordinance
- Utilizes FEMA DFIRMs, where available
- Monitors floodplain activities

As part of this planning effort, Shiawassee County NFIP Coordinators were given the opportunity to review and comment of the elements of this plan. The following individuals designated as NFIP Coordinators identified:

Table 74: Shiawassee County Jurisdictional NFIP Coordinators

Jurisdiction	Title	NFIP Coordinator
Shiawassee County	Not a participant	Not a participant
City of Durand	Nate Charles	Building and Zoning

Table 74: Shiawassee County Jurisdictional NFIP Coordinators

Jurisdiction	Title	NFIP Coordinator
City of Laingsburg	Rob Kehoe	Building and Zoning
City of Owosso	Tanya S. Buckelew	Building Department
City of Perry	Rob Kehoe	Building
Township of Owosso	Not a participant	Not a participant

Source: Shiawassee County

Participation in the NFIP is based on an agreement between the municipality and the federal government. If a municipality agrees to adopt and enforce a floodplain ordinance designed to reduce future flood risks, all citizens in the participating municipality can purchase flood insurance.

In Shiawassee County, as part of NFIP participation communities must:

- Use current NFIP flood maps in adopting floodplain management regulations.
- Require permits for all development in SFHAs
- Ensure that development does not increase the flood hazard on other properties.
- Meet current elevation standards. Ensuring the lowest occupied floor is elevated to or above the base flood elevation indicated on the NFIP flood map.

While most floodplain requirements have been incorporated into the current Building Codes, some additional provisions and regulations may be required by a community. Communities participating in the NFIP are required to adopt, enforce and maintain a local floodplain ordinance as a stipulation of compliance with the program. The purpose of this ordinance is to ensure public safety, minimize impact to persons and property from flooding, protect watercourses from encroachment, and maintain the capability of floodplains to retain and carry off floodwaters. The local floodplain administrator is typically the municipal official responsible for overseeing the enforcement and update of the document.

Floodplain ordinances are typically enforced by law enforcement departments or code enforcement offices. In general, the enforcement process generally works as follows:

- Identification of Violations: Violations are often identified through various means, such as citizen complaints, routine inspections, or observations by enforcement officers.
- Notification: Once a violation is identified, the responsible party is typically notified of the violation. This notification may come in the form of a written citation, warning letter, or verbal communication depending on the severity of the violation and local procedures.
- Correction Notice: In many cases, the responsible party is given a certain amount of time to correct the violation. They may be required to remedy the situation, obtain necessary permits, or comply with specific regulations.
- Follow-up Inspections: After the designated correction period, enforcement officers may conduct follow-up inspections to ensure that the violation has been addressed satisfactorily.
- Penalties and Fines: If the responsible party fails to comply with the ordinance or correct the violation within the specified timeframe, they may face penalties or fines. These penalties can vary depending on the nature and severity of the violation and may escalate for repeated offenses.
- Legal Action: In cases of persistent non-compliance or serious violations, local authorities may initiate legal proceedings against the responsible party. This can involve court appearances, injunctions, or other legal measures to compel compliance.

The following figure represents both pre- and post-disaster community NFIP requirements:

Figure 5: Pre- and Post-Disaster Community NFIP requirements

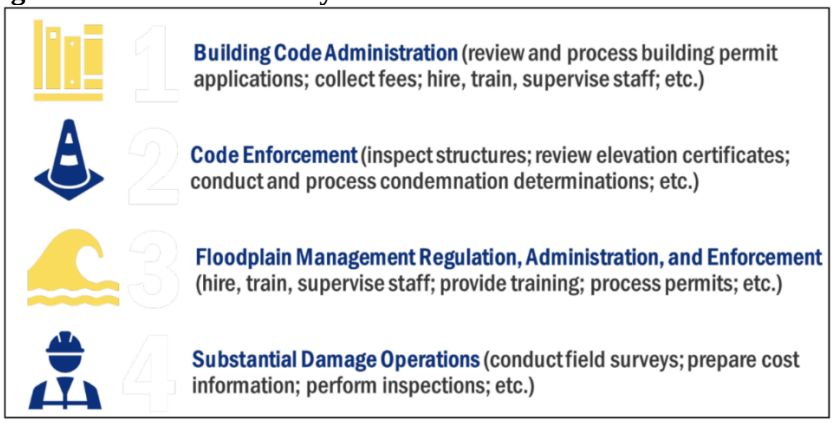
Source: FEMA

When structures located in the Special Flood Hazard Area are substantially modified (more than 50% damaged or improved) they are required to be brought into compliance with current NFIP standards and local building codes. In cases of repairs being conducted as a result of damage, jurisdictional NFIP Coordinators are responsible for substantial damage and improvement determinations. These determinations are required for compliance in the NFIP and must be completed before residents begin repairs or permits are issued.

A May 2020 Report to Congressional Committees on the National Flood Insurance Program by the United States Government Accountability indicates "FEMA generally does not collect or analyze the results of these assessments, limiting its ability to ensure the process operates as intended. Furthermore, FEMA has not clarified how communities can access NFIP claims data. Such data would help communities target substantial damage assessments after a flood." This has been found to be true in Shiawassee County, with submitted information and data underutilized and some FEMA available data unshared and/or unadvertised.

Section 1206 of the Disaster Recovery Reform Act of 2018 authorizes the FEMA to provide communities with the resources to administer and enforce building code and floodplain management ordinances following a major disaster declaration through FEMA's Public Assistance Program. To be eligible for reimbursement under the Public Assistance Program, including for the Disaster Recovery Reform Act of 2018 Section 1206, communities must be designated for Public Assistance permanent work under a major disaster declaration and be legally responsible to administer and enforce building codes or floodplain management regulations. Communities must also be in good standing with the NFIP. Available assistance includes:

Figure 6: Disaster Recovery Reform Act of 2018 Available Assistance



Source: FEMA

It is worth noting that this assistance is available for a variety of hazards occurrence types, not just flooding.

Key to achieving across the board reduction in flood damages is a robust community assistance, education, and awareness program. As such, NFIP participating jurisdictions will continue to develop both electronic (including social media) and in person outreach activities.

5.4 Jurisdictional Plans

Planning plays a critical role in hazard mitigation by helping communities identify, assess, and reduce risks associated with natural and man-made hazards. Effective planning involves a proactive, strategic, and comprehensive approach to minimize the impact of disasters and enhance community resilience. Jurisdictions were asked if they had completed the following plans:

- Comprehensive Plan: A comprehensive plan establishes the overall vision for a jurisdiction and serves as a guide to decision making, and generally contains information on demographics, land use, transportation, and facilities. As a comprehensive plan is broad in scope the integration of hazard mitigation measures can enhance the likelihood of achieving risk reduction goals.
- Emergency Operations Plan: An emergency operations plan outlines the responsibility and means and methods by which resources are deployed during and following an emergency or disaster. In Shiawassee County, the overarching county provides emergency operation planning for the majority of jurisdictions within its borders.
- Flood Mitigation Assistance Plan: The purpose of the flood mitigation assistance plan is to reduce or eliminate the long-term risk of flood damage to buildings and other structures insured under the NFIP.

The following table details the status of these plan types for each participating jurisdiction:

Table 75: Jurisdictional Planning Capabilities

Jurisdiction	Comprehensive Plan	Emergency Operations Plan	Flood Mitigation Plan
Shiawassee County	x	x	x
City of Durand	x	x	
City of Laingsburg	x	x	
City of Owosso	x	x	
City of Perry	x	x	
Township of Owosso			

5.5 Challenges and Opportunities for Capability Improvement

As always, challenges exist for all participating jurisdictions due to the day-to-day demands of the working environment including staffing issues, budget restrictions, and staffing turnover. These issues can, and do, impact the utilization and incorporation of the LHMP and the completion of identified hazard mitigation projects.

As part of this planning process, the MPC worked to identify gaps and deficiencies identified in the completion of this LHMP. Resulting from this assessment is a series of problem statements, concise descriptions of issues or challenges that need to be addressed. These problem statements were determined to be applicable to all participating jurisdictions:

- Continued climate change is driving an increased incidence of major hazard occurrences, stressing the response, recovery, and mitigation capabilities of even the most prepared jurisdiction.
- Available funding for the completion of hazard mitigation projects is at a premium, with all participating jurisdiction seeing minimal room in the budget for any required project match.
- The difficulties in applying for and managing hazard mitigation grants are beyond the capability of smaller jurisdictions.
- Staffing at all levels is stretched thin, with many personnel wearing multiple hats, compromising mitigation capabilities.

Improving capabilities can lead to enhanced performance, increased efficiency, and better outcomes in hazard mitigation planning and implementation. The following identify recommended improvements for all jurisdictions, with some recommendations being applicable to all jurisdictions, and other being specific to identified jurisdictions:

- All participating jurisdictions could receive instruction from the Michigan State Police Emergency Management and Homeland Security and FEMA Region V on grant application processes and grant management strategies. These classes could help all participating jurisdictions receive available grant funding.
- Jurisdictions that do not currently participate in the NFIP should enroll in the program to allow citizens to purchase federally backed flood insurance.
- Current NFIP participants should apply for membership in the CRS to allow citizens to receive discounts off their federally backed flood insurance policies.
- All participating jurisdictions should explore engaging in public-private emergency planning partnerships to further increase hazard resiliency through the infusion of additional funding and expertise to help complete mitigation projects.

