Assessment of Natural Hazards

1. Chapter Overview

This chapter evaluates the natural hazards that have or could occur in the county. Initially, 14 natural hazards were identified. They were prioritized and earthquakes, wildland fire, and land subsidence were dropped from future consideration. The remaining natural hazards are described in this chapter. After describing the nature of the hazard, the frequency of occurrence is documented along with its effect on critical facilities, various population groups, and economic sectors. Estimates of economic loss are included when there is enough empirical data to do so.

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2. Hazard Identification

As part of an initial screening process, the steering committee used the methodology developed by Wisconsin Emergency Management[1] to evaluate 14 natural hazards that were initially identified as a potential threat. The members of the steering committee used a group consensus process to assign a numeric value to the factors listed in Table 5-1 to help determine those hazards that warrant the most attention on a countywide basis. The most recent steering committee review in 2024 resulted in minor adjustments in individual scores.

Table 5-1. Hazard Assessment Criteria

Factor	Description
Historical Hazard Frequency	Frequency of past occurrences
Anticipated Hazard Probability	Probability of the hazard occurring again
Historical Health and Public Safety	Degree of past hazard events causing injuries, sickness, and/or deaths
Residential Damage	Degree of past hazard events causing damages to homes
Business Damage	Degree of past hazard events causing damages to businesses
Public Costs	Amount of local, state, and federal funds expended on past hazard recovery activities
Magnitude of Population at Risk	Amount of the area's population still vulnerable to injury, sickness, and/or death
Magnitude of Homes at Risk	Amount of homes still vulnerable to damage
Magnitude of Businesses at Risk	Amount of businesses still vulnerable to damage or interruption of business trade
Magnitude of Public Infrastructure at Risk	Amount of infrastructure that is susceptible to damages

Source: *Resource Guide to All Hazards Mitigation Planning in Wisconsin*, 2003. Wisconsin Emergency Management

[1] *Resource Guide to All Hazards Mitigation Planning In Wisconsin*, 2023. Wisconsin Emergency Management

Table 5-2 shows the results of that exercise. The three highest ranked natural hazards are flooding from rivers, thunderstorms, and tornadoes. Given the distance to a known fault line, earthquakes were judged to be of little concern. In addition, given the topography and soils in the county, land failures, including subsidence and mass movement, were judged to be of little concern. Wildland fire was also deemed to be comparatively of low priority. These were removed from further consideration in this plan.

Table 5-2. Countywide Comparative Analysis of Natural Hazards; Sauk County: 2025

Hazard	1 Historical Hazard Frequency (1,2,3)	2 Anticipated Hazard Probability (1,2,3)	3 Historical Health and Public Safety (1,2,3)	4 Residential Damage (1,2,3)	5 Business Damage (1,2,3)	6 Public Costs (1,2,3)	7 Magnitude of Population at Risk (1,2,3)	8 Magnitude of Homes at Risk (1,2,3)	9 Magnitude of Businesses at Risk (1,2,3)	10 Magnitude of Infrastructure at Risk (1,2,3)	11 Overall Score
Flooding – river	2	2	2	1	3	3	1	2	2	2	20
Thunderstorm	3	3	1	1	1	1	3	3	2	2	20
Tornado	1	1	1	1	3	2	3	3	3	2	20
Flooding – stormwater	2	2	1	1	3	3	1	1	1	2	17
Winter storm	1	1	1	1	2	2	3	2	2	1	16
Excessive heat	2	2	3	1	1	1	2	1	1	1	16
Dense fog	3	3	1	1	1	1	2	1	1	1	15
Extreme cold	2	2	3	1	1	1	2	1	1	1	15
Hail	2	2	1	2	1	1	1	2	2	1	14
Drought	1	1	1	1	2	1	3	1	1	1	13
Dam Failure	1	1	1	1	1	1	1	1	1	2	11

Notes: This matrix is based on a qualitative assessment and is intended to identify those hazards posing the greatest concern.

A low, medium, or high numerical rating of 1, 2, or 3, respectively, is assigned to each criterion and then the ratings for each hazard are totaled.

Column 1 refers to the frequency of past occurrences.
Column 2 refers to the probability of the hazard occurring again.
Column 3 refers to the degree of past hazard events causing injuries, sickness, and/or deaths.
Column 4 refers to the degree of past hazard events causing damage to homes.
Column 5 refers to the degree of past hazard events causing damage to businesses.
Column 6 refers to the amount of local, state, and federal funds expended on past hazard recovery activities.
Column 7 refers to the amount of the area's population still vulnerable to injury, sickness, and/or death.
Column 8 refers to the amount of homes still vulnerable to damage.
Column 9 refers to the amount of businesses still vulnerable to damage or interruption of business trade.
Column 10 refers to the amount of infrastructure that is susceptible to damage.
Column 11 is the raw score for the hazard.

The nature of the identified hazards are quite different as shown in Table 5-3. Some of the hazards are characteristically localized occurrences, while others could potentially cover the entire county and the surrounding region. Further, some hazards occur with little advance warning and others, such as riverine flooding on larger rivers, can be forecasted with some degree of accuracy several days in advance of the actual event. Some hazards have the potential to occur often, while others occur rather infrequently.

In an effort to keep residents and local officials informed about potential events, the National Weather Service (NWS) issues, outlooks, watches, and warnings for most weather events. NWS mentions the possibility of a hazard in daily message entitled "Hazardous Weather Outlook" (HWO) that is disseminated to the media, posted on its web site, broadcast on NOAA Weather Radio All Hazards, and made available on various computer circuits. An outlook covers possible events seven days out. Confidence factor is about 30 percent for issuance. A message entitled "watch" for most weather hazards is generally issued hours to a couple days in advance of a possible event. Confidence factor is about 60 percent for issuance. It is disseminated to the media, posted on the NWS web site, broadcast on NOAA Weather Radio All Hazards, and made available on various computer circuits. A "warning" message for most weather hazards has a confidence factor of 80 to 100 percent. It is disseminated to the media, posted on the NWS web site, broadcast on NOAA Weather Radio All Hazards, and made available on various computer circuits.

Table 5-3. Nature of Natural Hazards; Sauk County

Natural Hazard	Extent	Amount of Advance Notification	Recurrence Interval [1]
Dam Failure	Along affected stream corridor	None to weeks	N/A [2]
Flooding – Riverine	Along affected stream corridor and around lakes	Several days	0.01 [3]
Flooding – Stormwater	Poorly drained areas	Several days	0.01 [3]
Dense Fog	Small pockets in low-lying areas to countywide	Several days	0.7
Tornado	Generally, a linear path up to several miles long	Several days	0.7
Hail Storm	1 square mile and larger	Several days	0.7
Thunderstorm	10 square miles and larger	Several days	0.33
Snow Storm	Countywide	Several days	1.3
Extreme Heat	Countywide	Several days	0.4
Extreme Cold	Countywide	Several days	0.3
Drought - short-lived	Countywide	Several months	10
Drought - long-lived	Countywide	Year	75

Notes:

1. Recurrence interval is number of events occurring over a period of time.
2. It is not possible to define a recurrence interval for this type of hazard
3. Based on a 100-year flood

Table 5-4 lists each of the hazards and identifies whether they will have an impact on the critical facilities identified in this plan, noncritical buildings and structures, special populations, the general population, and broadly defined economic sectors.

Table 5-4. General Effects of Natural Hazards on Facilities, Population Groups, and Economic Sectors; Sauk County: 2025

Critical Facility		Dam Failure	Flooding - Riverine	Flooding - Stormwater	Dense Fog	Tornado/High Wind	Hail	Thunderstorm	Winter Storm	Extreme Temperature	Drought
Facility with Hazardous Materials		-	D	-	-	D	-	-	-	-	-
Infrastructure	Bridge	D	D	-	-	-	-	-	-	-	-
	Dam	D	D	-	-	-	-	-	-	-	-
	Communication Tower	-	-	-	-	D	-	-	-	-	-
	Electric Facility – Power Plant	-	-	-	-	D	-	-	-	-	-
	Electric Facility – Substation	-	-	-	-	D	-	-	-	-	-
	Natural Gas Facility	-	-	-	-	D	-	-	-	-	-
	Petroleum Pipeline	-	-	-	-	-	-	-	-	-	-
	Public-Use Airport	-	-	-	I	D	I	I	I	-	-
	Telephone Facility	-	-	-	-	D	-	-	-	-	-
	Utility Offices/Yard	-	-	-	-	D	-	-	-	-	-
	Water Facility [1]	-	-	-	-	D	-	-	-	-	I
	Wastewater Facility	-	-	-	-	D	-	-	-	-	-
Government Facility	Community Center	-	-	-	-	D	D	-	-	-	-
	Library	-	-	-	-	D	D	-	-	-	-
	Municipal Garage	-	-	-	-	D	D	-	-	-	-
	Municipal Office and Other	-	-	-	-	D	D	-	-	-	-
	Post Office	-	-	-	-	D	D	-	-	-	-
	Senior Center	-	-	-	-	D	D	-	-	-	-
Health Care Facility	Health Care Clinic	-	-	-	-	D	D	-	-	-	-
	Hospital	-	-	-	-	D	D	-	-	-	-
Public Safety Facility	EMS Facility	-	-	-	-	D	D	-	-	-	-
	Fire Station	-	-	-	-	D	D	-	-	-	-
	National Guard Facility	-	-	-	-	D	D	-	-	-	-
	Police Station	-	-	-	-	D	D	-	-	-	-
School	K-12	-	-	-	-	D	D	-	-	-	-
	Secondary	-	-	-	-	D	D	-	-	-	-
Special Care Facility - Residential	Adult Family Home	-	-	-	-	D	D	-	-	-	-
	Community Based Residential Facility	-	-	-	-	D	D	-	-	-	-
	Nursing Home	-	-	-	-	D	D	-	-	-	-
	Residential Care Apartment Complex	-	-	-	-	D	D	-	-	-	-
Special Care Facility - Nonresidential	Adult Day Care	-	-	-	-	D	D	-	-	-	-
	Group Day Care	-	-	-	-	D	D	-	-	-	-
Vulnerable Housing	Mobile Home Park	-	-	-	-	D	D	-	-	-	-
	Campground	-	-	-	-	D	D	-	-	-	-
Noncritical Buildings/Structures		-	-	-	-	D	D	-	-	-	-
Population Groups											
General Public		-	-	-	-	D	-	-	-	I	I
Elderly and People with Disabilities		-	-	-	-	-	-	-	-	I	-
Homeless		-	-	-	-	-	-	D	D	D	-
Economic Sector											
Agriculture		-	D	D	-	-	D	I	-	I	D
Commercial		-	-	-	-	-	-	-	-	-	I
Industrial		-	-	-	-	-	-	-	-	-	-
Transportation		-	-	-	-	-	-	-	-	-	-

Notes: 1. Types of facilities included in this category include wells, towers, and treatment plants

Key: - No or minimal effect; I – Indirect Effect; D – Direct Effect

3. History of Weather-Related Events

Table 5-5 presents a summary of weather-related events occurring in Sauk County and surrounding region since 1950 as documented by the National Weather Service (NWS). A complete list of weather events is listed in Appendix G. It should be noted that for excessive cold and heat and winter storms, the data for direct deaths and injuries, property damage, and crop damage is for the county and the surrounding region. It also appears that crop damage as documented by the NWS is under reported.

Out of all of the weather-related events, temperature extremes have caused the highest number of deaths. Tornadoes caused the next highest number of injuries. In terms of monetary loss, flooding has caused the most damage to property and crops.

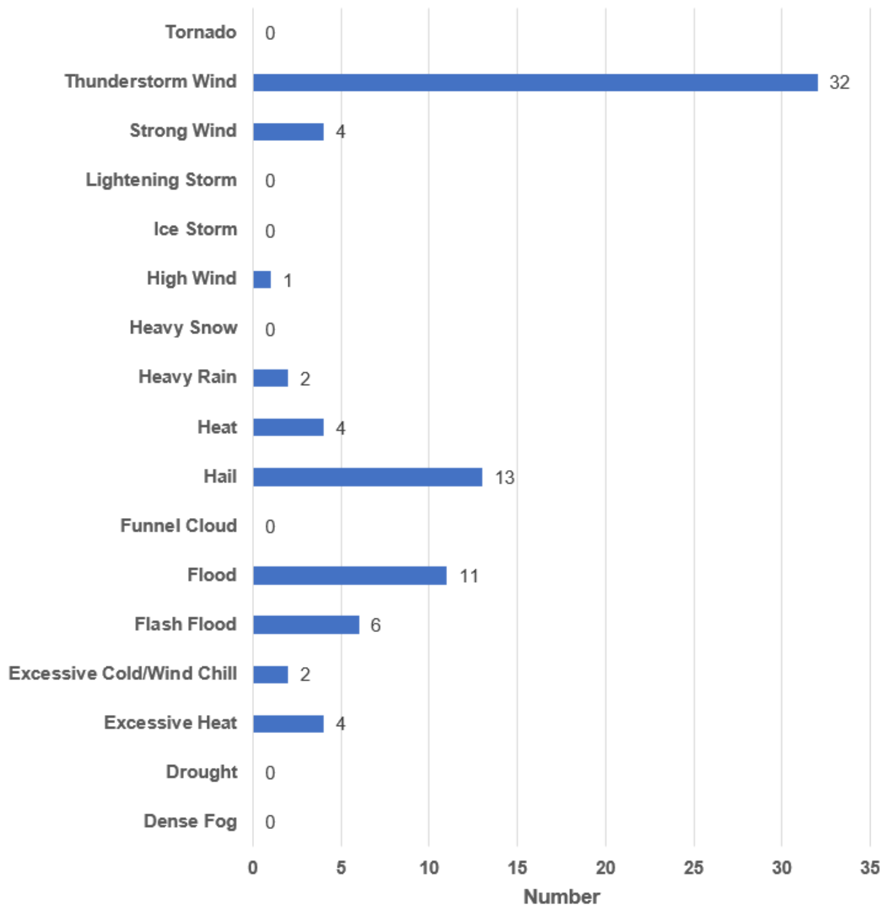
Thunderstorms have occurred with the highest frequency— about 2.7 times a year. Hail and winter storms were the next most common weather-related event. Flooding, lightning, severe winter weather, and tornadoes have about the same recurrence interval.