To help overcome many of these identified challenges, participating jurisdictions will work collaboratively using the following strategies, as appropriate:

- Innovation and Adaptation: Foster a culture of innovation and adaptability. Encourage employees to think creatively, embrace change, and explore new ways of doing things to overcome challenges.
- Training and Development: Invest in training and development to enhance skills and knowledge.
- Communication Improvement: Enhance communications and provide clear and transparent communication when sharing information, aligning teams, and addressing concerns.
- Collaboration and Teamwork: Encourage collaboration and teamwork which allows for the pooling of diverse skills and perspectives, leading to more effective problem-solving (the MPC is a good example of effective use of this strategy).
- Technology Adoption: Embrace technology to streamline operations and enhance productivity.
- Agile Project Management: Implement agile project management methodologies to enhance flexibility and responsiveness to changing conditions. Agile approaches allow teams to adapt quickly to challenges.

As appropriate, these strategies will be tailored for specific circumstances, with a combination of these strategies often being more effective than relying on a single approach.

Section 6 – Mitigation Strategy

6.1 Introduction

As part of this planning effort, Shiawassee County and its participating jurisdictions worked to minimize the risk of future impacts from identified hazards to all citizens of the county. In an attempt to shape future regulations, ordinances and policy decisions, the MPC reviewed and developed a hazard mitigation strategy. This comprehensive strategy includes:

- The consistent review and revision, as necessary, of obtainable goals and objectives
- The consistent review, revision and development of a comprehensive list of potential hazard mitigation actions

The development of a robust mitigation strategy allows for:

- The ability to effectively direct limited resources for maximum benefit
- The ability to prioritize identified hazard mitigation projects to maximize positive outcomes
- The increase in public and private level participation in hazard mitigation through transparency and awareness
- The potential direction of future policy decisions through awareness and education
- The achievement of the ultimate goal of a safer Shiawassee County for all our citizens

As per the previous hazard mitigation plan, and considering all of the factors listed above, the MPC continues to implement the following mitigation strategy:

- **Implement** the action plan recommendations of this plan.
- **Use** existing regulations, policies, programs, procedures, and plans already in place.
- **Monitor** multi-objective management opportunities, share and package funding opportunities, and garner broader constituent support.
- **Communicate** the hazard information collected and analyzed through this planning process so that local governments and residents better understand where disasters occur, and what they can do to mitigate their impacts. In doing so, also publicize the success stories that have been achieved through the County's ongoing mitigation efforts.

6.2 Identification of Goals

The following goals for hazard mitigation were established from the MPC's discovery and deliberation process, which consisted of:

- A review of identified hazards, vulnerabilities and impacts
- A review of hazard events subsequent to the last hazard mitigation plan revision
- A review of demographic, infrastructure and built environment data
- A review of the goals and objectives identified in previous hazard mitigation plans
- A review of local mitigation strategies and goals
- A review completed and remaining hazard mitigation actions

These goals represent a vision for hazard mitigation and disaster resistance for Shiawassee County. Each mitigation goal was reviewed and approved by both MPC members and stakeholders. Through group discussions at meetings, the MPC refined and combined the identified goals from the previous hazard mitigation plan. During this process it was determined that the priorities of the overall community in relation to hazard mitigation planning have not changed during the five years of the previous planning cycle. The identified goals are as follows:

- **Goal 1:** Reduce the risk to the people and property from the identified hazards in this plan.
- **Goal 2:** Work to protect all vulnerable populations, structures, and critical facilities from the impacts of the identified hazards.

- **Goal 3:** Improve public outreach initiatives to include education, awareness, and partnerships with all entities in order to enhance the understanding identified hazards and hazard mitigation opportunities.

The MPC will continuously evaluate these identified goals against current capabilities and conditions. As part of this process, the MPC will utilize a monitoring and evaluation system to systematically track, assess, and measure the progress of activities and outcomes related to the goals outlined in this LHMP. Key components to the monitoring and evaluation system include:

- Establishment of baseline data to quantify the starting point upon the approval of this plan. This will provide a reference against which progress can be measured.
- Enactment of a monitoring plan which outlines the specific activities, tasks, and responsibilities for regularly collecting, analyzing, and reporting data on the performance indicators.
- Identification and specification of the methods for collecting data, whether through surveys, interviews, focus groups, or observations.
- Definition of the criteria and methods for analyzing collected data. This includes determining how quantitative and qualitative data will be processed and interpreted to assess progress.
- Involvement of stakeholders to ensure that all perspectives are considered, and that feedback on the progress of achieving the delineated goals is taken into account.

In addition, the MPC will work with all local, county, regional, and state agencies and policy makers to help integrate the goals delineated in the LHMP and goals and plans for combating climate change.

6.3 Review and Classification of Mitigation Actions

Hazard mitigation actions are proactive measures taken to reduce or eliminate the long-term risk and impact of natural and human-made hazards. These actions are designed to minimize the damage caused by disasters and contribute to the overall resilience of communities and infrastructure.

For this plan update members of the MPC were provided with a complete list of previously identified mitigation actions and asked to review them to determine their status. Due to the age of the previous LHMP (completed 2015, adopted 2016), and with a thorough review of the previous actions indicating that that none of the actions were jurisdictionally specific, that many actions cannot be defined as mitigation actions, and that many of the actions were programmatic in nature, the MPC elected to create new mitigation actions for this plan.

As part of this process, all reasonable and obtainable mitigation actions were considered to help achieve the general goals. Priorities were developed based on past damages, existing exposure to risk, and weaknesses identified by capability assessments. In identifying mitigation actions, the following activities were considered:

- The use of applicable building construction standards.
- Hazard avoidance through appropriate land-use practices.
- Relocation, retrofitting, or removal of structures at risk.
- Removal or elimination of the hazard.
- Reduction or limitation of the amount or size of the hazard.
- Segregation of the hazard from that which is to be protected.
- Modification of the basic characteristics of the hazard.
- Control of the rate of release of the hazard.
- Provision of protective systems or equipment for both cyber or physical risks.
- Establishment of hazard warning and communication procedures.
- Redundancy or duplication of essential personnel, critical systems, equipment, and information materials.

In general, all identified mitigation actions can be classified under one of the following broad categories:

- **Local plans and regulations:** Actions that create or update plans to reflect situational changes and/or actions that aid in the creation, revision, or adoption of regulations related to hazard mitigation and management.
- **Natural resource protection:** Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems.
- **Preparedness and response:** Emergency response or operational preparedness actions.
- **Public education and awareness:** Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them.
- **Structural:** Actions that the modification of existing buildings or structures or involve the construction of structures to reduce the impact of hazard.

6.4 Prioritization of Mitigation Actions

The MPC and subject matter experts worked together to prioritize newly identified hazard mitigation actions. The methodology used to determine mitigation action priorities was based upon the following:

- Review of the updated risk assessments.
- Review of revised goals and objectives.
- Review of capabilities.

A multi-pronged and flexible analysis method was used for determining and prioritizing mitigation actions. For newly identified actions, the FEMA recommended Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) criteria were used to assist with prioritization. The following table details the STAPLEE criteria:

Table 76: STAPLEE Review Criteria

Criteria	Discussion	Example Considerations
Social	There should be community acceptance and support for the mitigation action?	Does the action have community acceptance? Will the proposed action adversely affect one segment of the population?
Technical	The proposed mitigation action should be technically feasible and should provide a long-term reduction in losses.	How effective is the action in avoiding or reducing future losses? Does it solve a problem or only a symptom? Does the action create additional problems?
Administrative	Personnel and administrative capabilities should be available to administer all phases of the project.	Are the staffing and administrative capabilities to implement the action in place? Is there someone to coordinate and lead the effort?
Political	Political support for the mitigation action needs to be present.	Is the action politically acceptable? Have political leaders been involved in the planning process? Is there a political champion to help see the project to completion?
Legal	The legal authority to implement the actions need to be in place or possible with the passing of laws or regulations.	Does the legal authority to implement the proposed action exist? Are there potential legal repercussions?
Economic	The current budget (and/or general obligation bonds or other instruments) need to be in place to fully fund the mitigation action.	Do the potential benefits of this action exceed the potential costs? Has funding been secured for the proposed action? What are the potential funding sources (public, non-profit, and private)? How will this action affect the fiscal capability of the community(s)?

Table 76: STAPLEE Review Criteria

Criteria	Discussion	Example Considerations
		Does the action contribute to other community goals, such as capital improvements or economic development?
Environmental	Actions should interface with the need for sustainable and environmentally healthy communities. Also, statutory considerations, such as the National Environmental Policy Act need to considered for federal funds.	How will the action affect the environment? Will the action need environmental regulatory approvals? Will it meet federal, state, and local state regulatory requirements? Are endangered or threatened species likely to be affected?

Based on the prioritization review, the MPC assigned each action the following prioritized ranking:

- **High Priority:** Actions that provide substantial progress towards improving resiliency and are determined as potentially urgent in nature by the MPC. This would include actions that strongly support the reduction of high hazard risks and meet mitigation goals. Additionally, actions in this ranking may have imminent funding availability or strong community support.
- **Medium Priority:** Actions that provide reasonable progress towards improving resiliency and are determined as moderately urgent in nature by the MPC. This would include actions that would lessen impact hazard events, but not eliminate the impact completely.
- **Low Priority:** Actions that provide incremental progress towards improving resiliency and are determined as slightly urgent in nature by the MPC. This would include actions that are generally the responsibility of the local community, actions outside the normal authority of the State, or actions whose cost/benefit analysis returns a low yield.

6.5 Mitigation Action Funding Sources

It is generally recognized that mitigation actions help realize long term savings by preventing future losses due to hazard events. However, many mitigation actions are beyond the budgetary capabilities of a single jurisdiction. This section provides a general description of some of the avenues available to defray the cost of implementing mitigation actions.

FEMA provides financial assistance to state, local, tribal, and territorial governments, as well as certain private non-profit organizations, to implement projects that help reduce the risk and impact of future disasters. These grant programs are designed to support initiatives aimed at mitigating hazards and improving resilience. The main grant program offered by FEMA for hazard mitigation is the Hazard Mitigation Assistance (HMA) program. The HMA program includes four subprograms, the Hazard Mitigation Grant Program (HMGP), the HMGP Post-Fire, Building Resilient Infrastructure and Communities (BRIC), and the Flood Mitigation Assistance (FMA) grant program. Applicants to these grant programs are required to submit project proposals that demonstrate the effectiveness of their proposed mitigation projects. The eligibility criteria, application process, and specific requirements for each program are outlined by FEMA in their guidelines and announcements, which are typically published on FEMA's website.

The following provides a general overview of major grant funding streams:

- **HMGP and HMGP Fire:** The HMGP grants assist in implementing long-term hazard mitigation measures following Presidential disaster declarations, including fire declarations. Funding is available to implement projects in accordance with State, Tribal, and local priorities.
- **BRIC:** BRIC supports states, local communities, tribes and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. The BRIC program guiding principles are supporting communities through capability- and capacity-building; encouraging and enabling innovation; promoting partnerships; enabling large projects; maintaining flexibility; and providing consistency. Working

in coordination with BRIC, the National Mitigation Investment Strategy is intended to provide a national, whole-community approach to investments in mitigation activities and risk management.

- **FMA Grant Program:** FMA is a competitive grant program that provides funding to states, local communities, federally recognized tribes and territories. Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the NFIP. FEMA chooses recipients based on the applicant's ranking of the project and the eligibility and cost-effectiveness of the project. FEMA requires state, local, tribal and territorial governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance, including funding for hazard mitigation assistance projects.

The following figure summarizes HMA grants programs:

Figure 7: HMA Grant Program Summary

HMA Program Comparison	HMGP	HMGP Post Fire	BRIC	FMA
Program Type	Post-disaster	Post-disaster	Pre-disaster	Pre-disaster
Funding Availability	Presidentially declared disaster	FMAG-declared disaster	6% set aside from federal post-disaster grant funding	Annual appropriations
Competitive?	No	No	Yes	Yes
Eligible Applicants	States, federally recognized tribes, territories and the District of Columbia (DC)	States, federally recognized tribes, territories and DC	States, federally recognized tribes, territories and DC	States, federally recognized tribes, territories and DC
Eligible Subapplicants	State agencies, local governments, tribes and private nonprofit organizations	State agencies, local governments, tribes and private nonprofit organizations	State agencies, local governments and tribes	State agencies, local governments and tribes
Hazard Mitigation Plan Requirement	Yes	Yes	Yes	Yes
NFIP Participation	Communities with projects in Special Flood Hazard Areas (SFHAs)	Communities with projects in SFHAs	Communities with projects in SFHAs	Subapplicants and properties

Source: FEMA

Additionally, the following provide available grant funding avenues for hazard mitigation projects:

- **Rehabilitation Of High Hazard Potential Dam (HHPD) Grant Program:** HHPD awards provide technical, planning, design and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams. A state or territory with an enacted dam safety program, the State Administrative Agency, or an equivalent state agency, is eligible for the grant.
- **Emergency Management Performance Grant:** Program provides state, local, tribal and territorial emergency management agencies with the resources required for implementation of the National Preparedness System and works toward the National Preparedness Goal of a secure and resilient nation. Allowable costs support efforts to build and sustain core capabilities across the prevention, protection, mitigation, response and recovery mission areas.

- **State Homeland Security Program:** Program includes a suite of risk-based grants to assist state, local, tribal and territorial efforts in preventing, protecting against, mitigating, responding to and recovering from acts of terrorism and other threats. This grant provides grantees with the resources required for implementation of the National Preparedness System, working toward the National Preparedness Goal of a secure and resilient nation.
- **Nonprofit Security Grant Program:** Program is one of three grant programs that support DHS/FEMA's focus on enhancing the ability of state, local, tribal, and territorial governments, as well as nonprofits, to prevent, protect against, prepare for, and respond to terrorist or other extremist attacks. These grant programs are part of a comprehensive set of measures authorized by Congress and implemented by DHS to help strengthen the nation's communities against potential terrorist or other extremist attacks. Among the five basic homeland security missions noted in the DHS Strategic Plan for Fiscal Years 2020-2024
- **Public Assistance Program:** The mission of FEMA's Public Assistance program is to provide assistance to State, Tribal and local governments, and certain types of Private Nonprofit organizations so that communities can quickly respond to and recover from major disasters or emergencies declared by the President. Through the Public Assistance program, FEMA provides supplemental Federal disaster grant assistance for debris removal, emergency protective measures, and the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain private non-profit organizations. The Public Assistance Program also encourages protection of these damaged facilities from future events by providing assistance for hazard mitigation measures during the recovery process. The Federal share of assistance is not less than 75% of the eligible cost for emergency measures and permanent restoration. The grantee determines how the non-Federal share (up to 25%) is split with the eligible applicants.
- **Individual Assistance Program:** After a disaster, the federal government determines if any county in the state meets the criteria for individual disaster assistance. The decision is based on damage related to the severity and magnitude of the event. When a county receives an Individual Assistance declaration from the President of the United States, anyone who lives in that county can apply for assistance.
- **Small Business Administration Disaster Loans:** The Small Business Administration provides low-interest disaster loans to homeowners, renters, businesses of all sizes, and most private nonprofit organizations. Small Business Administration disaster loans can be used to repair or replace the following items damaged or destroyed in a declared disaster: real estate, personal property, machinery and equipment, and inventory and business assets.
- **The Housing and Urban Development Agency**: Provides flexible grants to help cities, counties, and States recover from Presidentially declared disasters, especially in low-income areas, subject to availability of supplemental appropriations.
- **Community Development Block Grant Program**: This is a flexible program that provides communities with resources to address a wide range of unique community development needs. The program provides annual grants on a formula basis to general units of local government and States.
- **Individual and Households, Other Needs Assistance Program:** This program provides financial assistance to individuals or households who sustain damage or develop serious needs because of a natural or man-made disaster. The funding share is 75% federal funds and 25% state funds. The program provides grants for necessary expenses and serious needs that cannot be provided for by insurance, another federal program, or other source of assistance. The current maximum allowable amount for any one disaster to individuals or families is $25,000. The program gives funds for disaster-related necessary expenses and serious needs, including personal property, transportation, medical and dental, funeral, essential tools, flood insurance, and moving and storage.
- **WUI Grants:** The 10-Year Comprehensive Strategy focuses on assisting people and communities in the WUI to moderate the threat of catastrophic fire through the four broad goals of improving prevention and suppression, reducing hazardous fuels, restoring fire-adapted ecosystems, and promoting community assistance. The WUI Grant may be used to apply for financial assistance towards hazardous fuels and educational projects within the four goals of: improved prevention, re duction of hazardous fuels, restoration of fire-adapted ecosystems and promotion of community assistance.

Small and impoverished communities that receive grants may receive a federal cost share of up to 90% of the total amount approved under the grant award. As defined in 44 CFR 201.2, a small and impoverished community is:

- A community of 3,000 or fewer individuals that is identified by the State as a rural community
- Is not a remote area within the corporate boundaries of a larger city
- Is economically disadvantaged, by having an average per capita annual income of residents not exceeding 80% of national, per capita income
- The local unemployment rate exceeds by one percentage point or more, the most recently reported, average yearly national unemployment rate
- Any other factors identified in the State Plan in which the community is located

6.6 Completed Mitigation Actions

Since the completion of the previous LHMP in 2016 one of the identified mitigation action has been completed, as follows:

Table 77: Completed Hazard Mitigation Actions

Previous HMP Action Number	Description
Flood 6, Severe Weather 2 Severe Winter Weather 2, Tornado 3	Marketing and public outreach for general public to sign-up for CodeRED

Neither Shiawassee County nor any participating jurisdiction has received any FEMA Hazard Mitigation Grant funding (HMGP, BRIC, PDM, FMAG) as of this plan. Compounding issues, the onset of COVID-19 early in 2019 caused many available local resources, funding, and capabilities to be reassigned to help manage the pandemic. However, Shiawassee County and its participating jurisdictions remain committed to investigating and obtaining all available grant funding for the completion of hazard mitigation projects.

6.7 Previous Mitigation Actions

It is important to note that since the previous LHMP (completed in 2016), requirements for plan approval have changed. In the previous plan all actions were identified at the county level to cover local participants. As such, the actions in this plan have been re-written and reclassified on a wholesale basis to ensure each participating jurisdiction has identified at least one action per identified hazard.

Shiawassee County and participating jurisdictions elected to delete mitigation actions that were considered part of a standard operating procedure (programmatic) or that were outside of control, or not considered mitigation actions. Deleted actions are identified in the following table along with the reason for deletion.