Table 5-5. Summary of Weather-Related Events, Sauk County: 1950 through 2023

Type of Event	Number	Direct Deaths	Direct Injuries	Property Damage	Crop Damage
Dense Fog	63	0	0	0	0
Drought	18	0	0	0	$300,000
Excessive Heat	6	1	0	0	0
Extreme Cold/Wind Chill	7	0	0	$3,000	0
Flash Flood	33	0	0	$34,581,000	$25,882,000
Flood	29	0	0	$16,529,000	$11,346,000
Funnel Cloud	4	0	0	0	0
Hail	136	0	0	$984,000	$438,000
Heat	30	0	0	0	0
Heavy Rain	12	0	0	$7,000	0
Heavy Snow	13	0	0	0	0
High Wind	7	0	0	$147,000	$50,000
Ice Storm	2	0	0	$300,000	0
Lightning	10	0	1	$1,996,000	0
Strong Wind	30	0	0	$101,000	0
Thunderstorm Wind	229	0	0	$2,621,000	$548,000
Tornado	23	0	13	$6,544,000	$530,000

Source: National Climatic Data Center database accessed 2024
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=55%2CWISCONSIN

Table 5-6. Summary of Weather-Related Events, Sauk County: 2018 - 2023



Source: National Climatic Data Center database accessed on 2024
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=55%2CWISCONSIN

4. Presidential Declarations

Since 1965, there have been 38 declarations issued for Wisconsin. Sauk County was included in 8 disaster declarations and two emergency declarations.

Major Disaster Declaration A major disaster declaration was issued for Sauk County, along with other counties, in 1992, 1993, 2000, 2004, 2007, 2008, 2018, and 2020 (Table 5-7).

Emergency Declaration In 2005, an emergency declaration was issued for all 72 counties in the state as part of the nationwide response to Hurricane Katrina. In 2020, an emergency declaration was issued for all 72 counties in the state as part of the nationwide response to Covid-19 Pandemic. A second emergency declaration was issued in 2020 related to the Covid pandemic.

Fire Management Assistance Declaration No fire management assistance declarations have been issued for Sauk County.

Table 5-7. Presidential Disaster Declarations, Sauk County: 1965 through 2024

			Type of Assistance	
Major Disaster	**Year**	**Description**	**Public**	**Individual**
DR-964-WI	1992	Flooding, severe storm	Yes	Yes
DR-994-WI	1993	Severe storms, tornadoes, flooding	Yes	Yes
DR-1332-WI	2000	Severe storms, tornadoes, flooding	Yes	Yes
DR-1526-WI	2004	Severe storms, flooding	Yes	Yes
DR-1719-WI	2007	Severe storms, tornadoes, flooding	Yes	No
DR-1768-WI	2008	Severe storms, tornadoes, flooding	Yes	Yes
DR-4402-WI	2018	Severe storms, tornadoes, straight-line winds, flooding and landslides	Yes	Yes
DR-4520-WI	2020	Covid-19 Pandemic	Yes	Yes
Emergency Declaration	**Year**	**Description**		
FEMA-3249-EM	2005	Hurricane Katrina evacuation	Yes	No
FEMA-3454-EM	2020	Covid-19	Yes	No
Fire Management Assistance	Year	**Description**		
None	-	-	-	-

Source: Federal Emergency Management Agency https://www.fema.gov/disaster/declarations accessed December 2024

Denied Applications for Presidential Disaster Declaration The county's application for a presidential disaster declaration has been denied on two occasions (Table 5-8).

Table 5-8. Denied Applications for Presidential Disaster Declarations; Sauk County: 1965 through 2024

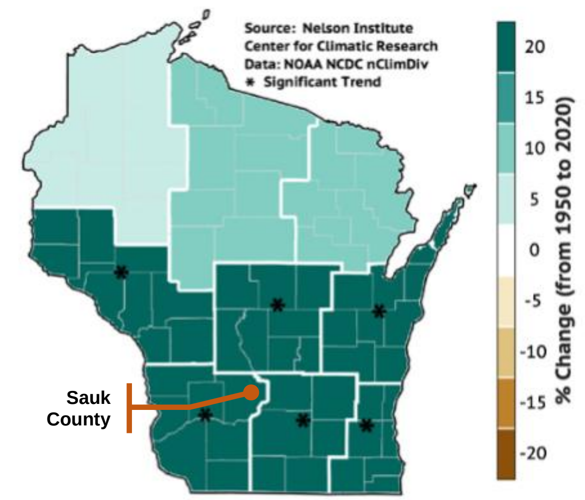
Year	Description
1996	Flooding, severe storm
1998	High winds, severe storms

Source: Wisconsin Emergency Management and Sauk County Emergency Management

5. Climate Change

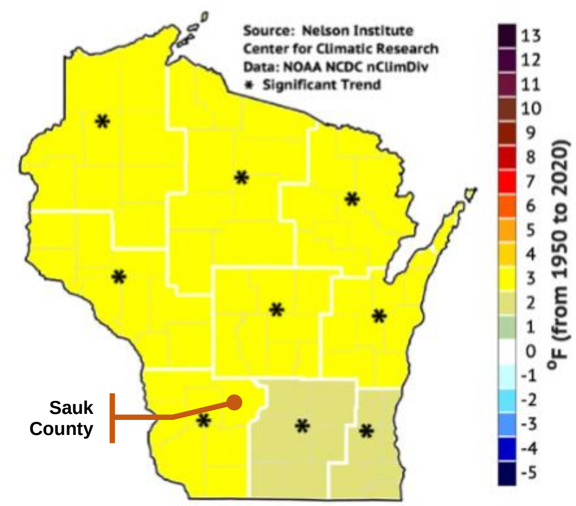
Historical Change To better understand the nature of the changing climate in our state, the Wisconsin Initiative on Climate Change Impacts (WICCI) released an initial report in 2011 and an update in 2023. As documented, Wisconsin's climate has been undergoing significant changes. Historically, precipitation has increased statewide from 1950 to 2023 (Exhibit 5-1). The southern part of the state saw the largest increase. Sauk County experienced an increase of 20 percent in precipitation. Temperatures over the same period also increased statewide. Sauk County saw an average increase of 3 °F (Exhibit 5-2).

Exhibit 5-1. Historical Change in Annual Precipitation from 1950 to 2020



Source: Wisconsin's changing climate: Impacts and solutions for a warmer climate. 2021. Wisconsin Initiative on Climate Change Impacts. Nelson Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, Wisconsin.

Exhibit 5-2. Historical Change in Annual Temperature from 1950 to 2020

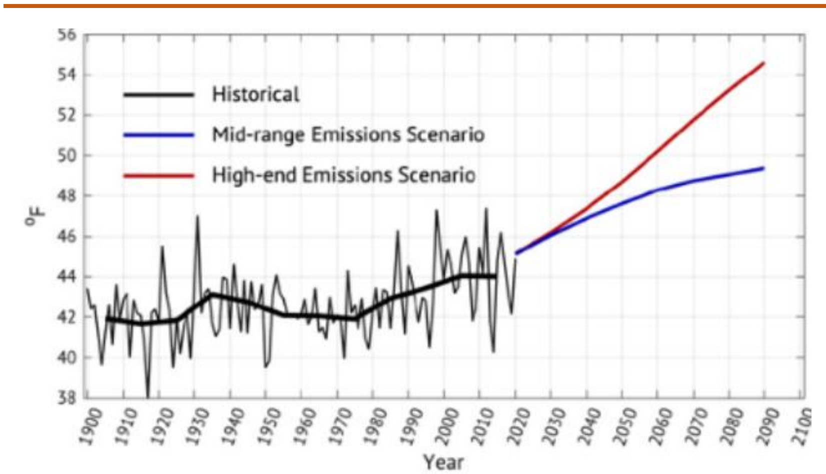


Source: Wisconsin's changing climate: Impacts and solutions for a warmer climate. 2021. Wisconsin Initiative on Climate Change Impacts. Nelson Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, Wisconsin.

Future Conditions Looking ahead, WICCI analyzed Wisconsin's projected climate under two different future climate scenarios, based on a mid-range and high-end estimate of future greenhouse gas emissions. For both scenarios, the average temperatures in Wisconsin will be about four to six degrees warmer compared to our baseline climate conditions at the end of the 20th century (Exhibit 5-3). Further into the future, the emissions scenarios diverge dramatically and show a difference of six degrees between each other by the late 21st century.

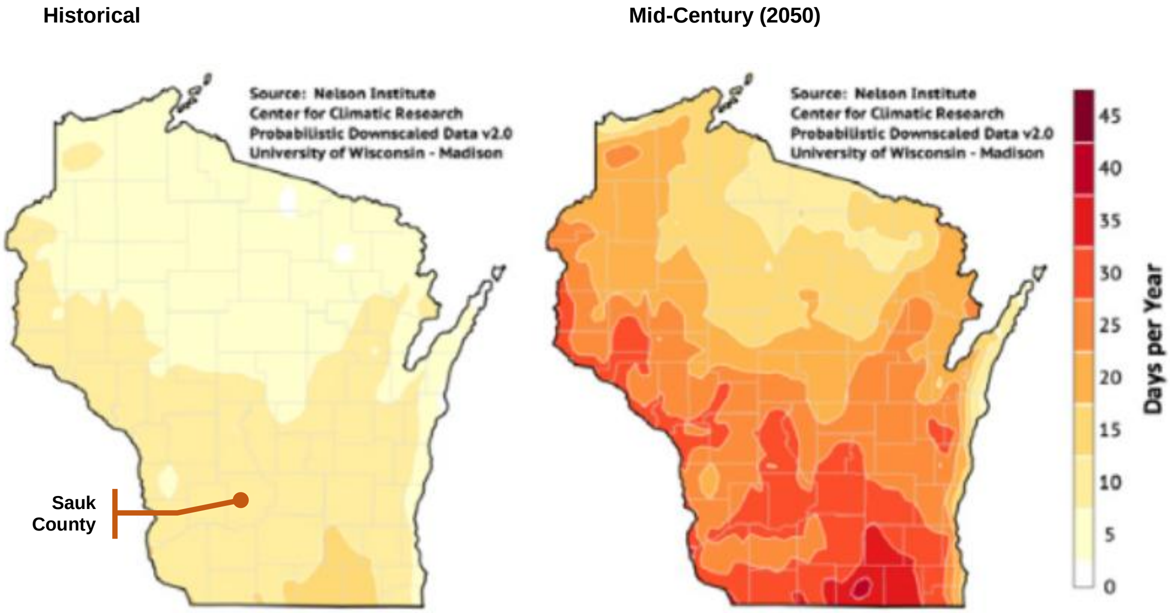
While seemingly modest, an increase of a single degree will yield significant impacts on the frequency and magnitude of many extreme weather events. (Exhibit 5-4).

Exhibit 5-3. Historical Average Temperature: Historical (1900-2020) and Projected (2020-2090)



Source: Wisconsin's changing climate: Impacts and solutions for a warmer climate. 2021. Wisconsin Initiative on Climate Change Impacts. Nelson Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, Wisconsin.