Table 78: Deleted Hazard Mitigation Actions

Previous LHMP Action Number	Description	Rationale for Removal
Drought 3, Extreme Temperature 3, Flood 7, Severe Weather 6, Winter Weather, 6, Tornado 6	Promote general & specialized training for all emergency responders	Programmatic, not mitigation
Drought 4, Extreme Temperature 4, Flood 8, Severe Weather 7, Winter Weather 8, Tornado 7	Encourage workplaces, schools, offices, retail, factories, hospitals, etc. to develop emergency plans.	Programmatic, not mitigation
Drought 5, Extreme Temperature 5, Flood 9, Severe Weather 8, Winter Weather 9, Tornado 8	Develop and implement GIS system to assist in preparedness, development of mitigations strategies, and response.	Programmatic
Drought 7, Extreme Temperature 7, Flood 11, Severe Weather 10, Winter Weather 11, Tornado 10	Continually monitor/update disaster response plan	Programmatic, not mitigation
Extreme Temperature 2, Severe Weather 4, Winter Weather 5	Encourage/support elderly assistance programs	Non-specific

Table 78: Deleted Hazard Mitigation Actions

Previous LHMP Action Number	Description	Rationale for Removal
Flood 4	Mitigation assistance program for structures in the flood plain.	Non-specific
Flood 5	Implement River flood control measures	Non-specific c
Severe Weather 3, Tornado 4	Weather spotter training	Programmatic
Severe Weather 5, Winter Weather 4	Tree trimming program/Support and encourage public utilities programs.	Programmatic, responsibility of utilities

The following actions, identified in the previous hazard mitigation plan, have been carried forward to this plan. Please note that the action description may have been updated for clarity:

Table 86: Carried Over Hazard Mitigation Actions

New Action Number	Previous Action Number	Description
Shiawassee County 3	Drought 1	Promote and educate water rationing program for drought conditions
Shiawassee County 3	Drought 2	Promote and educate public concerning water conservation program
Shiawassee County 3	Drought 6	Public education for disaster preparedness/Encourage programs such as “Do1Thing”
Shiawassee County 8, Durand 5, Laingsburg 5, Owosso 5, Perry 5, Owosso Township 3	Extreme Temperature 1	Establish warming or cooling stations/centers/shelters
Shiawassee County 3	Extreme Temperature 6	Public education for disaster preparedness/Encourage programs such as “Do1Thing”
Shiawassee County 9, Durand 6, Laingsburg 6, Owosso 6, Perry 6	Flood 1	Promote NFIP programs/FEMA programs/Other programs that prevent or fund removal of improvements in floodplain areas.
Shiawassee County-14	Flood 2	Amend land use and zoning regulations to prohibit development in the flood plain/Support other development regulations, such as soil erosion & sedimentation regulations, storm water run-off controls, etc. in development review
Shiawassee County-10	Flood 3	Identify structures in the flood plain/Monitor for repetitive loss areas
Shiawassee County 3	Flood 10	Public education for disaster preparedness/Encourage programs such as “Do1Thing”
Shiawassee County-18	Severe Weather 1	Enhance storm warning system/distribution of NOAA radios
Shiawassee County 3	Severe Weather 9	Public education for disaster preparedness/Encourage programs such as “Do1Thing”
Shiawassee County-18	Winter 1	Enhance storm warning system/distribution of NOAA radios
Shiawassee County 8, Durand 5, Laingsburg 5, Owosso 5, Perry 5, Owosso Township 3	Winter 3	Establish warming stations/centers/shelters
Shiawassee County 3	Winter 10	Public education for disaster preparedness/Encourage programs such as “Do1Thing”

Table 86: Carried Over Hazard Mitigation Actions

New Action Number	Previous Action Number	Description
Shiawassee County-2	Winter 6	Monitor for repetitive hazard areas (drifting/black ice)/Implement signage or other notification measures upon warning/Implement fencing & preventive measures
Shiawassee County 17, Durand 10, Laingsburg 10, Owosso 10, Perry 10, Owosso Township 6	Tornado 1	Provision for accessible shelters/home sheltering education
Shiawassee County-18	Tornado 2	Enhance storm warning system/distribution of NOAA radios
Shiawassee County 4, Durand 2, Laingsburg 2, Owosso 2, Perry 2	Tornado 5	Enforce building codes, especially concerning prospering anchoring structures/Educate general public on building codes/engineering techniques.
Shiawassee County 3	Tornado 9	Public education for disaster preparedness/Encourage programs such as "Do1Thing"

6.8 Jurisdictional Mitigation Actions

To support the mitigation goals identified in this LHMP, all participating Shiawassee Couty jurisdictions identified a comprehensive range mitigation projects and activities. The selected set carefully takes an all-hazards approach to mitigation while simultaneously addressing each of the plan's profiled hazards. The list of mitigation actions is based upon the potential to reduce risk to life and property with an emphasis on ease of implementation, community and agency support, consistency with local jurisdictions' plans and capabilities, available funding, and jurisdictional vulnerability.

A revised version of the requirement allows for a more tailored approach to mitigation planning, ensuring that communities address the hazards most relevant to their circumstances while also acknowledging that not all hazards may be equally significant across different areas. It promotes a more efficient use of resources by focusing efforts on mitigating the most pressing risks faced by each community.

For each identified action, the following applies:

- New actions that have been added to this plan update are identified as such
- Some actions have been reassigned or reclassified. In these cases, not all information is provided under the original listing, rather the newly assigned responsible entity has been given the opportunity to detail the requested information
- All mitigation action information was provided by jurisdictional officials through outreach from the MPC

The following table provides a mitigation action cross check for each participating jurisdiction.

Table 79: Participating Jurisdiction Mitigation Action Cross Check

Jurisdiction	Drought	Extreme Temperatures	Flood	Severe Weather	Severe Winter Weather	Tornado
Shiawassee County	4, 5	6, 7	8-13	14-17	6, 7, 17, 18, 19	16, 17, 20
City of Durand	3, 4	5	6, 7, 8	9, 10	11	10
City of Laingsburg	3, 4	5	6, 7, 8	9, 10	11	10
City of Owosso	3, 4	5	6, 7, 8	9, 10	11	10
City of Perry	3, 4	5	6, 7, 8	9, 10	11	10
Township of Owosso	2	3	4	5	3	6

The following tables identify mitigation action items for each participating jurisdiction, along with the following information:

- Hazard addressed
- Responsible party
- Overall priority
- Goal(s) addressed
- Estimated cost
- Potential funding source
- Proposed completion timeframe
- Current status

Table 80: Shiawassee County and Participating Jurisdictions Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Shiawassee County-1	Install generators in all county facilities to mitigate against loss of power as a cascading impact from hazards detailed in this plan.	All hazards	Shiawassee County Emergency Manager, County Facilities Director	High	1, 2	$10,000 to $50,000 per location	HMGP, BRIC, Jurisdiction budget	Ten years	New
Shiawassee County-2	Conduct regular hazard mitigation classes, including handouts, for public throughout country on a regular basis.	All hazards	Shiawassee County Emergency Manager	High	3	$1,000 per occurrence	Jurisdiction budget	On-going	On-going, revised
Shiawassee County-3	Continued enforcement of all building code provisions for both new construction and any renovation of existing buildings.	All hazards	Building Code Official	High	1, 2	Staff time	Jurisdiction budget	On-going	Continuous
Shiawassee County-4	Conduct a Xeriscaping program for all jurisdictional owned facilities	Drought	Shiawassee County Facilities Director	Low	1, 2	$5,000 - $50,000 per location	HMGP, BRIC, Jurisdiction budget	Five years	New
Shiawassee County-5	Revise building codes to require low water flow toilets and faucets.	Drought	Shiawassee County Administrator	High	1, 2	Staff Time	Jurisdiction budget	Five years	New
Shiawassee County-6	Modernization HVAC systems in jurisdictional facilities.	Extreme Temperatures, Severe Winter Weather	Shiawassee County Facilities Director	Low	1, 2	$25,000 per facility	HMGP, BRIC, Jurisdiction budget	Ten years	New
Shiawassee County-7	Identify and prepare county building for usage as heat/cold shelters.	Extreme Temperatures, Severe Winter Weather	Shiawassee County Facilities Director	Low	1, 2	$2,000 per facility	Local budget	Five years	Carried over, lack of staff and budget
Shiawassee County-8	Apply for acceptance to the NFIP.	Flood	Shiawassee County Emergency Manager	High	1, 2	Staff time	Jurisdiction budget	Three years	New
Shiawassee County-9	Identify, purchase, and demolish flood prone properties	Flood	Shiawassee County Emergency Manager, NFIP Administrator	High	1, 2	Per property cost	FMA, HMGP, BRIC, Jurisdiction budget	Ten years	Carried over, lack of funding, revised

Table 80: Shiawassee County and Participating Jurisdictions Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Shiawassee County-10	Conduct a flood insurance awareness program.	Flood	NFIP Administrator	High	1, 3	Staff Time	Jurisdiction budget	Five years	New
Shiawassee County-11	Construct rainwater retention/detention ponds at strategic locations.	Flood	NFIP Administrator, County Public Works Director	Medium	1, 2	Facility size dependent	HMGP, Jurisdiction budget	Ten years	New
Shiawassee County-12	Procure permanent signage to warn of flood hazard areas.	Flood	NFIP Administrator, County Emergency Manager	Medium	1, 2, 3	Location dependent	HMGP, BRIC, Jurisdiction budget	Five years	New
Shiawassee County-13	Amend land use and zoning regulations to prohibit development in the flood plain/Support other development regulations, such as soil erosion & sedimentation regulations, storm water run-off controls, etc. in development review	Flood	NFIP Administrator, County Emergency Manager	Medium	1, 2, 3	Staff Time	Jurisdiction budget	Five years	Carried over, lack of staff capacity
Shiawassee County-14	Install surge protectors in all jurisdictional facilities.	Severe Weather	Shiawassee County Facilities Director	Medium	1, 2	$10,000 per location	HMGP, BRIC, Jurisdiction budget	Five years	New
Shiawassee County-15	Install hail resistant roofing on all jurisdictional facilities.	Severe Weather	Shiawassee County Facilities Director	Medium	1, 2	$50,000 per location	HMGP, BRIC, Jurisdiction budget	Five years	New
Shiawassee County-16	Construct community safe rooms throughout the county to required building standards	Severe Weather, Tornado	Shiawassee County Emergency Manager	Medium	1, 2	$1,000,000 per facility	HMGP, BRIC, Jurisdiction budget	Ten years	Carried over, lack of funding, revised
Shiawassee County-17	Enhance storm warning system/distribution of NOAA radios	Severe Weather, Severe Winter Weather, Tornado	Shiawassee County Emergency Manager	High	1, 2	$10,000	HMGP, Jurisdiction budget	Five years	Carried over, lack of funding