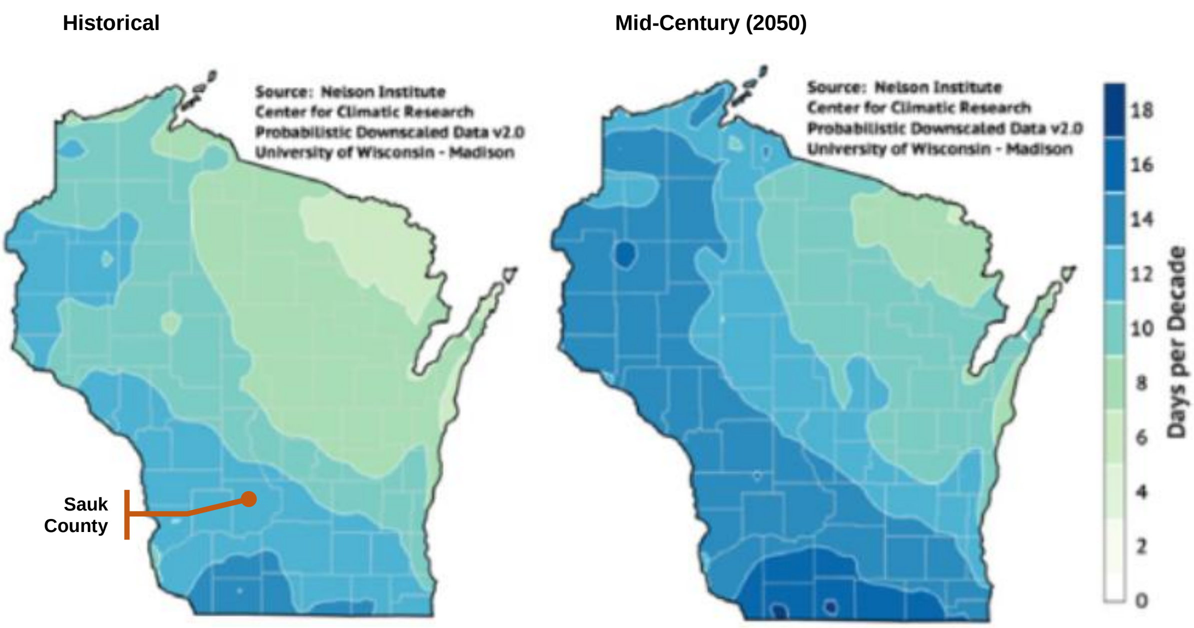
Exhibit 5-4. Number of Extremely Hot Days per Year



Source: Wisconsin's changing climate: Impacts and solutions for a warmer climate. 2021. Wisconsin Initiative on Climate Change Impacts. Nelson Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, Wisconsin.

The report suggests Wisconsin will likely to continue to trend toward wetter conditions, especially during winter, spring, and fall (Exhibit 5-5). Extreme rain events will also increase significantly. Extreme precipitation events are likely to remain most common in the southern and western parts of the state.

Exhibit 5-5. Frequency of Extreme Rainfall (2 or more inches of precipitation in 24hr period)



Source: Wisconsin's changing climate: Impacts and solutions for a warmer climate. 2021. Wisconsin Initiative on Climate Change Impacts. Nelson Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, Wisconsin.

6. Dam Failure

Profile

A dam failure involves the uncontrolled release of impounded water when the structure fails. A dam can fail because of excessive rainfall or melting snow, poor construction or maintenance, flood damage, earthquake activity, weakening caused by burrowing animals, vegetation, surface erosion, vandalism, or a combination of factors. When a dam does fail, the impounded water flows unimpeded and, depending on what development is located downstream, can potentially cause significant property damage and loss of life.

Table 5-9. Dams; Sauk County: 2024

Status	Large	Small	Unknown
Active	23	102	14
Removed	6	3	13
Total	29	105	27

Source: Wisconsin Department of Natural Resources, data accessed December 2024

According to the Department of Natural Resources, there were 161 dams in the county in 2024 (Table 5-9). Of that number, 139 remain active in that they impound some water. The others were abandoned or were otherwise destroyed, no longer impound water, or have been permitted but have not been built yet.

Most of dams in the county were “millpond” dams that were built more than 80 years ago. There were also small dams for watering livestock and various recreational ponds around the county. Sauk County owns two dams, White Mound, put in to control flooding on the Honey Creek Watershed, and Lake Redstone, a recreational lake near La Valle. Two electric power generating dams were also located in Sauk County.

If any of the mill type dams failed, the runoff would hardly be noticed downstream. The electric power generating dams within the county are of the greatest concern, but consistent maintenance keeps them in good repair.

Castle Rock Lake and Petenwell Lake are located along the Wisconsin River in Adams and Juneau counties. A dam failure of one or both would cause significant flooding in Sauk County along the river.

History of Past Occurrences

According to the Wisconsin Department of Natural Resources, there were about 3,800 dams in the state. Between 1990 and 1995, 75 dam failures were documented, many of which resulted from the flooding that occurred statewide in 1993. In Sauk County, there are no documented dam failures of significance. Although the Lake Delton Dam did not fail, County Highway A in the Village of Lake Delton washed out in 2008, causing Lake Delton to empty into the Wisconsin River.

Vulnerability Assessment

Over the years, more than 20 dams in the county have been removed or have fallen into disrepair and do not currently impound water. Of the 128 dams that remain intact, 24 are classified as large, 102 are small, and 2 are unclassified.

A failure of a small dam would likely not cause damage. Given the amount of water impounded behind a large dam, dam failure is a concern in varying degrees. Dams are also classified based on the threat to downstream property if a dam failed as specified in Section 333.06, Wisconsin Administrative Code. A dam rated as a high hazard indicates that a failure would most probably result in the loss of life. A significant hazard indicates that a dam failure could result in appreciable property damage. A low hazard rating is assigned to dams where a dam failure would result in only minimal property damage and where loss of life is unlikely. Of the 21 large dams, 4 are classified as high and 17 are low (Table 5-10).

Section NR 333.07 (3) of the Wisconsin Administrative Code mandates that owners of a large dam or a dam that poses a threat to life or property must prepare an emergency action plan (EAP). An EAP is a document that identifies potential emergency conditions at a dam and procedures to be followed to eliminate the loss of life and minimize downstream property damage. When drafting an EAP, the dam operator must consult with the local units of government that lie downstream of the dam as well as the county emergency management department. An EAP has been prepared for a number of dams based on DNR records (Table 5-10). This table also indicates in which municipality the dams are located.

Table 5-10. Large Dams; Sauk County: 2024

DNR ID	Official Name	Municipality	Ownership	Hazard Rating Code [1]	Impoundment Storage (Acrefeet)	Status of Emergency Action Plan	Regulatory Authority
6	Kilbourn Dam	City of Wisconsin Rapids	Utility	High	36,000	2024	WI
30	Prairie du Sac Dam	Town of Prairie du Sac	Utility	High	193,200	2023	FERC 11162
56	Dell Creek Dam	Village of Lake Delton	Village	High	2,500	2019	WI
190	Delton Dam	Village of Lake Delton	County	High	1,280	2019	WI
191	Leland Dam	Town of Honey creek	Private	Low	65	2010	WI
192	Schramms	Town of Freedom	Private	Low	180	-	WI
193	Dutch Hollow Lake	Town of La Valle	Private	Low	5,500	2016	WI
381	Plain Honey Creek 4	Town of Franklin	County	Low	800	-	WI
382	Plain Honey Creek 3	Town of Franklin	County	Low	2,850	-	WI
418	Magruder Dam	Town of Woodland	Private	Low	50	-	WI
456	Satterlee Dam	Town of Woodland	Private	Low	50	-	WI
480	Steinhorst and Coughlin Dam	Town of Freedom	Private	Low	60	2017	WI
497	Plain Honey Creek 2	Town of Franklin	County	Low	710	2019	WI
568	Huey Duck Lake	Town of Excelsior	Private	Low	87	2012	WI
653	Lake Redstone	Town of La Valle	County	High	15,200	2019	WI
654	Dells Manor Dam	Village of Lake Delton	Private	Low	460	2015	WI
815	Long Lake Flowage Dam	Town of Spring Green	WI-DNR	Low	1,000	2023	WI
816	Bakkens Pond Dam	Town of Spring Green	WI-DNR	Low	300	2023	WI
829	Virginia Lake Dam	Town of Excelsior	Private	Low	450	2014	WI
830	Polk Dam	Town of Woodland	Private	Low	75	-	WI
846	Marking Dam	Town of Dellona	Private	Low	120	-	WI
896	Sensnovis Dam	Town of Woodland	Private	Low	50	2011	WI
956	Hemlock Dam	Town of La Valle	County	Low	85	2019	WI
4837	Lake of the Dells	City of Wisconsin Dells	Private	Low	74	-	WI

Source: Wisconsin Department of Natural Resources, data accessed December 2024
Notes:
1. Key: High - loss of life likely should dam fail; Significant - significant property damage is likely; Low - neither loss of life or property will occur
2. The Village is in the process of working with the Wisconsin Department of Natural Resources on the removal of this dam. It is anticipated that it will be removed during the winter of 2009/2010.
3. Data unknown

Effects on Facilities – Because a dam break analysis has not been conducted on any of the dams in Sauk County, it is not possible to determine what effects would occur.

Effects on Population Groups – A dam failure would not disproportionately affect the elderly, people with disabilities, or the homeless.

Effects on Economic Sectors – Although a dam failure could damage individual structures, it likely would not affect the overall economy of the area or any particular economic sector.

Effects on New Development – Communities have the opportunity through the land division process to ensure that new development does not occur within defined dam inundation areas.

Climate change can be expected to lead to more annual precipitation with more frequent and heavier high precipitation events. This will lead to more flooding and the potential for dam failure.

7. FLOODING

PROFILE

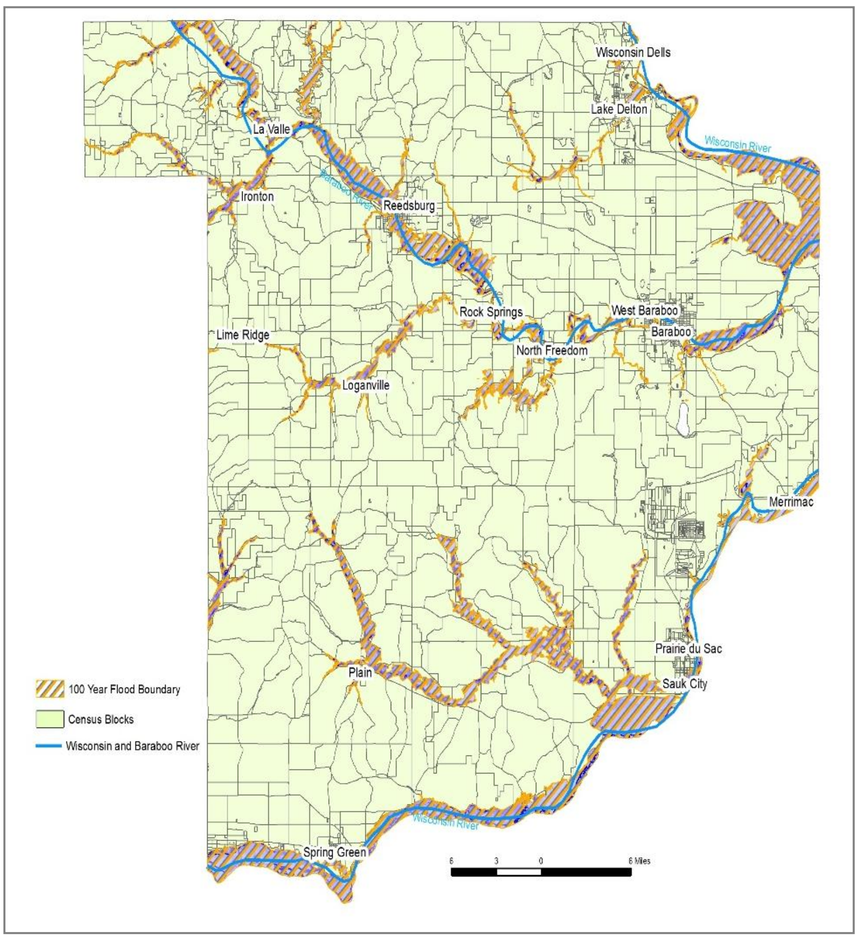
Riverine flooding occurs when a stream, lake, or other body of water overflows its banks onto normally dry land. Stormwater flooding occurs when stormwater pools in normally dry depressions in the land. Flooding can develop slowly over a period of days but can also occur within a few hours in some watersheds with narrow stream channels.

Flooding that occurs in the spring due to snow melt or during a period of heavy rain is characterized by a slow build-up of flow and velocity in rivers and streams over a period of days. This buildup continues until the river or stream overflows its banks for as long as a week or two then slowly recedes. Generally, the timing and location of this type of flooding is fairly predictable and allows ample time for evacuation of people and property.

For prediction and warning purposes, floods are classified by the National Weather Service into two types: those that develop and crest over a period of approximately six hours or more and those that crest more quickly. The former are referred to as "floods" and the latter as "flash floods." Flash flooding occurs solely from surface run-off as a result of intense rainfalls. Flash flooding occurs less frequently in Wisconsin than flooding associated with spring snow melt. This type of flooding, however, is generally unpredictable. These are a particular concern in Sauk County because the topographical profile of the county is generally flat.

Terms commonly used when referring to flooding are "100-year flood" and "flood plain." A 100-year flood is defined as the flood water level that can be expected to occur or to be exceeded in a given location once every 100 years. There is a one percent chance of a flood of such magnitude or greater occurring in any given year. The DNR, working with local zoning offices, has designated floodplain areas as those places where there is the greatest potential for flooding.

Exhibit 5-6. HAZUS-MH Analysis 100-Year Flood;



VULNERABILITY ASSESSMENT

Staff with Wisconsin Emergency Management conducted a vulnerability assessment of flooding in the county using the HAZUS-MH MR3 program released in July 2007. As part of this analysis, the bundled aggregated general building stock was updated to Dun & Bradstreet 2006 and building valuations were updated to R.S. Means 2006. Building counts based on census housing unit counts (as opposed to calculated building counts) are available for RES1 (single-family dwellings) and RES2 (manufactured housing). The site-specific inventory (specifically schools, hospitals, fire stations, emergency operation centers, and police stations) was updated using the best available statewide information.

HAZUS-MH was used to generate the flood depth grid for a 100-year return period calculated by clipping the USGS 30m digital elevation model to the DFIRM boundary. The most damage occurs near the Baraboo and Wisconsin rivers. Exhibit 5-6 depicts the flood boundary generated by HAZUS-MH.

History of Past Occurrences

Documentation of historic flooding is available from the following sources:

- presidential disaster declarations
- insurance claim records from the Federal Flood Insurance Program
- National Weather Service
- flood accounts derived from various authoritative sources

Presidential Disaster Declarations – Since 1965, there have been 8 presidential declarations in Sauk County, 7 of which were flood related (Table 5-8). Presidential disaster declarations were issued in Sauk County for flooding in 1992, 1993, 2000, 2004, 2007, 2008, and 2018.

National Flood Insurance Program Claims In 1968, Congress adopted the National Flood Insurance Act, which among other things created the National Flood Insurance Program (NFIP). This federal program allows property owners to purchase flood insurance if their community participates in the program. Those homeowners with mortgages backed by a federal program must purchase flood insurance when their property is located in the regulatory floodplain. All county residents are eligible to purchase flood insurance because all of the jurisdictions participate in the program.

The number of paid claims for flood damage under the NFIP is a good indicator of the extent of flooding in a community and the number of affected properties. From 1980 through 2023, 158 insurance claims were paid in Sauk County for a total of in excess of $7.1 million (Table 5-11).

Table 5-11. National Flood Insurance Program Claims; Sauk County; 1980 - 2023

Year	Number of Claims	Claim Payments
1980-1984	0	0
1985	1	0
1986-1991	0	0
1992	3	19,959
1993	6	60,391
1994-1999	0	0
2000	7	31,769
2001	1	0
2002-2003	0	0
2004	3	0
2005-2006	0	0
2007	1	0
2008	61	3,152,325
2009	0	0
2010	1	27,367
2011-2012	0	0
2013	1	0
2014-2015	0	0
2016	2	0
2017	0	0
2018	69	3,712,050
2019	2	105,675
2020-2023	0	0
Total	158	7,109,536

Repetitive Loss Properties A property for which two or more National Flood Insurance Program losses of at least $1,000 each have been paid within any 10-year rolling period since 1978 is referred to as a repetitive loss property.

According to the National Flood Insurance Program, there were six repetitive loss properties in Sauk County (Table 5-12). Requirements of the program stipulate that individual policy information may not be disclosed, including addresses of such properties.

Table 5-12. Repetitive Loss Properties; Sauk County: 2024

	Commercial	Residential
City of Reedsburg	0	2
Village of Rock Springs	0	2
Unincorporated Sauk County	0	2
Total	0	6

Source: National Flood Insurance Program

Historical Events Wisconsin has experienced several major floods during the last two decades. Recent floods revealed that no floodplains or urban areas in Wisconsin can be considered safe from flood damages. Sauk County has experienced 11 major floods and two major flash floods since 1965. In addition, there is usually some localized flooding primarily caused by heavy rainfall, spring runoff, or both.

2008 Flooding[2] The flood of record for the Baraboo River occurred in 2008. The flood was measured at 872.5 feet in Rock Springs (1-percent-chance elevation of 870.0 feet), 848.8 feet in West Baraboo (848.2 feet), and 814.1 feet in Baraboo (812.5 feet). These elevations equate to approximately a 0.3- percent-chance-annual flood hazard. During this event, the dam on Lake Delton held, but County Highway A in the village of Lake Delton washed out, causing Lake Delton to drain. This washout eroded the shoreline and caused five houses to be washed away downstream into the Wisconsin River (Exhibit 5-7).

Exhibit 5-7. Lake Delton, June 2008

Extensive flooding occurred on July 17, 1993. Flooding caused by precipitation varied considerably by basin. The storm's center remained relatively stagnant, producing an extreme intensity and volume of precipitation. The worst flooding occurred just south of Baraboo on two small, steep tributaries to the Baraboo River. One death occurred and damages were extensive. According to reports from the Wisconsin State Climatologist Office, rainfall near the storm center was in excess of 12 inches in approximately three hours.

Exhibit 5-8. Reedsburg, June 2008

Devil's Lake Tributary built up behind two 72-inch corrugated metal pipes under Highway DL until the adjacent railway grade gave way. The washout reacted similar to a dambreak and the resulting rapid increase in elevation caused much damage to the north including the Devi-Bara Lodge and Hein-Werner building. There were also washouts to Highway 113 and many driveways along Clark Creek. Vehicles fell into these washouts and resulted in one fatality. The Baraboo River reached an elevation equivalent to a 0.2-percent-annual-chance flood elevation, while Devil's Lake Tributary and Clark Creek exceeded 0.1-percent-annual-chance flood elevations.
Newspaper reports from several incorporated communities indicate substantial flooding of the Baraboo River in February 1966. During this flood, 2 feet of water was reported over Broadway Street in the village of Rock Springs, and the city of Baraboo reported water 9 feet above flood stage (Exhibit 5-8).

[2] Source: *Flood Insurance Study, Sauk County, Wisconsin and Incorporated Areas*, Federal Emergency Management Agency

Major damage to flooded basements was reported as well as an isolated collapse of basement walls. Most bridges on the Baraboo River have sufficient capacity to pass the regional 100-year flood with little backwater effect. The flood stages during February 1966 were increased by ice jams along the river. At the USGS gaging station at County Highway X, east of Baraboo, ice jams increased the flood elevation 1.3 feet higher than with the same discharge and no ice jams. Four major floods, each with a 10-year frequency interval, occurred on the Wisconsin River in April 1920, April 1951, May 1960, and March 1973, in addition to a 25- to a 30-year flood in September 1938. Numerous reservoirs in the headwaters of the Wisconsin River are managed by the Wisconsin Valley Improvement Company to stabilize flow in the Wisconsin River. These reservoirs reduce flood discharges from the areas upstream of the reservoirs. There is a large, uncontrolled drainage area between these reservoirs and Sauk County, so the flood-control effects are greatly reduced.

Three large hydroelectric dams upstream from Sauk County are managed to reduce spring flood peaks. The reservoirs controlled by these dams are partly drained in late winter each year and refilled by May 1. Until June 15, the water-level reservoirs may be permitted to rise one foot above their normal levels to reduce flood discharge. After June 15, the water level in the reservoirs must be maintained within narrow limits, so the reservoirs have no flood-control potential during the summer and fall. Near Portage, about six miles east of Sauk County on the Wisconsin River, large floods will overtop the levees and flow to the Fox River. This will reduce flood peaks downstream, affecting the southern edge of Sauk County. Devil's Lake does not have a natural outlet, however, the lake has gotten high enough on two occasions to overtop its banks and drain towards the Baraboo River via Devil's Lake Tributary. This occurred in July 1993 and June 2008. The 1993 lake elevation was estimated to have a frequency of 0.2 percent-chance-annual flood hazard and the 2008 lake elevation was estimated at less than a 0.1-percent-chance-annual flood hazard.

Table 5-13 lists some of the more recent flooding incidents in Sauk County.

Table 5-13. Recent Flood Events: 1978 through 2024

Date	General Location	Description
1978 July	Countywide	$150,565 property damage
1979 March	Baraboo River	Log jams treatment plant flooded
1980 January	Baraboo River	Ice jams - damage to 6 bridges
1980 July	Baraboo and Wisconsin rivers	Minor home evacuation some crop damage
1989 January	Baraboo River	Ice jam - no damage
1990 June	Two thirds of county	$3,190,700 damage
1992 September	Northern half of county	$282,000 damage
1993 June	Wisconsin River	Levee Road, included below
1993 June	High water table	Spring Green, included below
1993 July	Flash flood	$33,243,300 damage and crop loss
1996 June	Flash flood	$2,418,500 damage & crop loss in the Narrows Creek, Baraboo River area
1999 June	Flash flood	Baraboo and also Leyland
2000 May	Flash flood	Baraboo
2000 June	Flash flood	Countywide
2000 July	Flash flood	Lime Ridge, significant property/crop damage
2001 August	Flash flood	Countywide, significant property damage
2008 June	Countywide	Significant damage to infrastructure, structures, and agricultural land
2018 August	Countywide	Significant damage to infrastructure, structures, and agricultural land
2019 March	Rock Springs, Prairie du Sac, Reedsburg	$17,000 property damage
2019 July	Flashflood - La Valle, Sauk City	$250,000 property damage
2019 September	Flashflood - Lone Rock	$1,000 property damage
2020 October	Flashflood - Witwen	$2,000 property damage

The July 1993 flood set the most rainfall record in Wisconsin with 7 inches per hour, the Spring Green area received approximately 46 inches that summer. There were 286 houses flooded and 41 with structural damage totaling $641,000; vehicles $30,000; industrial and commercial structures $5.5 million; public property $2.9 million; crops $23 million and farm buildings $169,000. The 2000 floods resulted in around $3 million damage to homes, businesses and roadway, plus farm fields and crop damage. Presidential declarations have been received for flooding in 1978, 1990, 1992, 1993, 2000, 2007, and 2008.

Clark Creek Flooding – Flooding along Clark Creek south of the city of Baraboo was especially pronounced. As a result of the damage, the Federal Emergency Management Agency initiated a study to evaluate the situation, the results of which are contained in a report titled *Flooding Conditions at Clark Creek and Possible Mitigatio*n.

Buildings and agricultural land along State Highway 113 experienced flooding from Clark Creek and the highway, which provides principal north-south access, sustained significant damage. In fact, State Highway 113 was closed for more than three months after the June 2008 flood event.

As part of the investigation, the Federal Emergency Management Agency conducted four technical visits to the Clark Creek area as well as several non-technical visits. The technical teams included hazard mitigation specialists, floodplain managers, geologists, and professional engineers.

Most at-risk assets were located in the lower reach. Approximately 60 buildings (residential / non-residential) along Clark Creek were determined to be at risk from flooding or bank collapse. Most of the structures at risk from flooding are located within two miles of the Clark Creek – Baraboo River confluence. At least one residential structure is at risk from bank collapse.

The analysis showed that a number of culverts are not properly aligned with the current stream channel causing water-borne debris to form dams at the culvert crossings. If not corrected, this will restrict and probably reroute the stream. A portion of Tower Road in the upper Clark Creek watershed is at considerable risk. It appears that the culvert is under sized and/or poorly maintained.

According to the report, resolving the Clark Creek flood problem must be accomplished at the local level and include an analysis of physical and geological settings. The study considered various options including the following:

- Stabilization of the banks to pre- 1993 conditions
- Realignment of the channel of Clark Creek
- Installation of flow diverters in channel of Clark Creek
- Construction of sediment-catchment basins along the stream
- Construction of a dam at the Clark Creek headwaters
- Construction of an emergency spillway at Maxwell farm
- Realignment of Highway 113
- Replacing culverts at the Maxwell far m with a bridge
- Replacing culverts at Maxwell farm with a low water crossing -
- Realignment of the culverts.
- Installation of debris barriers at entrances to culverts
- Installation of perforated standpipes in lieu of the standard culverts
- Acquisition
- Relocation
- Elevation / flood-proofing of structures

Flood and siltation problems in the lower reach of Clark Creek cannot be resolved without mitigating up-stream causes. Debris dams are particularly problematic. Removing woody debris from the upper reaches of Clark Creek may be one of the few cost-effective options. The study concluded that a detailed watershed study be conducted by the U.S. Department of Agriculture (USDA) through the Natural Resources Conservation Service (NRCS). Either the

Emergency Watershed Protection Program or Flood Prevention Program would be adequate in evaluating the given situation. In undertaking these studies, scientific as well as engineering principles can be evaluated / incorporated into the final corrective action plan. This will ensure that all environmental considerations will be adequately addressed and supported.