Table 80: Shiawassee County and Participating Jurisdictions Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Shiawassee County-18	Construct snow fences along major transportation routes.	Severe Winter Weather	Shiawassee County Public Works Director	Low	1, 2	$25,000 - $100,000 per location	HMGP, Jurisdiction budget	Ten years	New
Shiawassee County-19	Insulate water lines in all jurisdictional facilities.	Severe Winter Weather	Shiawassee County Building Department	Low	1, 2	$10,000 - $50,000 per location	HMGP, BRIC, Jurisdiction budget	Five years	New
Shiawassee County-20	Upgrade and enhance sirens throughout county	Tornado	Shiawassee County Emergency Manager	High	1, 2	Staff Time	HMGP, BRIC, Jurisdiction budget	Five years	New

Table 81: City of Durand Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Durand-1	Install generators in all critical city facilities to mitigate against loss of power as a cascading impact from hazards detailed in this plan.	All hazards	Mayor	High	1, 2	$25,000 - $50,000 per facility	HMGP, BRIC, Jurisdiction budget	Five years	New
Durand-2	Continued enforcement of all building code provisions for both new construction and any renovation of existing buildings.	All hazards	Building Code Official	High	1, 2	Staff time	Jurisdiction budget	On-going	Continuous
Durand-3	Conduct a xeriscaping program for all jurisdictional owned facilities	Drought	Facilities Director	Medium	1, 2	$5,000 - $20,000 per facility	HMGP, BRIC, Jurisdiction budget	Ten years	New
Durand-4	Conduct a personal water use education program.	Drought	Mayor	Low	3	Staff time	HMGP, BRIC, Jurisdiction budget	Five years	New
Durand-5	Identify and prepare local facilities to serve as heating/cooling centers.	Extreme Temperatures, Severe Winter Weather	Facilities Director	Medium	1, 2	$3,000 per facility	HMGP, Jurisdiction budget	Five years	Carried over, lack of staff and funding
Durand-6	Continue to participate in the NFIP.	Flood	NFIP Coordinator	High	1, 2	Staff time	Jurisdiction budget	Continuous	On-going
Durand-7	Construct rainwater retention/detention ponds at strategic locations.	Flood	Mayor	Low	1, 2	Location and size dependent	HMGP, BRIC, Jurisdiction budget	As required	New
Durand-8	Clean and repair drainage ditches to maintain capacity.	Flood	Mayor	Low	1, 2	Location, length, and size dependent	HMGP, BRIC, Jurisdiction budget	Ten years	New
Durand-9	Install hail and high wind resistant roofing on all jurisdictional facilities.	Severe Weather	Facilities Director	Low	1, 2	$50,000 per location	HMGP, BRIC, Jurisdiction budget	Five years	New

Table 81: City of Durand Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Durand-10	Construct community saferooms in select jurisdictional buildings.	Severe Weather, Tornado	Mayor	High	1, 2	Facility size dependent	HMGP, BRIC, Jurisdiction budget	Ten years	Carried over, lack of funding
Durand-11	Conduct public education program for driving in winter conditions.	Severe Winter Weather	Mayor	Low	3	Staff Time	Jurisdiction budget	Five years	New

Table 82: Laingsburg Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Laingsburg-1	Install generators in all critical city facilities to mitigate against loss of power as a cascading impact from hazards detailed in this plan.	All hazards	Mayor	High	1, 2	$25,000 - $50,000 per facility	HMGP, BRIC, Jurisdiction budget	Five years	New
Laingsburg-2	Continued enforcement of all building code provisions for both new construction and any renovation of existing buildings.	All hazards	Building Code Official	High	1, 2	Staff time	Jurisdiction budget	On-going	Continuous
Laingsburg-3	Conduct a xeriscaping program for all jurisdictional owned facilities	Drought	Facilities Director	Medium	1, 2	$5,000 - $20,000 per facility	HMGP, BRIC, Jurisdiction budget	Ten years	New
Laingsburg-4	Conduct a personal water use education program.	Drought	Mayor	Low	3	Staff time	HMGP, BRIC, Jurisdiction budget	Five years	New
Laingsburg-5	Identify and prepare local facilities to serve as heating/cooling centers.	Extreme Temperatures, Severe Winter Weather	Facilities Director	Medium	1, 2	$3,000 per facility	HMGP, Jurisdiction budget	Five years	Carried over, lack of staff and funding
Laingsburg-6	Continue to participate in the NFIP.	Flood	NFIP Coordinator	High	1, 2	Staff time	Jurisdiction budget	Continuous	On-going
Laingsburg-7	Construct rainwater retention/detention ponds at strategic locations.	Flood	Mayor	Low	1, 2	Location and size dependent	HMGP, BRIC, Jurisdiction budget	As required	New
Laingsburg-8	Clean and repair drainage ditches to maintain capacity.	Flood	Mayor	Low	1, 2	Location, length, and size dependent	HMGP, Jurisdiction budget	Ten years	New
Laingsburg-9	Install hail and high wind resistant roofing on all jurisdictional facilities.	Severe Weather	Facilities Director	Low	1, 2	$50,000 per location	HMGP, BRIC, Jurisdiction budget	Five years	New
Laingsburg-10	Construct community saferooms in select jurisdictional buildings.	Severe Weather, Tornado	Mayor	High	1, 2	Facility size dependent	HMGP, BRIC, Jurisdiction budget	Ten years	Carried over, lack of funding

Table 82: Laingsburg Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Laingsburg-11	Conduct public education program for driving in winter conditions.	Severe Winter Weather	Mayor	Low	3	Staff Time	Jurisdiction budget	Five years	New

Table 83: City of Owosso Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Owosso-1	Install generators in all critical city facilities to mitigate against loss of power as a cascading impact from hazards detailed in this plan.	All hazards	Mayor	High	1, 2	$25,000 - $50,000 per facility	HMGP, BRIC, Jurisdiction budget	Five years	New
Owosso-2	Continued enforcement of all building code provisions for both new construction and any renovation of existing buildings.	All hazards	Building Code Official	High	1, 2	Staff time	Jurisdiction budget	On-going	Continuous
Owosso-3	Conduct a xeriscaping program for all jurisdictional owned facilities	Drought	Facilities Director	Medium	1, 2	$5,000 - $20,000 per facility	HMGP, BRIC, Jurisdiction budget	Ten years	New
Owosso-4	Conduct a personal water use education program.	Drought	Mayor	Low	3	Staff time	HMGP, BRIC, Jurisdiction budget	Five years	New
Owosso-5	Identify and prepare local facilities to serve as heating/cooling centers.	Extreme Temperatures, Severe Winter Weather	Facilities Director	Medium	1, 2	$3,000 per facility	HMGP, Jurisdiction budget	Five years	Carried over, lack of staff and funding
Owosso-6	Continue to participate in the NFIP.	Flood	NFIP Coordinator	High	1, 2	Staff time	Jurisdiction budget	Continuous	On-going
Owosso-7	Construct rainwater retention/detention ponds at strategic locations.	Flood	Mayor	Low	1, 2	Location and size dependent	HMGP, BRIC, Jurisdiction budget	As required	New
Owosso-8	Clean and repair drainage ditches to maintain capacity.	Flood	Mayor	Low	1, 2	Location, length, and size dependent	HMGP, Jurisdiction budget	Ten years	New
Owosso-9	Install hail and high wind resistant roofing on all jurisdictional facilities.	Severe Weather	Facilities Director	Low	1, 2	$50,000 per location	HMGP, BRIC, Jurisdiction budget	Five years	New
Owosso-10	Construct community saferooms in select jurisdictional buildings.	Severe Weather, Tornado	Mayor	High	1, 2	Facility size dependent	HMGP, BRIC, Jurisdiction budget	Ten years	Carried over, lack of funding

Table 83: City of Owosso Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Owosso-11	Conduct public education program for driving in winter conditions.	Severe Winter Weather	Mayor	Low	3	Staff Time	Jurisdiction budget	Five years	New

Table 84: City of Perry Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Perry-1	Install generators in all critical city facilities to mitigate against loss of power as a cascading impact from hazards detailed in this plan.	All hazards	Mayor	High	1, 2	$25,000 - $50,000 per facility	HMGP, BRIC, Jurisdiction budget	Five years	New
Perry-2	Continued enforcement of all building code provisions for both new construction and any renovation of existing buildings.	All hazards	Building Code Official	High	1, 2	Staff time	Jurisdiction budget	On-going	Continuous
Perry-3	Conduct a xeriscaping program for all jurisdictional owned facilities	Drought	Facilities Director	Medium	1, 2	$5,000 - $20,000 per facility	HMGP, BRIC, Jurisdiction budget	Ten years	New
Perry-4	Conduct a personal water use education program.	Drought	Mayor	Low	3	Staff time	HMGP, BRIC, Jurisdiction budget	Five years	New
Perry-5	Identify and prepare local facilities to serve as heating/cooling centers.	Extreme Temperatures, Severe Winter Weather	Facilities Director	Medium	1, 2	$3,000 per facility	HMGP, Jurisdiction budget	Five years	Carried over, lack of staff and funding
Perry-6	Continue to participate in the NFIP.	Flood	NFIP Coordinator	High	1, 2	Staff time	Jurisdiction budget	Continuous	On-going
Perry-7	Construct rainwater retention/detention ponds at strategic locations.	Flood	Mayor	Low	1, 2	Location and size dependent	HMGP, BRIC, Jurisdiction budget	As required	New
Perry-8	Clean and repair drainage ditches to maintain capacity.	Flood	Mayor	Low	1, 2	Location, length, and size dependent	HMGP, Jurisdiction budget	Ten years	New
Perry-9	Install hail and high wind resistant roofing on all jurisdictional facilities.	Severe Weather	Facilities Director	Low	1, 2	$50,000 per location	HMGP, BRIC, Jurisdiction budget	Five years	New
Perry-10	Construct community saferooms in select jurisdictional buildings.	Severe Weather, Tornado	Mayor	High	1, 2	Facility size dependent	HMGP, BRIC, Jurisdiction budget	Ten years	Carried over, lack of funding