2018 Floods

The heavy rain started on the evening of August 27, 2018 and stooped in the early morning hours of August 28, 2018. Sauk County received approximately 3 – 6 inches of rain. Upstream of the Baraboo River received approximately 8 – 10 inches of rain in Vernon and Juneau County. Water started to rise rapidly in the Baraboo River basin causing a tremendous sandbagging response to mitigate damage. Sauk County declared a state of emergency on August 29, 2018. Sauk County received DR-4402 Presidential disaster declaration for Individual Assistance and Public Assistance on October 17, 2018.

Digital Resource - Story Map for the Village of Rock Springs

https://storymaps.arcgis.com/stories/ae8ce45936fb4ac9848b95448e00a90f

On August 29, 2018 the Hillsboro dam, which feeds into the Baraboo River above LaValle, breached. This caused additional water to enter the Baraboo River basin. The water reached 27.7 feet in Rock Springs (28.5 feet in 2008) on August 30, 2018 and then slowly started to recede. Approximately 400 homes and 50 businesses were impacted by the flood for an estimated damage total of $15 million.

Residents started to clean out their impacted properties as the water slowly receded. In the late evening of September 2, 2018, heavy rain returned to Sauk County. The La Valle area received approximately 7-8 inches of rain. The rain was not forecasted and was a surprise. This again caused the river to start rising rapidly and started another round of sandbag operations. During this period, we had one death due to a man falling on broken steps by Lake Redstone. The stairs were part of his property. The water eventually rose to 26.76 feet in Rock Springs.

More homes were impacted during this flood along the Baraboo River even though the peak water was lower. Homes had water in them this year and had had not been impacted in the 2008 flood. There were no issues with the Wisconsin River during the flooding period.

The Department of Natural Resources Incident Management Team came in to assist in volunteer management. Samaritan's Purse, Southern Baptist's, and other religious organizations came to Sauk County to assist with the flood clean-up.

A long-term recovery committee was established to assist in unmet needs. A donation fund was set up with the Greater Sauk Community Foundation on August 28, 2018.

An emergency operations center was opened on August 28, 2018 and remained open until September 13, 2018. County staff and volunteers manned the phones and did data collection related to flood damage. There was a mental health professional in the Emergency Operations Center (EOC) as well to triage calls that needed assistance.

Recent Flooding

As part of the 2024 plan update, local officials were asked to identify roads in their jurisdiction that are prone to localized flooding. Of those responding, 18 towns, 4 cities, and 2 villages identified general areas (Table 5-14).

Table 5-14. Localized Flooding

Town	Location	Year
Baraboo	No response	
Bear Creek	• Dawn Road	--
Dellona	• South Avenue, Dell Creek bridge area; North Avenue, Dell Creek bridge areas	2023, 2024
Delton	• Berry Lane from Townline 1 mile east • Indian Trail from County Road A to end of road • Sheri Lane from County Road A to end of road; Birchwood at intersection with Berry Lane; Lage Road at intersection with Birchwood (culvert)	• 2024 • 2022 • Not sure of dates
Excelsior	• Beth Road between STH 136 and Schneider Road; Highlow Road bridge south on STH 154 • Schneider Road, middle section	• Multiple • 2018
Fairfield	• No flooding since 2008	
Franklin	• Short Cut Road between Highland and Valley View; Dawn Road between STH 23 and Hickory; Ohio Road between Highland and Skyview	• 2024
Freedom	• Diamond Hill Road by Mid Continent RR Museum; Diamond Hill Road between CTH PF and CTH W; Kosin Road south of CTH DD; Klien Road south of CTH W; Maple Hill Road south of CTH W	• Many years
Greenfield	None	
Honey Creek	• Sky View; Riech; Pine Hollow; Denzer	• 2024
Ironton	• Brantin Road near bridge over Little Baraboo	• 2008, 2018
La Valle	• Douglas Road, Stout Road, Branton Road, Pearson Road	--
Merrimac	• Resusch Road, eastern end	• Every year
Prairie du Sac	• Prairie Road at Otter Creek bridge; River Road at Otter Creek bridge; Beaver Road south of Riner • Otter Creek Road at Otter Creek bridge; Huerth Road from 1/4 mile S of Seitz Road; Fen Road between Roeser and Beaver Road	• 2019, 2024 • 2024
Reedsburg	• Herritz Road between Prairie View to Cty Road SI?	• 2024
Spring Green	• Weidner Road from CTH C to Soldner Road; Butternut Road north end and south end; Horseshoe Road at intersection with CTH G	• 2024
Sumpter	• County Road C, Otter Creek below Baxter's Hollow; Stones Pocket Road between Kings Corner Road and County Road C; Stones Pocket Road north of Kings Corner Road • County Road C west of Stones Picket Road	• Most years • Twice
Troy	• Mill Road in Black Hawk bridge area	• 2024
Washington	• North View from 154 to Narrows Creek Road • Hickory Glenn from West Hillpoint to Willow Line; Little Brook Road from Hillpoint road to Crest Road; West Hillpoint from 154 to Willow Line; Sand Hill Road from Westfield Line to Westfield Line; Croal Hollow Road from Washington .62 hundredth mile; Rustic View from 154 to town of Willow Line; Hillpoint Road, 2 culverts Hwy 154 to Lake Road; Sugar Maple Road 154 to G then G to Town line; Fern Road Hwy G to Rocky Circle; 154 spur from Hwy 154 to end of Town Road	• Most years • 2024
Westfield	• Open View Road at Seely Creek bridge	• Yearly
Winfield	• Churchill Road; Drovers Pass; Ekes Drive; Farber Road; Fuller Road; Hirst Road; Katuin Road; Luedtke Road; Old Town Hall Road; Pine Rock Road; Skinner Road; Theinhart Road	• 2018
Woodland	None	
Village		
Cazenovia [1]	• Sparks Hill Drive from just east of Highway 58 intersection	--
Ironton	None	
Lake Delton	None	
La Valle	None	
Lime Ridge	None	
Loganville	• Walnut Street from 230 to 180; West Street from 205 to 355; Spring Valley from village limit to 480	• 2024
Merrimac	None	
North Freedom	None	

Table 5-14. Localized Flooding

	Location	Year
Plain	None	
Prairie du Sac	• 9th Street from Grand Avenue to Lincoln Avenue • Lueders Road from Parkside Drive to Lincoln Avenue; Parkside drive from Lueders Road to 14th Street; Grand Avenue from 15th Street to 13th Street; 13th Street from Sunset Circle to Lincoln Street; Broadway Street from 13th street to Lueders Road	• 2019 • Every year
Rock Springs	• Highway 136 – in downtown all along the river; Highway 154 in downtown from bridge to past 1st street	• 2018
Sauk City	None	
Spring Green	None	
West Baraboo	None	
City		
Baraboo	None	
Reedsburg	• Grant Avenue near the River; numerous streets	• 2018
Wisconsin Dells [1]	• Sweet Briar	• 2018

Note: [1]

Source: 2024 Community Survey conducted as part of plan update

Vulnerability Assessment

Areas within Sauk County that are susceptible to riverine flooding include those areas in close proximity to the Wisconsin River, the Baraboo River, and the multiple creeks and streams that actively flow year-round and are within or near the floodplain of these waterways. Flash flooding can occur anywhere in Sauk County where a significant amount of rainfall happens in a short amount of time. Lower, flat areas and depressions as well as those areas with poor infiltration capacity or inadequate drainage have a higher susceptibility to flash flood events. Roadways are where many people encounter flash flooding.

Sauk County has a high probability for flash flooding in certain areas of the county. The percentage chance of at least one flash flood event per year is estimated at 80 percent. Riverine flooding has improved with the removal of the dam on the Baraboo River, there remains areas that are subject to flooding after heavy rains or spring runoff. The chance of riverine flooding is estimated at 40 percent in a given year.

Flash flooding caused by snowmelt or heavy rain occurs regularly in some of the watersheds in Sauk County. Heavy rains or snow melt north of Sauk County can cause river or overbank flooding anytime during the year.

Effects on Facilities –Essential facilities encounter the same impacts as other buildings within the flood boundary: structural failure, extensive water damage to the facility, and loss of facility functionality (i.e., a damaged police station will no longer be able to serve the community).

Table 5-15. Sauk County Essential Facility Loss – 100-Year Flood

Class	Total	At Least Moderate Damage	At Least Substantial Damage	Loss of Use
Care facility	9	0	0	0
Emergency operations center	1	0	0	0
Fire station	13	2	0	0
Police station	12	1	0	0
School	43	2	0	0
Total	78	5	0	0

Source: Wisconsin Emergency Management

The HAZUS-MH analysis identified two fire stations, two schools, and one police station that may be subject to flooding. A list of the essential facilities within Sauk County is included in Table 5-15. Maps of essential facilities potentially at risk of flooding are shown in Exhibits 5-9, 5-10, and 5-11.

Exhibit 5-9. 100-Year Flood Boundary Overlaid with Essential Facilities; Village of Sauk City

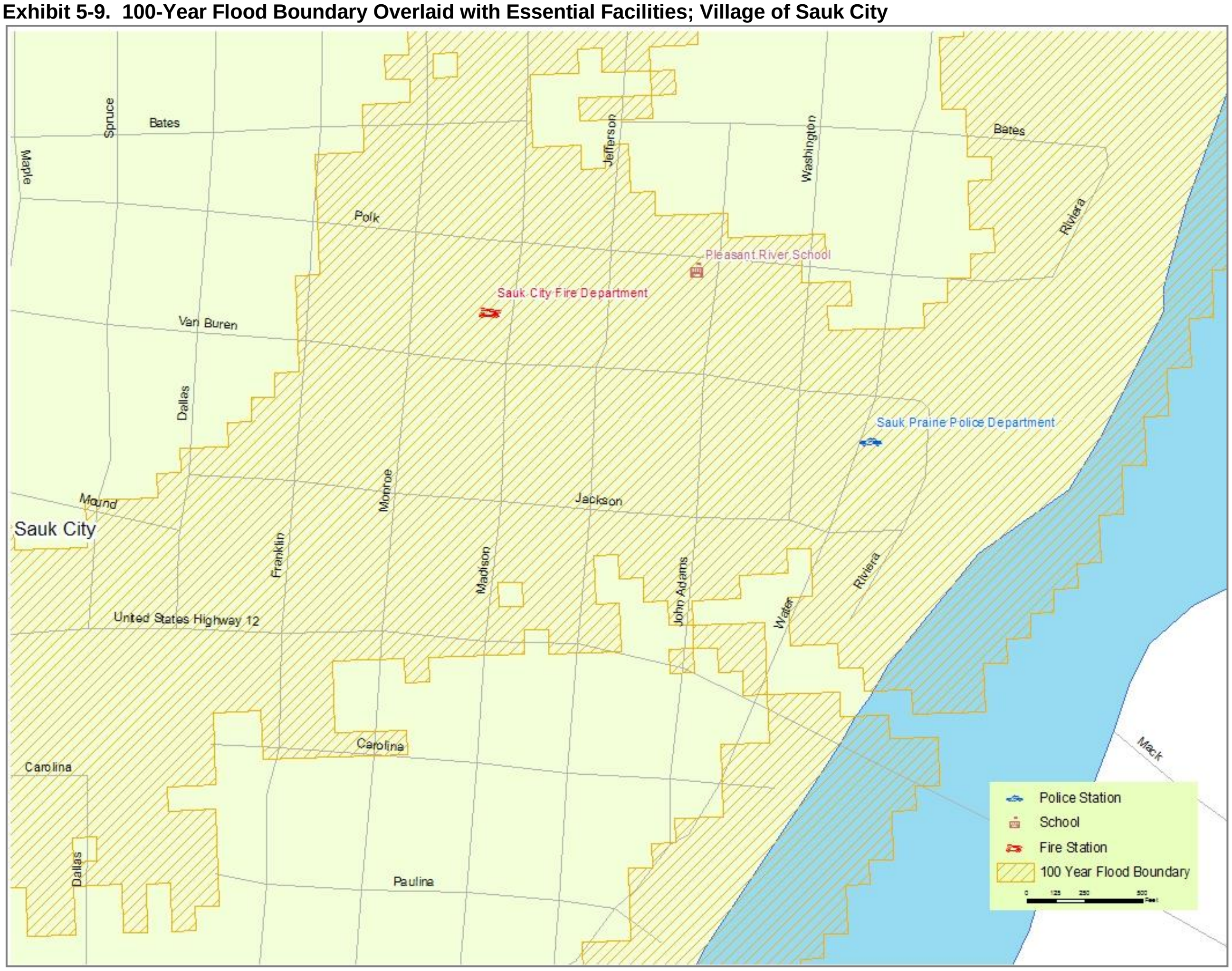


Exhibit 5-10. 100-Year Flood Boundary Overlaid with Essential Facilities: Village of La Valle