Table 84: City of Perry Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Perry-11	Conduct public education program for driving in winter conditions.	Severe Winter Weather	Mayor	Low	3	Staff Time	Jurisdiction budget	Five years	New

Table 85: Township of Owosso Mitigation Actions

Action Identification	Description	Hazard Addressed	Responsible Party	Overall Priority	Goal(s) Addressed	Estimated Cost	Potential Funding Source	Proposed Completion Timeframe	Current Status
Township of Owosso-1	Install generators in critical township facilities to mitigate against loss of power as a cascading impact from hazards detailed in this plan.	All hazards	Mayor	High	1, 2	$25,000 - $50,000 per facility	HMGP, BRIC, Jurisdiction budget	Five years	New
Township of Owosso-2	Conduct a xeriscaping program for all jurisdictional owned facilities	Drought	Facilities Director	Medium	1, 2	$5,000 - $20,000 per facility	HMGP, BRIC, Jurisdiction budget	Ten years	New
Township of Owosso-3	Identify and prepare local facilities to serve as heating/cooling centers.	Extreme Temperatures, Severe Winter Weather	Facilities Director	Medium	1, 2	$3,000 per facility	HMGP, Jurisdiction budget	Five years	Carried over, lack of staff and funding
Township of Owosso-4	Clean and repair drainage ditches to maintain capacity.	Flood	Mayor	Low	1, 2	Location, length, and size dependent	HMGP, Jurisdiction budget	Ten years	New
Township of Owosso-5	Install hail and high wind resistant roofing on all jurisdictional facilities.	Severe Weather	Facilities Director	Low	1, 2	$50,000 per location	HMGP, BRIC, Jurisdiction budget	Five years	New
Township of Owosso-6	Construct community saferooms in select jurisdictional buildings.	Tornado	Mayor	High	1, 2	Facility size dependent	HMGP, BRIC, Jurisdiction budget	Ten years	Carried over, lack of funding

Of major concern was the potential or identified cost of each action. In general, identified actions were proposed to reduce future damage. As such, it is critical that selected and implemented actions provide a greater saving over the life of the action than the initial cost. Prior to the implementation of any action further feasibility analysis will be performed. Additionally, a Benefit-Cost Analysis that determines the future risk reduction benefits of a project and compares those benefits to its costs will be conducted as required. Applicants and sub-applicants will use FEMA approved methodologies and tools, such as the Benefit-Cost Analysis Toolkit, to demonstrate the cost-effectiveness of their projects. The result of the analysis is a Benefit-Cost Ratio, and a project is considered cost-effective when the Benefit-Cost Ratio is 1.0 or greater. Depending on the project, either a full Benefit-Cost Analysis will be completed by entering documented values into the FEMA Benefit-Cost Analysis Toolkit, which calculates a benefit-cost ratio or, if the project meets specified criteria, a streamlined Benefit-Cost Analysis may be completed (FEMA's cost-effectiveness requirement is never waived).

For structural and property protection actions cost effectiveness is primarily assessed on:

- Likelihood of damages occurring
- Severity of the damages
- Potential effectiveness

For all other types of actions cost effectiveness is primarily assessed on likely future benefits as these actions may not easily result in a quantifiable reduction in damage.

The Shiawassee County MPC acknowledges that the adoption and approval of this plan does not obligate any participating jurisdictions to complete each identified action. Rather, the MPC understands that progress should be shown in mitigation efforts which may include the completion of mitigation actions or other actions or progress in achieving the goals of the LHMP.

6.9 Mitigation Action Implementation and Monitoring

Shiawassee County and all participating jurisdictions are responsible for implementing their mitigation actions. To foster accountability and increase the likelihood that actions will be implemented, every proposed action is assigned to a specific department or position as a champion. In general:

- The identified champion will be responsible for tracking and reporting on action status.
- The identified champion should provide input on whether the action as implemented is successful in reducing vulnerability, if applicable.
- If the action is unsuccessful in reducing vulnerability, the identified champion will be tasked with identifying deficiencies and additional required actions.

Additionally, each action has been assigned a proposed completion timeframe to determine if the action is being implemented according to plan.

In general, Shiawassee County is responsible for monitoring the progress of mitigation activities and projects throughout the county in conjunction with participating jurisdictions. To facilitate the tracking of any awarded hazard mitigation grants, Shiawassee County, in conjunction with participating jurisdictions will compile a list of projects funded throughout the calendar year, if any, and add it to an electronic database. Additionally, the MPC will be solicited annually to provide information on any other mitigation projects that were not funded through hazard mitigation grants for addition to the electronic database.

To track mitigation projects from initiation to closeout, participating jurisdictions will use a project tracking spreadsheet that includes, at a minimum, the following information:

- Applicant/Subrecipient
- Grant Identifier

- Contractor
- Total Cost Estimate
- Federal/Local share
- Award Date
- Period of Performance
- Quarterly Reports
- Subrecipient Risk
- Reimbursements

Upon completion of a project, a member of the SCEMHS or the awarded participating jurisdiction will conduct a closeout site visit to:

- Review all files and documents
- Review all procurement files and contracts to third parties
- Take photos of the completed project

Project closeout packages will generally be submitted 90 days after a project has been completed, and will include the following:

- Summary of documentation
- Pictures of completed project
- Materials, labor and equipment forms, if required
- Close-out certification

Additionally, the State of Michigan is currently working with FEMA to apply the FEMA GO system to all FEMA grants. The FEMA GO system allows users to apply, track, and manage all disaster and non-disaster grants and helps improve oversight and monitoring.

6.10 Plan Integration

The Shiawassee County LHMP will be incorporated into existing planning mechanisms in varying processes. These processes will be tailored to the unique characteristics of the planning mechanism and the governing structure of each participating jurisdiction. The LHMP will be integrated, when possible, into the following:

- **Emergency Management Planning:** All jurisdictions in the Shiawassee County LHMP have deferred their emergency management authority to the county, who will utilize the LHMP in all planning decisions.
- **Shiawassee County EMAC:** The Shiawassee County EMAC is a conduit for all mitigation actions and projects. It is headed by the SCEMHS and meets regularly, although there is flexibility in their schedule. The location of the meetings is not fixed so as to increase jurisdictional participation. Members of the EMAC come from all jurisdictions and a wide variety of local agencies and departments.
- **Comprehensive Plans:** Helps guide long term community development to ensure future resilience against identified hazards.
- **Capital Improvement and Economic Development Planning:** Data from this plan will be utilized to provide an understanding of potential hazards and allow for sensible economic and development planning.
- **Threat and Hazard Identification and Risk Assessment:** Utilizes information from the HMP to understand the specific threats and hazards that may impact the community. This informs the development of strategies and resource allocation for emergency management capabilities, ensuring that the community is well-prepared to respond effectively.
- **Comprehensive Land-Use Plans:** Helps guide the development and zoning decisions in a way that minimizes vulnerability to hazards. This includes avoiding construction in high-risk areas and encouraging resilient building practices.

- **Climate Action Plans:** Can help address both short-term hazards and long-term climate-related risks. This includes considerations for extreme temperatures and changes in precipitation patterns.
- **Transportation Plans:** Helps ensure the resilience of transportation infrastructure to hazards such as floods, and earthquakes. This may involve designing infrastructure to withstand extreme weather events.
- **Infrastructure Master Plans:** Contributes to the design, construction, and maintenance of critical infrastructure, such as water supply systems, roads, bridges, and utility networks.
- **Community** Development Plans: Helps ensure that new development projects align with hazard resilience goals. This may involve establishing building codes that prioritize hazard-resistant construction.
- **Open Space and Recreation Plans:** Provides for the consideration of green infrastructure and open spaces for flood control, wildfire buffers, and other hazard mitigation purposes.
- **School Emergency Plans: Enhances the safety and resilience of educational facilities.** This may involve retrofitting buildings, establishing evacuation routes, and conducting regular drills.
- **Public Health Preparedness Plans:** Addresses potential health risks associated with hazards. This includes planning for medical surge capacity, disease prevention, and healthcare facility resilience.
- **Emergency Operations Plans:** The Shiawassee County Emergency Operations Plan will be reviewed and updated to reflect the most probable and dangerous hazard event scenarios from the LHMP's risk assessment. This revision is the responsibility of the SCEMHS for all of the jurisdictions participating in this plan. Upon revision completion, all participating jurisdictions and appropriate emergency services will be notified of the revisions and send out new copies.
- **State of Michigan Hazard Mitigation Plan:** The state's hazard mitigation plan is required by FEMA regulation to include all LHMPs. The process of integrating the Shiawassee County LHMP into this plan is already an established process and is managed by MSP/EMHSD.