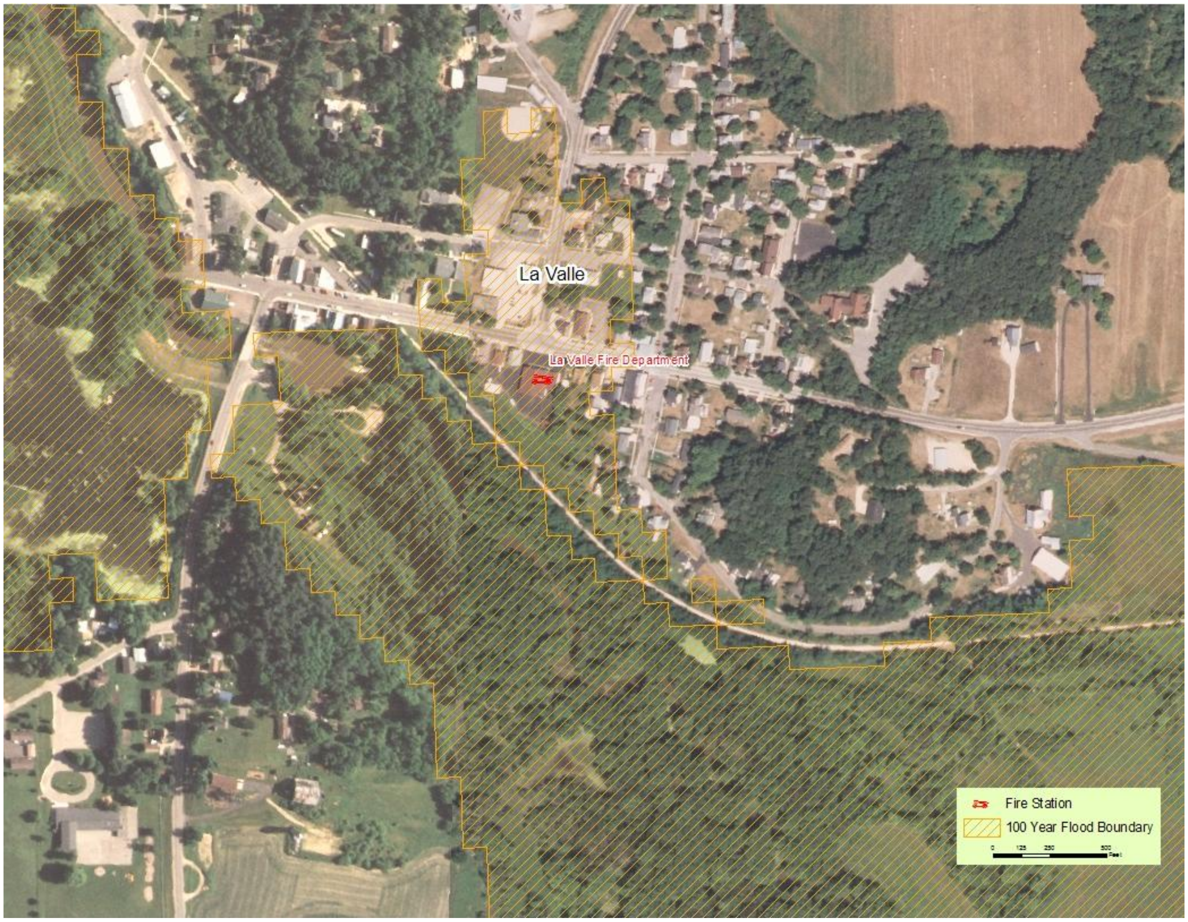


Exhibit 5-11. 100-Year Flood Boundary Overlaid with Essential Facilities: City of Reedsburg

Effects on Population Groups – There are no population groups that are especially vulnerable to flooding except to the extent older homes, which were built prior to floodplain regulations, are occupied by lower income residents.

HAZUS-MH estimates the number of households expected to be displaced from their homes due to flooding and the associated potential evacuation. HAZUS-MH also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 1,193 households will be displaced due to a 100-year flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,696 people (out of a total population of 55,225) will likely seek temporary shelter in public shelters.

Effects on Economic Sectors – While flooding can impact a number of economic sectors, the agricultural sector is the most vulnerable. Aside from damaging farm buildings, flooding can destroy crops and reduce crop yields for surviving crops. In addition, harvesting crops on wet soils causes soil compaction that reduces crop yields in subsequent years. Heavy rains, which are often associated with flooding, cause a considerable amount of soil erosion on unprotected soils.

Damages sustained by businesses in the county are primarily a direct reflection of the agricultural production losses. The effects of the agricultural base extend throughout the county. Farming supports a variety of farm (e.g., implement dealers, feed stores, granaries) and non-farm related (e.g., grocery stores, hardware stores) businesses.

Other Effects – During periods of flooding, no-wake boating restrictions are imposed which limit recreational uses, but are needed to protect shorelines from erosion. Road closures do occur, and in some cases cause a significant impediment to the flow of traffic within and through the county.

Effects on New Development – All new development in the unincorporated parts of the county and in the municipalities is subject to local floodplain regulations. Therefore, all new buildings in the regulated floodplain will meet or exceed adopted development standards, which are designed to afford a reasonable level of protection from floodwaters. In addition, communities have the opportunity through the subdivision review process to ensure that new projects are not susceptible to flooding that may result from the ponding of storm water.

Climate change can be expected to lead to more annual precipitation with more frequent and heavier high precipitation events. This will lead to more flooding and the potential for dam failure. Flood damage will affect more people over a wider area of the County, and resulting damage will be higher.

Estimated Damage

Based on an analysis using HAZUS-MH in 2010, it is estimated that during a 100-year flood event in Sauk County 221 buildings would be impacted with damage totaling $53 million in building losses and $134 million in economic losses. The total estimated number of damaged buildings, total building losses, and estimated total economic losses are shown in Table 5-16.

Table 5-16. Effects of a 100-Year Flood Event; Sauk County: 2010

General Occupancy	Estimated Number of Buildings	Total Damaged Buildings	Total Building Exposure (1000)	Total Economic Loss (1000)	Total Building Loss (1000)
Agriculture	2	0	$69,573	$3,471	$935
Commercial	241	1	$863,224	$48,375	$11,341
Education	0	0	$67,359	$2,048	$317
Government	5	0	$26,031	$2,175	$269
Industrial	27	0	$300,852	$15,160	$3,756
Religious/Non-Profit	14	0	$76,361	$5,967	$786
Residential	20,539	220	$3,305,908	$57,343	$35,845
Total	20,828	221	$4,709,308	$134,539	$53,249

Source: Wisconsin Emergency Management

A countywide 100-year flood could potentially cause more than $53 million in damage to buildings.

HAZUS-MH estimated 25 census blocks with losses exceeding $1 million. The distribution of losses is shown in Exhibit 5-12.

HAZUS-MH aggregate loss analysis is evenly distributed across a census block. Census blocks of concern should be reviewed in more detail to determine the actual percentage of facilities that fall within the flood hazard areas. The aggregate losses reported in this study may be overstated. Examples are provided in Exhibit 5-8 and 5-9.

Table 5-16 Flood-Damaged Essential Facilities

Sauk Prairie Police Department
Sauk City Fire Department
La Valle Fire Department
South Elementary
Pleasant River School

Source: Wisconsin Emergency Management

The reported building counts should be interpreted as degrees of loss rather than as exact numbers of buildings exposed to flooding. These numbers were derived from aggregate building inventories which are assumed to be dispersed evenly across census blocks. HAZUS-MH requires that a predetermined amount of square footage of a typical building sustain damage in order to produce a damaged building count. If only a minimal amount of damage to buildings is predicted, it is possible to see zero damaged building counts while also seeing economic losses.

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typical building sustain damage in order to produce a damaged building count. If only a minimal amount of damage to buildings is predicted, it is possible to see zero damaged building counts while also seeing economic losses.

Exhibit 5-12. Sauk County Total Economic Loss – 100-Year Flood

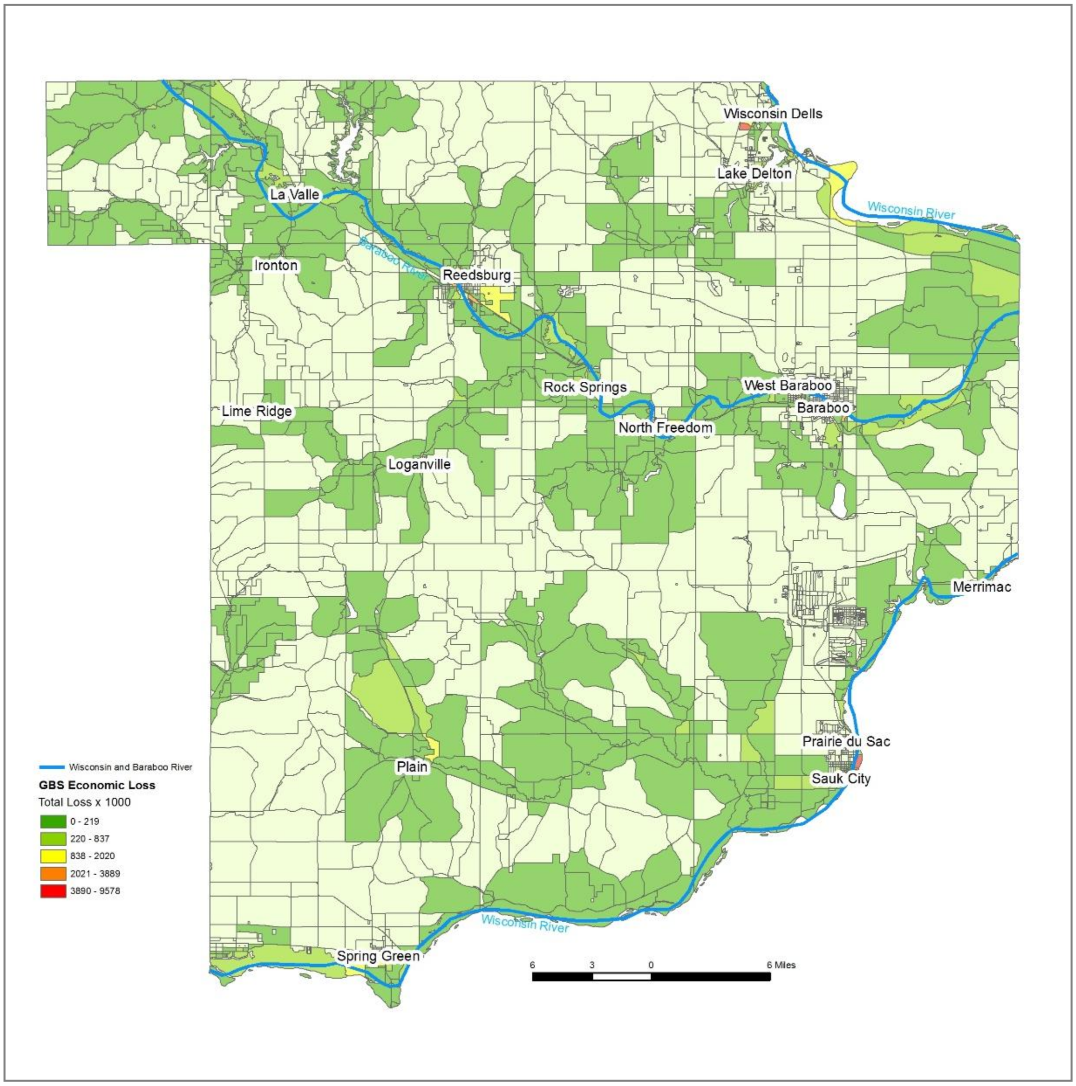


Exhibit 5-13 shows census blocks overlaid with the flood boundary and orthophoto near Spring Green along the Wisconsin River. Census block 551110008002041 has an estimated building loss of $265,000 with a combined replacement cost of $572,000. The overlay of the flood boundary with the aerial photo shows that no buildings are at risk.