Integration of hazard mitigation into these various plans ensures that resilience efforts are embedded in the broader fabric of community development. Coordination and collaboration among different sectors and stakeholders are essential for the successful implementation of hazard mitigation strategies on the local level. Plan incorporation and integration is crucial for creating a cohesive and coordinated approach to address various aspects of hazard mitigation. All participating jurisdiction and stakeholders and participating jurisdictions utilize similar internal procedures for plan incorporation and integration. The following represent commonly utilized integration methods:

- Cross-Referencing: Identify and cross-reference relevant sections of different plans and policies. This involves explicitly noting connections between the goals, strategies, and actions outlined in one plan with those in others.
- Consistency Checks: Conduct consistency checks to ensure that the language, objectives, and strategies in different plans and policies align with each other.
- Joint Planning Committees: Establish joint planning committees or task forces that involve representatives from different departments or agencies responsible for various plans (for example, the MPC). These committees facilitate communication, collaboration, and the coordination of planning efforts across sectors.
- Collaborative Workshops and Meetings: Organize collaborative workshops and meetings to bring together stakeholders involved in different planning processes (as seen in the planning meetings for the LHMP). These forums provide an opportunity for stakeholders to share information and discuss common goals.
- Alignment with State and Regional Plans: Ensure that local plans align with broader regional and state plans. This involves considering regional and state priorities and incorporating them into local planning efforts to create a harmonized approach to development.
- Data Sharing and Analysis: Share relevant data among planning efforts and conduct joint data analysis. This helps in creating a common understanding of the challenges and opportunities, facilitating evidence-based decision-making across different plans.
- Unified Implementation Strategies: This involves identifying common actions and initiatives that contribute to the achievement of multiple goals outlined in various plans.

All participating jurisdictions within Shiawassee County have good working relationships with both each other, the State of Michigan, and FEMA indicating great potential for plan incorporation and integration across the planning area. Where appropriate, Shiawassee County will take the lead in integrating this LHMP into overarching plans, codes, ordinances and any other relevant documents, policies, or procedures.

Community Rating System Integration

The CRS is a voluntary program within the National Flood Insurance Program (NFIP) that incentivizes communities to undertake floodplain management activities beyond the minimum NFIP requirements. Participating communities can earn discounts on flood insurance premiums for their residents based on their level of CRS activity.

According to FEMA, HMP and CRS plan are more valuable and offer greater benefits if they are developed in an intentionally coordinated fashion. Consider the following quote from FEMA's Mitigation Planning and the Community Rating System bulletin:

- "...too often, if a community prepares both, they are done as two separate processes with different planning products. This does not have to be the case. Communities can coordinate these two processes and develop a single plan that meets the goals, intent, and requirements of each program. It is intended for local governments to use [both plans together] to improve their local mitigation plans and leverage the insurance benefits of the CRS to advance mitigation outcomes. This one-plan approach can save time and add value for local communities."

Leveraging HMP and CRS together offers several benefits not realized when creating separate plans. These include:

- An integrated mitigation planning process with more specific flood mitigation actions and projects
- Eligibility for FEMA mitigation grants to help fund actions and projects recommended in the plan
- Credits toward a reduction in flood insurance premiums in CRS-participating communities
- Familiarizing more communities with the CRS program and the benefits of its flood insurance benefits

For communities currently participating in the CRS, or communities considering taking part in the program, the following table provide a CRS and HMP integration cross-check:

Table 86: CRS and HMP Integration

CRS Planning Step	Region L HMP Planning Section
Organize to prepare the plan	Section 2: Document of the Planning Process.
Involve the public	Section 2.9: Community Outreach
Review existing studies	Section 2.11: Planning Document Resources Section 2.12: Technical Resources Section 6.9: Hazard Mitigation Plan Incorporation and Integration
Coordinate with agencies and organizations	Section 2.7: Stakeholders
Assess the hazard	Section 4.0: Hazard Identification and Risk Assessment
Assess the problem	Section 4.0: Hazard Identification and Risk Assessment Section4.12.10: Repetitive Loss Structures
Set goals	Section 6.2: Goals and Objectives Section 6.3: Review and Creation of Mitigation Actions
Review possible activities	Section 5.0: Capability Assessment Section 5.4: Jurisdictional Compliance with NFIP Section 6.0: Mitigation Strategy
Draft action plan	Section 6.4: Prioritization of Mitigation Actions Section 6.9: Hazard Mitigation Plan Incorporation and Integration.
Implement, evaluate, and revise	Section 3.0: Regional Profile and Development Trends

Table 86: CRS and HMP Integration

CRS Planning Step	Region L HMP Planning Section
	Section 6.6; Completed Mitigation Actions Section 2.4: 2024 Plan Update Section 7.0: Plan Maintenance Section 1.4 Plan Adoption

Federal Program Integration

Shiawassee County and the State of Michigan work closely with FEMA in all aspects of planning, response, and mitigation. To ensure understanding and cooperation, the State of Michigan State Hazard Mitigation Officer and Shiawassee County Emergency Manager regularly interface with FEMA mitigation staff on changing FEMA guidelines and opportunities for closer working relationships.

Risk Mapping, Assessment, and Planning Program Integration

SCEMHS and MSP/EMHSD work closely with FEMA, and local partners to identify flood risk and promote informed planning and development practices through the Risk MAP program. Risk MAP is the process used to make FIRMs which both map flood risk and provide informational datasets. Mapping occurs in four phases:

- Discovery: An initial investigation into a community's flood risk, challenges, and goals.
- Analysis and Mapping: A complete engineering analysis is performed that leads to the initial updates to the flood maps. Work is completed with technical experts in each community to make sure the drafts line up with community knowledge.
- Preliminary Flood Map Release: A preliminary flood map and supporting preliminary flood hazard data is generated for review and comment.
- Map Adoption: Community takes full ownership of the updated flood maps and data.

SCEMHS and MSP/EMHSD work with FEMA during the map update process from discovery to map adoption. In addition, SCEMHS and MSP/EMHSD provide any available data to FEMA as requested.

Section 7 – Plan Maintenance

7.1 Introduction

The LHMP is a living document that will be updated and submitted to FEMA for approval every five years as required by 44 CRF 201.4. During the five-year cycle, the plan will undergo continuous monitoring and evaluation to ensure that the policies, procedures, priorities, and state environment established in the plan reflect current conditions. Shiawassee County will utilize the MPC to provide plan updates, revisions, and data collection for future LHMP planning purposes.

7.2 Plan Maintenance Responsibilities

Shiawassee County serves as the lead coordinating agency for plan maintenance. Additional assistance in the plan maintenance process is provided by members of the MPC, subject matter experts, and representatives of local jurisdictions.

Shiawassee County and the MPC will facilitate the review and revision of the LHMP every five years. The review and revision will be an ongoing process. This process will incorporate all of the revisions made during the life of the plan, especially new data obtained from participating jurisdictions.

7.3 Plan Review Meetings

A spart of this planning effort, and to ensure the plan is a living document, the MPC will meet annually for the first two years after plan approval. MPC members will determine the meeting dates and locations and will ensure that the meetings are open to all participating jurisdictions and the public. The Shiawassee County Emergency Manager will be the main point of contact for these meetings and will maintain attendance and meeting minutes.

The purpose of these meetings is to discuss agency capability changes, the status of proposed projects, and any new studies or mapping that may inform the LHMP. Should a specific plan element or section require revision or amendment due to a state or federal legislation or policy change, the MPC will work with the State of Michigan SHMO to complete a plan addendum and submit it to FEMA as quickly as is practicable.

During these meetings, and in order to monitor LHMP progress, the following information will be tracked:

- How the actions from the mitigation strategy are being pursued and completed
    - Are actions being prioritized
- How the plan goals and objectives are being carried out
- How mitigation funding mechanisms are being utilized
- How local jurisdictions are receiving technical assistance

Additionally, the following planning elements will be monitored to ensure the LHMP is current and correct:

- Reviewing the hazards and determining if any of them have changed
- Determining if there are new hazards that pose a risk to the state
- Ensuring goals and objectives are still relevant
- Determining if any actions have been completed or are deemed irrelevant
- Determining if new actions should be added
- Determining if capabilities have changed

After each meeting, the Shiawassee County Emergency Manager will compile a meeting report for usage in future plan revisions.

In addition to these meetings, MPC members and local jurisdictional representatives will monitor and evaluate the progress of mitigation projects via quarterly reports, site visits, correspondence, and reimbursements. Completed projects will be evaluated for loss avoidance and alignment with local development plans.

Any member of the MPC may request a non-scheduled report on the monitoring, evaluation, or updating of any portion of the LHMP plan due to irregular progress on mitigation actions and or projects, in the aftermath of a hazard event, or for any reason deemed appropriate.

7.4 Plan Monitoring and Situational Change

Plan monitoring can be defined as the ongoing process by which stakeholders obtain regular feedback on the progress being made towards achieving their goals and objectives. In the more limited approach, monitoring may focus on tracking projects and the use of the agency's resources. In the broader approach, monitoring also involves tracking strategies and actions being taken by partners and non-partners, and figuring out what new strategies and actions need to be taken to ensure progress towards the most important results.

The MPC will track and record all substantial situational changes and will address, as appropriate, the following questions:

- Is the mitigation project under, over, or on budget?
- Is the mitigation project behind, ahead of, or on schedule?
- Are there any changes in jurisdictional capabilities which impact the plan?
- Are there any changes in jurisdictional hazard risk?
- Has the mitigation action been initiated, or its initiation planned?
- Is the current process of prioritizing mitigation actions and projects appropriate and accurate?
- Has the current method of incorporating mitigation actions and projects yielded a comprehensive action and project strategy to address seen and unforeseen hazards?
- If applicable, has participation in a mitigation action's collaboration been regular?
- Was a negative result caused directly or indirectly by insufficient levels of public outreach?
- If any, what plan updates occurred, why they occurred, and what is their impact?