Exhibit 5-13. Flood Damage Exposure in Spring Green

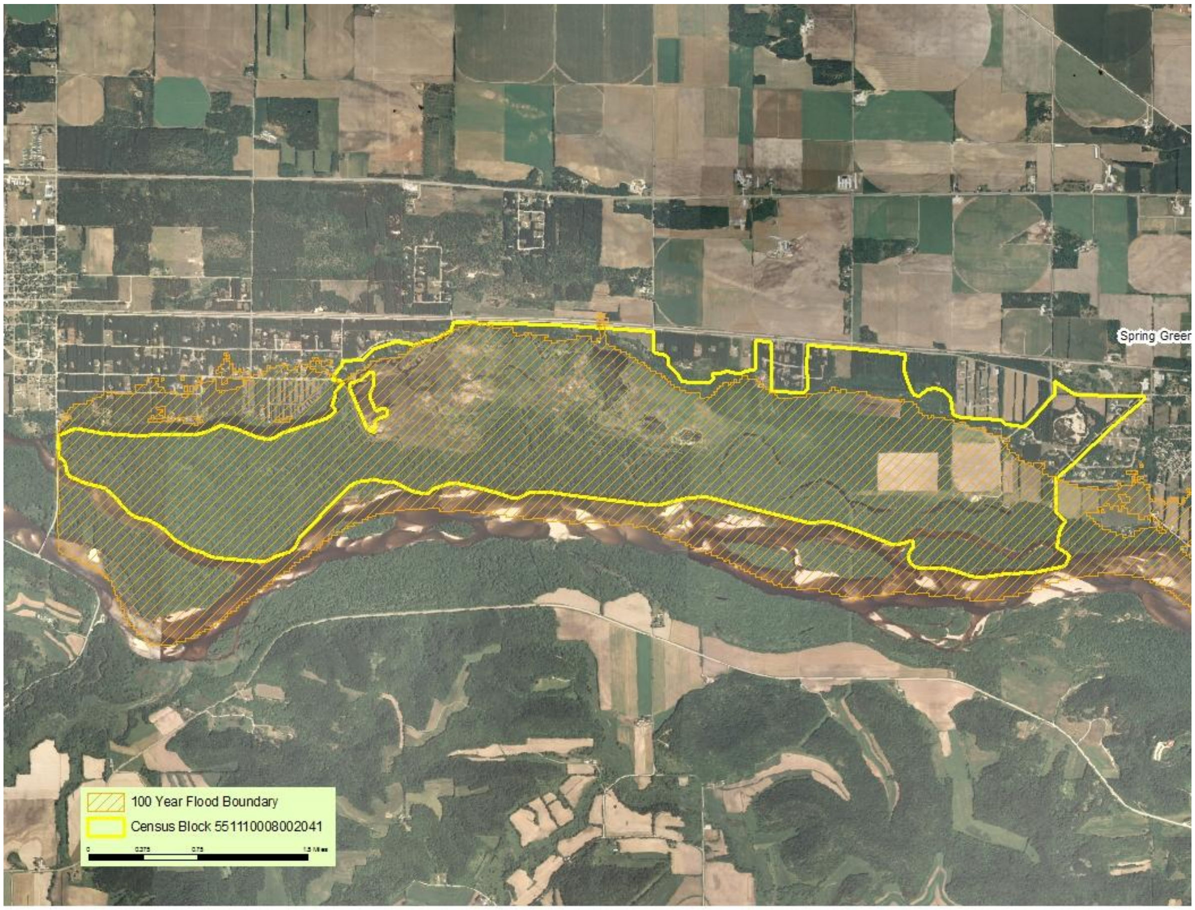
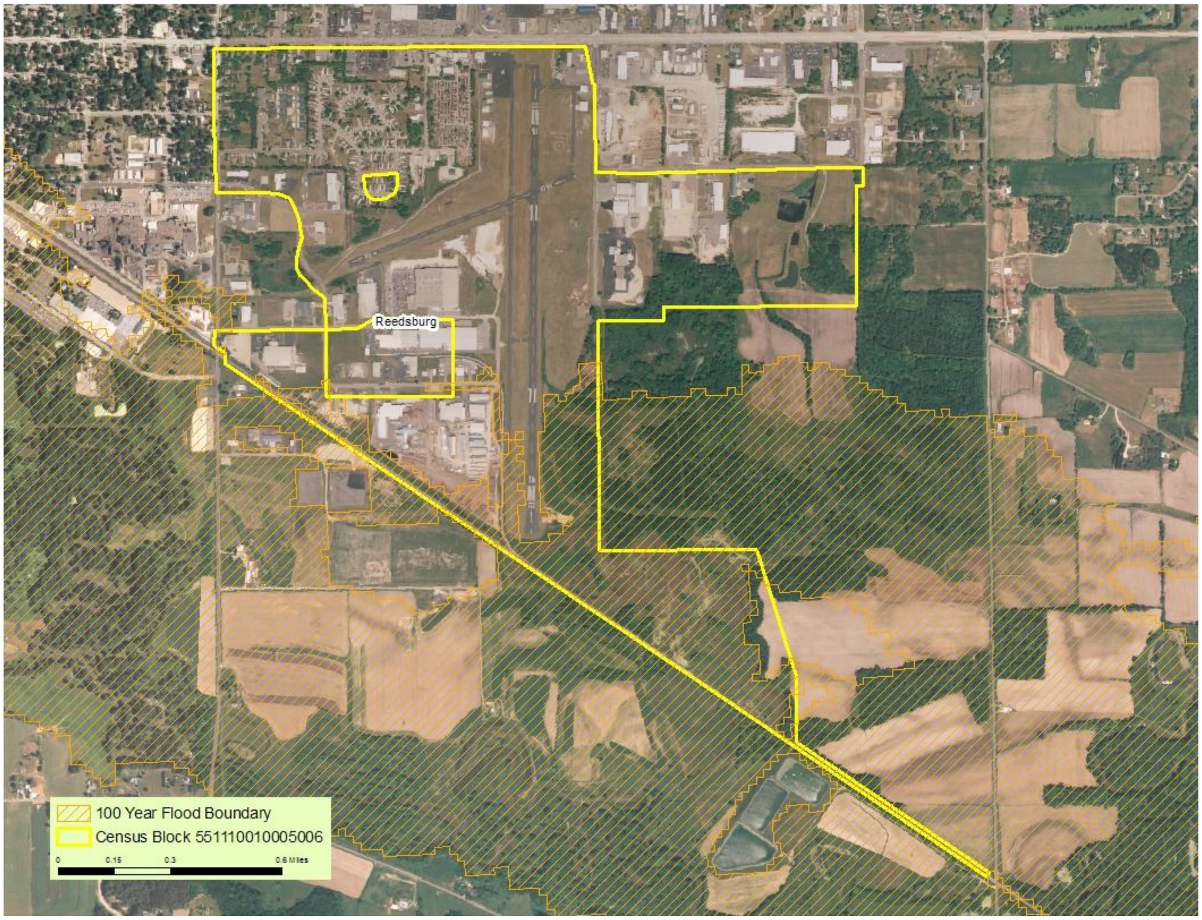


Exhibit 5-14 shows census blocks overlaid with the flood boundary and orthophoto of Reedsburg. Census block 551110010005006 has an estimated building loss of $500,000 and a combined replacement cost of $1.65 million.

Exhibit 5-14. Flood Damage Exposure in Reedsburg



2023 Analysis

In 2023, an additional HAZUS-MH analysis was conducted by Dr. Shane Hubbard with the Space Science and Engineering Center at UW-Madison. The analysis focused on the Baraboo River and the effects of variable rainfall and how green infrastructure affected the results. Runs were completed for the following return intervals: 10, 25, 50, 100, and 500. Results for the 100-year return interval are in Table 5-17, which a reduction for each of the parameters with the inclusion of green infrastructure.

None of the damaged buildings were classified as critical facilities. Additional maps and raw data are kept in the Emergency Management Office and GIS department.

Table 5-17. Scenarios Based on 100-Year Return Interval

Present	Damaged Buildings	Dollar Losses
No green infrastructure	37	22,360,000
Green infrastructure	25	20,580,000
Numeric change associated with green infrastructure	-12	-197,347
Future Rainfall, 25th Percentile Increase		
No green infrastructure	79	25,540,000
Green infrastructure	70	24,640,000
Numeric change associated with green infrastructure	-9	-900,000
Future Rainfall, 50th Percentile Increase		
No green infrastructure	114	43,450,000
Green infrastructure	87	35,370,000
Numeric change associated with green infrastructure	-27	-8,080,000
Future Rainfall, 75th Percentile Increase		
No green infrastructure	144	59,070,000
Green infrastructure	137	55,760,000
Numeric change associated with green infrastructure	-7	-3,310,000

Source: UW-Madison, Space Science and Engineering Center, HAZUS Analysis from May, 2023

8. Dense Fog

Profile

Fog is a visible concentration of small water droplets suspended in the air at the earth's surface that obscures visibility to less than one kilometer. It forms when air temperature falls to its dew point, which is the temperature at which air is holding as much moisture as it can. When air reaches its dew point, it condenses into very small water droplets.

History of Past Occurrences

Fog can form throughout the year but is most common from September through April. As shown in Appendix G, there have been 63 reported occurrences of fog in Sauk County since 1950. In Sauk County, fog tends to cover large areas.

Vulnerability Assessment

Effects on Facilities – Fog does not damage or impair the operation of facilities.

Effects on Population Groups – Fog does not negatively affect any population group.

Effects on Economic Sectors – Fog impairs visibility and can hamper ground and air transportation. When visibility is decreased, the potential for motor vehicle crashes increase as does the possibility of an airplane accident on landing or take off.

Effects on New Development – Dense fog does not affect buildings, whether current or future.

ESTIMATED DAMAGE

Based on historical data, dense fog events do no cause or result in property damage.

9. TORNADOES

PROFILE

A tornado is a violently rotating column of air extending from the ground to the base of a convective cloud. The tornado may or may not have a visible condensation funnel (commonly referred to as a "funnel cloud"), which may or may not extend from the cloud base all the way to the ground. In the absence of a visible condensation funnel, a severe weather spotter can determine they are looking at a tornado if they observe cloud-base rotation superimposed over rotating dirt and debris at ground level. Wind speeds in a tornado typically range from 80 mph to 150 mph, but on occasions reach speeds in excess of 200 mph. There have been documented tornado winds exceeding 300 mph outside of Wisconsin. The majority of damage resulting from a tornado occurs within one-eight mile of the tornado's path, which characteristically does not exceed 16 miles. In fact, the average path length of tornadoes in Wisconsin for the period of 1950-2005 was 5.8 miles with a duration of about 10 minutes. Tornadoes with track lengths greater than 150 miles have been reported in Wisconsin, although they are quite rare.

Tornadoes are visible because low atmospheric pressure in the vortex leads to cooling of the air by expansion with condensation and formation of water droplets. They are also visible as a result of the airborne debris and dust associated with the vortex. The destructive power of the tornado lies primarily in its high horizontal winds, a built-in upward-lifting force, and airborne debris impacting structures (collectively resulting in about 95 percent of the damage). To a much lesser degree, air pressure differences associated with a tornado result in additional damage. Years ago, it was assumed that air pressure differences accounted for a large portion of the damage, however, it is now realized that most buildings have enough air leakage or infiltration so that most of the air pressure differences between the inside and outside of a structure are minimized as the tornado approaches. Since tornadoes are usually associated with organized storm systems that consist of several thunderstorm cells of varying intensity, large hail, torrential rain, and intense lightning usually accompany the storm that spins up a tornado.

Although a tornado can form at any time during the year, the peak tornado season is May through July. They can also occur at any time of the day. The peak hour for tornado initiation is between 6:00 and 7:00 p.m. and the peak hours of occurrence are between 3:00 and 9:00 p.m.

Prior to 2007, the Fujita Tornado Scale was used to estimate the wind speed of a tornado based on damage to structures (Table 5-18). Though the Fujita Scale has 13 ratings (F0-F12), tornadoes never exceed an F5 (261 to 318 MPH). Beginning in 2007, tornadoes are rated using the Enhanced Fujita Tornado Scale, which is essentially the same as the former scale except for the wind speed (Table 5-19).

Table 5-18. Fujita Tornado Scale

Fujita Rating	Wind Speed	Characteristic Damage
F0	40 to 72 mph	Some damage to chimneys, TV antennas, roof shingles, trees, and windows
F1	73 to 112 mph	Automobiles overturned, carports destroyed, and trees uprooted
F2	113 to 157 mph	Roofs blown of homes, sheds and outbuildings demolished, mobile homes overturned
F3	158 to 207 mph	Exterior walls and roofs blown off homes; metal buildings collapsed or are severely damaged; forests and farmland flattened
F4	208 to 260 mph	Few walls, if any, standing in well-built homes; large steel and concrete missiles thrown far distances
F5	261 to 318 mph	Homes leveled with all debris removed; schools, motels, and other larger structures have considerable damage with exterior walls and roofs gone; top stories demolished

Table 5-19. Enhanced Fujita Tornado Scale

Fujita Rating	Wind Speed	Characteristic Damage
EF0	65 to 86 mph	Some damage to chimneys, TV antennas, roof shingles, trees, and windows
EF1	86 to 110 mph	Automobiles overturned, carports destroyed, and trees uprooted
EF2	111 to 135 mph	Roofs blown of homes, sheds and outbuildings demolished, mobile homes overturned
EF3	136 to 165 mph	Exterior walls and roofs blown off homes; metal buildings collapsed or are severely damaged; forests and farmland flattened
EF4	166 to 200 mph	Few walls, if any, standing in well-built homes; large steel and concrete missiles thrown far distances
EF5	>200 mph	Homes leveled with all debris removed; schools, motels, and other larger structures have considerable damage with exterior walls and roofs gone; top stories demolished

History of Past Occurrences

Wisconsin lies along the northern edge of the nation's tornado belt that extends northeastward from Oklahoma into Iowa. Winter, spring, and fall tornadoes are more likely to occur in southern Wisconsin than in northern counties. Yet, tornadoes have occurred in Wisconsin during every month except February.