7.5 Post-Disaster Review

After each Presidential disaster declaration, and in coordination with FEMA and the State of Michigan, the MPC will convene to document impacts and to determine if any mitigation actions should be considered to reduce future risk. This will allow for the development of hazard mitigation recommendations to FEMA during the disaster operation as well as to update the mitigation strategy as needed. The post-disaster review may coincide with established meetings or may be convened as separate events.

7.6 Plan Evaluation

A plan evaluation is a rigorous and independent assessment of either completed or ongoing activities to determine the extent to which they are achieving stated goals and contributing to decision making.

A plan evaluation report will be completed by the MPC when the situation dictates. The following situations are typical examples of when an evaluation will be necessary.

- Post hazard event
- Post training exercise
- Post tabletop or drill exercise
- Significant change or completion of a mitigation project
- Significant change or completion of a mitigation action

An evaluation report will ask the following questions in response to the previously listed events.

- Do the mitigation objectives and goals continue to address the current hazards?
- Are there new or previously unforeseen hazards?

- Does a change in hazard vulnerability demand a change of or addition of mitigation actions or projects?
- Does a change in the mitigation strategy demand a change of or addition of mitigation actions or projects?
- Are current resources appropriate for implementing a mitigation project?
- Was the outcome of a mitigation action/project expected?
- Are there implementation problems?
- Was the public engaged to the point where they were satisfied with current engagement strategies?
- Did the public participate in a number that produced a positive yield on the plan, action, or project?
- Are there coordination problems?

7.7 Plan Updates

Typically, the updating of a LHMP is initiated upon the completion of a plan evaluation when the evaluation determines an update is appropriate. A plan update also occurs every five years per FEMA guidelines or at any time it is deemed necessary by MPC members or the State of Michigan.

According to FEMA DMA 2000 guidelines for mitigation planning, Shiawassee County will begin the update process three years from this plan's adoption under the direction of the MPC. An increase in meeting tempo to twice yearly will allow the MPC to gather relevant information needed for the next plan update. The following meeting schedule indicates the tasks to be performed during this plan update period:

- **2027 Spring Meeting:** The MPC will begin updating the risk assessment portion of the plan. Hazards will be analyzed to determine if they are still relevant, if location should be updated, and if new hazards should be added. Previous occurrences will be reviewed to help determine the probability of future events.
- **2027 Fall Meeting:** The MPC will begin updating the vulnerability assessment. The MPC will update the vulnerability assessment portion of the plan. Data will need to be gathered for assets, critical facilities, building stock values, jurisdictional damages, etc.
- **2028 Spring Meeting:** The MPC will review information received and determine if the goals and objectives are still relevant and if new ones should be added. Actions will be reviewed to determine if they should remain in the plan, have been completed, or are no longer relevant. The MPC will review the potential funding sources for each action.
- **2028 Fall Meeting:** As appropriate, a new MPC will be formed, and all participating jurisdictions will be convened, to take over the planning process. The new MPC and all participating jurisdictions will evaluate the policies, programs, capabilities, and funding sources from the previous plan to determine if they are still accurate and if any new items should be added.
- **2029 Spring Meeting:** The new MPC and all participating jurisdictions will review the draft copy of the mitigation plan and make comments and updates if necessary. Formal submittal to FEMA for re-approval will follow.

In general, the following steps will be taken to complete the next LHMP revision:

Table 87: LHMP Update Task List

Task	Action
1	Evaluate and update the planning process.
2	Review the stakeholder contact list and identify new stakeholders.
3	Initiate plan outreach and discussion, including a stakeholder meeting.
4	Consider the addition, removal, or modification of hazards identified in the plan.
5	Update and revise membership of the MPC.
6	Evaluate risk assessment methodologies and data sources.
7	Evaluate and update critical facility inventory information.
8	Evaluate and update the hazard profiles.
9	Evaluate and update the risk assessment summary.

Table 87: LHMP Update Task List

Task	Action
10	Evaluate and update the mitigation strategy, including proposed mitigation actions.
11	Evaluate and update the mitigation implementation system.
12	Integrate new and updated local plans.
13	Evaluate and update other plans sections.
14	Identify and add any additional sections or information needed.
15	Review updated plan in its entirety.
16	Conduct updated plan outreach, including public information, comment period, and meetings.
17	Integrate additional comments received.
18	Finalize plan document.
19	Complete crosswalk and submit final plan to FEMA for review and approval.
20	Make additional modifications as required.
21	Obtain jurisdictional adoption resolutions.

7.8 Continued Public Involvement

Shiawassee County and all participating jurisdictions are dedicated to involving the public in the continual shaping of the LHMP and in the development of its mitigation projects and activities.

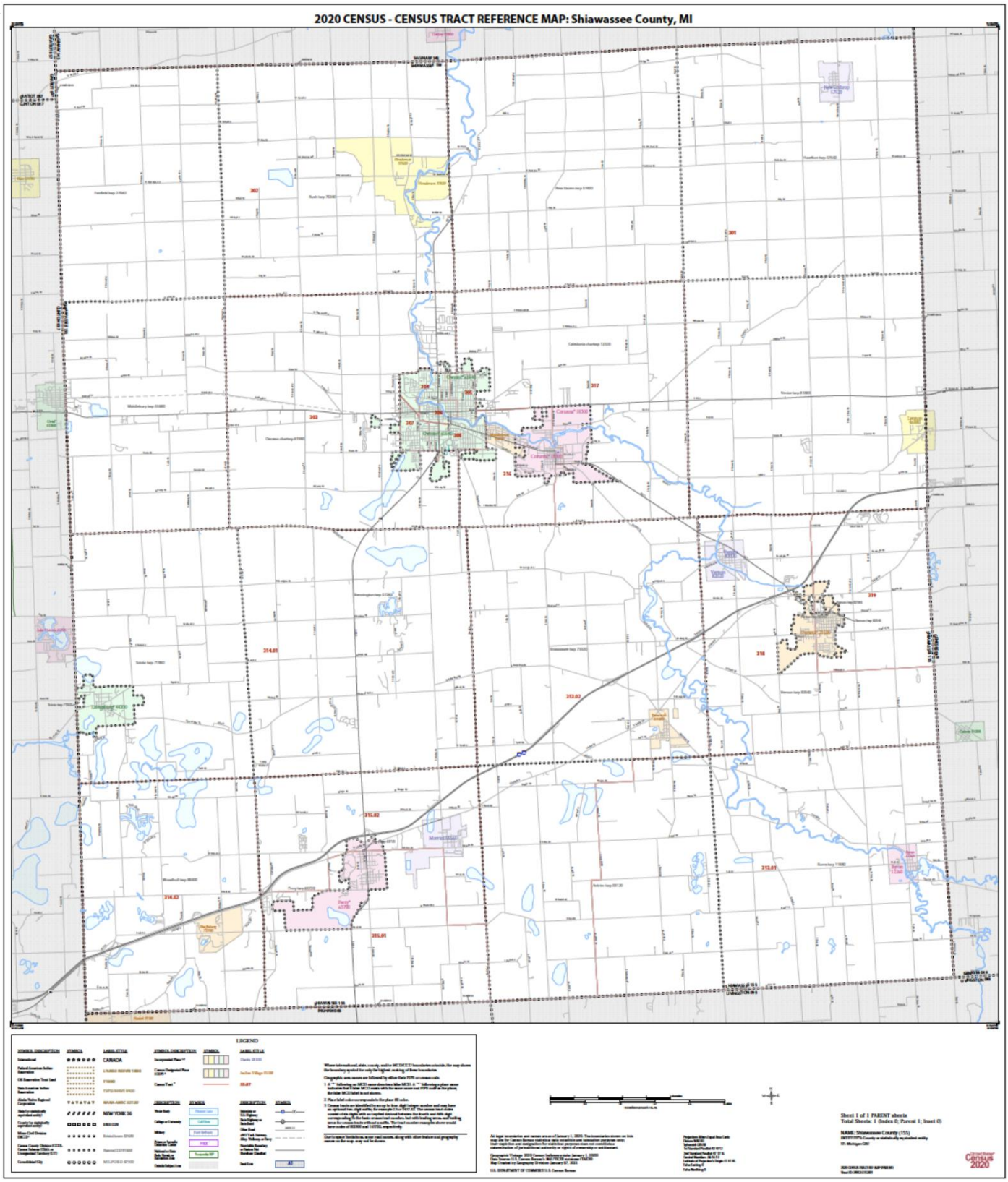
The MPC and all participating jurisdictions will continue to keep the public informed about hazard mitigation projects and activities through jurisdictional websites, and as appropriate, public announcements. The public will also be invited to participate in all meetings to review and discuss the mitigation-related events. Additionally, participating jurisdictions will present to public officials in a public forum concerning the progress of mitigation actions identified in this plan as progress is made.

Copies of the Shiawassee County LHMP will be distributed to all the participating jurisdictions and made available to the public. Methods of public availability may include electronically posted on a website or a hard copy kept at a jurisdictional office

Appendix A - Participating Jurisdiction Adoption Documentation and FEMA Region V Approval Documentation

Appendix B – Community Feedback

Appendix C – Census Tract Map


2020 CENSUS - CENSUS TRACT REFERENCE MAP: Shiawassee County, MI
LEGEND