Wisconsin's tornado season runs from the beginning of April through September. The most severe tornadoes typically occur during April, May, and June. Many tornadoes strike in late afternoon or early evening. However, tornadoes have occurred at other times. Personal property damage, deaths, and injuries have and will continue to occur in Wisconsin. On average, one person dies from tornado-related injuries each year.

In 2005, Wisconsin had a record of 62 verified tornadoes, including 27 that occurred on August 18, 2005.

In Sauk County, there have been 23 verified tornadoes since (Appendix G). More than three quarters of the tornadoes were F0 or F1 (Table 5-20). Prior to 1982 when the National Weather Service began classifying tornadoes, ratings are at best broad estimates, with an accuracy of plus/minus 1.

While there have been no fatalities in any of the Sauk County tornado disasters, there have been events that have caused injuries on three different occasions (1965, 1966, 1989). From 1950 through 2023, tornadoes have cause $6.5 million in property damage and $530,000 in crop damage.

On July 4, 1994 a tornado passed through the town of Prairie du Sac, town of Merrimac, and part of the village of Merrimac. This tornado caused approximately $1,030,000 in damages to homes and property. In 1989 and 1984 two tornadoes touched down in the Sauk City area causing $443,500 and $1,547,000 worth of damage, respectively.

Table 5-20. Tornado Frequency: Sauk County: 1950 through 2023

Fujita Rating [1]	Number of Occurrences	Probability of Occurrence
F0	10	45%
F1	7	32%
F2	5	23%
F3	0	0%
F4	0	0%
F5	0	0%
EF0	1	67%
EF1	0	33%
EF2	0	0%
EF3	0	0%
EF4	0	0%
EF5	0	0%

Source: National Weather Service
Notes:
1. Refer to Table 5-18 and 5-19 for a description of the Fujita ratings
2. Based on data collected by the National Weather Service

Vulnerability Assessment

Effects on Facilities – Because tornadoes apparently occur randomly across the landscape, all areas of the county are equally as likely to experience a tornado. Therefore, all of the critical facilities which have been identified are at risk.

Effects on Population Groups – Even though all areas of the county are equally likely to experience a tornado, those living in mobile homes or staying in a campground are more vulnerable than those people living in a residence with a basement. In 2023, there were 32 campgrounds, 4 recreational/educational camps, and 22 manufactured/mobile home parks.

Effects on Economic Sectors – While individual businesses may be damaged, the overall economy generally experiences short-term effects of a tornado, if at all.

Effects on New Development – New buildings are no more or less susceptible to the effects of a tornado that are existing buildings.

Estimated Damage

Depending on where a tornado occurs in the county and its magnitude, damage can vary widely from minimal economic damage to tens of millions. Table 5-21 lists the damage caused by each of the tornado ratings. Based on historical occurrences in the county and documented damage estimates, an EF2 tornado would be expected to cause about $1.2 million in damage to buildings and infrastructure.

Table 5-21. Tornado Property Damage; Sauk County: 1950 through 2023

Fujita Rating [1]	Number	Range of Damage		Total Damage	Average Damage
		Low	High		
F0	10	$2,500	$25,000	$35,500	$3,550
F1	7	$2,000	$250,000	$384,500	$54,928
F2	5	$25,000	$2,500,000	$6,125,000	$1,225,000
F3	0	-	-	-	-
F4	0	-	-	-	-
F5	0	-	-	-	-

Source: National Weather Service
Notes:
1. Refer to Table 5-18 and 5-19 for a description of the Fujita ratings

Climate change can be expected to lead to more frequent, higher intensity tornados. This will affect more people over a wider area of the County, and the resulting damage will be higher.

10. Hailstorms

Profile

A hailstorm is a weather event where water particles in the upper atmosphere form into round or irregular masses of ice that fall to earth. Hail stones form when sub-freezing temperatures in the upper atmosphere cause water in thunderstorm clouds to accumulate in layers around an icy core. When strong underlying winds no longer can support their weight, the hailstones fall to Earth. The size of hail typically ranges from ¼" up to three inches in diameter. In a rather rare occurrence, a 2006-hail storm in Lake Mills created hail stones with a diameter of 4.25 inches.

Hail tends to fall in swaths that may be 20-115 miles long and 5-30 miles wide. The swath is not normally an even bombardment of hail but generally consists of a series of hail strikes that are produced by individual thunderstorm clouds traversing the same general area. Hail strikes are typically one-half mile wide and up to five miles long. They may partially overlap but often leave completely undamaged gaps between them. Hailstorms tend to occur in conjunction with severe thunderstorms.

History of Past Occurrences

Since 1950, there have been 136 documented hailstorm events in the county (Appendix G).

Vulnerability Assessment

Effects on Facilities – The threat of hail damage increases as the size of the hailstones increase. Hail can break windows, damage roofs and siding, and dent motor vehicles.

Effects on Population Groups – All population segments are equally susceptible to hailstorms. Hailstorms while resulting in property and crop damage, rarely causes serious injury or loss of life.

Effects on Economic Sectors – Of all the economic sectors, agriculture is the most susceptible to hail damage. When hailstones approach golf ball size, crops are damaged and are not able to recover, resulting in a total loss.

Effects on New Development - Because a hailstorm can occur anywhere in the county, new buildings will not be any more or less affected than current buildings.

Estimated Damage

Based on historical data, hailstorms, while quite numerous, do not cause widespread or significant property damage. For the purposes of this plan, it is estimated that a hailstorm would cause about $13,300 in property damage per event and $6,000 in crop damage. While the average crop damage is relatively low, there was a storm near Loganville in 1997 that caused crop damage totaling $240,000.

Climate change can be expected to lead to more frequent, higher intensity severe storm events and resultant high winds, hail and lightning. This will affect more people over a wider area, and the resulting damage will be higher.

11. Thunderstorms

Profile

Thunderstorms are severe and violent forms of convection produced when warm moist air is overlaid by dry cool air. As the warm air rises, thunderheads (cumulonimbus clouds) form and cause the strong winds, lightening, hail, and rain characteristically associated with these storms. Thunderheads may be a towering mass 6 miles or more across and 40,000 to 50,000 feet high. As much as 1.5 million tons of water may be held in a thunderhead.

A storm event arising for a single thunderhead typically lasts less than 30 minutes in a given location. However, strong frontal systems may spawn more than one squall line composed of many individual thunderheads.

As defined by the National Weather Service, a severe thunderstorm is a thunderstorm event that produces one or more of the following: downbursts with winds of 58 mile per hour or greater, hail ¾ of an inch in diameter, or a tornado.

History of Past Occurrences

Out of all the weather-related events in Sauk County, powerful thunderstorms are the most common. They account roughly one-third (32%) of all weather-related events documented since 1950. On average county residents can expect slightly less than three significant thunderstorm events each year (2.7/year). Although thunderstorms can occur throughout the year, they are most common from May through September. Typically, they occur after noon until 10:00 pm.

Vulnerability Assessment

Effects on Facilities – Aside from hail, straight line winds from a thunderstorm can damage property and to a less extent crops. Overhead utility lines are quite susceptible to downed trees and tree branches. Entire neighborhoods and even larger areas can lose power because of a thunderstorm. All areas of the county are equally susceptible to thunderstorms, meaning that all critical facilities are at risk.

Effects on Population Groups – Wind associated with severe thunderstorms can cause injury or loss of life. With the exception of those living in mobile home parks or staying in campgrounds, no population group is uniquely susceptible to a thunderstorm event. Those in mobile homes and campgrounds are at risk from falling trees and branches, and damage to their residence or camper.

Effects on Economic Sectors – Thunderstorms do not affect any economic sector disproportionately more than others.

Effects on New Development – Because a thunderstorm can occur anywhere in the county, new buildings will not be any more or less affected than current buildings.

Estimated Damage

Based on historical data, a severe thunderstorm on average is expected to cause about $35,500 in property damage and about $7,500 in crop damage.

Climate change can be expected to lead to more frequent, higher intensity severe thunderstorms and resultant high winds, hail and lightning. This will affect more people over a wider area, and the resulting damage will be higher.

12. Winter Storms

Profile

Winter storms include a wide range of weather-related events including snowstorms, blizzards, freezing rain, sleet, and ice storms. Typical snow events produce totals of between one and three inches. On a statewide basis, heavy snowfall happens on average only five times per winter. Total snow accumulations in central Wisconsin average about 50 inches. Both ice and sleet storms can occur at any time from October into April. They are more common in southern and central Wisconsin than in the northern part of the state.

Terms Related to Winter Storms

Heavy snowfall - The accumulation of six or more inches of snow in a 12-hour period or eight or more inches in a 24-hour period.

Blizzard - The occurrence of sustained wind speeds in excess of 35 miles per hour accompanied by heavy snowfall or large amounts of blowing or drifting snow.

Ice storm - An occurrence where rain falls from warmer upper layers of the atmosphere to the colder ground, freezing upon contact with the ground and exposed objects near the ground forming an accumulation of at least 1/4" in 12 hours or less.

Freezing drizzle / freezing rain - The effect of drizzle or rain freezing upon impact on objects that have a temperature of 32 degrees Fahrenheit or below.

Sleet - Solid grains or pellets of ice formed by the freezing of raindrops or the refreezing of largely melted snowflakes. This ice does not cling to surfaces.

History of Past Occurrences

Since 1950, there have been 15 winter storm events in Sauk County consisting of blizzard conditions, heavy snow, ice, or sleet.

Vulnerability Assessment

Effects on Facilities – Heavy snow can cause the structural collapse of buildings with flat roofs.

Effects on Population Groups – Winter storms affect all population groups equally. People who commute a comparatively long distance are disproportionately affected.

Effects on Economic Sectors – A prolonged winter storm event with a large accumulation of snow can have a short-term effect on the local economy in terms of lost productivity. Transportation-related businesses are often negatively affected when winter weather hits.

Effects on New Development – Because winter storms generally affect the county as a whole, new buildings will not be any more or less affected than current buildings.

Estimated Damage

The cost of snow removal is incorporated into local government budgets so there is no direct financial impact arising from a winter storm unless the community experiences a prolonged winter season with a high number of snowfall events, such as the 2007-2008 winter when record amounts of snow fell across much of the state.

Climate change can be expected to lead to more frequent, more powerful winter storm events and occurrences of severe cold. Heavier, more frequent winter storms will increase the frequency of power outages, structural collapse, and transportation impacts.

13. Extreme Heat

Profile

Periods of excessive heat, often referred to as heat waves, are quite common in Wisconsin during the summer months. When high temperatures do occur, they cover large areas of the country. Summertime heat and exposure to solar radiation can cause a number of heat disorders ranging from sunburn to heat stroke as described in Exhibit 5-15.

Exhibit 5-15. Heat Disorders and Symptoms

Heat Disorder	Symptoms
Sunburn	Redness and pain; in severe cases swelling of skin, blisters, fever, headaches
Heat Cramps	Painful spasms usually in muscles of legs and abdomen possible; heavy sweating
Heat Exhaustion	Heavy sweating, weakness, skin cold, pale and clammy; pulse thready; normal temperature possible; fainting and vomiting
Heat Stroke	High body temperature (106 or higher); hot dry skin; rapid and strong pulse; possible unconsciousness

Source: National Weather Service, National Oceanic and Atmospheric Administration

If left untreated, heat stroke can be deadly. About 237 people die from excessive heat every year in the United States. The elderly, small children, chronic invalids, people on certain medications or drugs, and people with weight and alcohol problems are particularly susceptible to heat disorders. The human body dissipates heat by varying the rate and depth of blood circulation, by perspiring, and as a last resort, by panting. Perspiration is an effective way of cooling the body's surface, but as the relative humidity increases, the positive effects of perspiration decline.

The National Weather Service (NWS) devised the Heat Index as a way to measure the combined effects of temperature and relative humidity. The Heat Index chart (Exhibit 5-16) also shows when certain physiological responses are commonly seen with prolonged exposure and/or physical activity. As the relative humidity increases, even modest temperatures can cause heat stroke and other less serious heat disorders.

Exhibit 5-16. Heat Index (Apparent Temperature)

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

Source: National Weather Service, National Oceanic and Atmospheric Administration

With Prolonged Exposure and/or Physical Activity

- Extreme Danger – Heat stroke or sunstroke highly likely
- Danger – Sunstroke, muscle cramps, and/or heat exhaustion likely
- Extreme Caution – Sunstroke, muscle cramps, and/or heat exhaustion likely
- Caution – Fatigue possible

History of Past Occurrences

Based on records maintained by the National Weather Service, there have been 17 reported events with excessive temperatures since 1950 (Appendix G). The most recent event occurred on June 23rd 2009 when the county experienced heat index reaching 106 degrees. The southern tier of counties experiences the highest number of heat wave days.

Table 5-22 Heat-Related Fatalities and Injuries; Wisconsin: 2000 - 2023

Year	Deaths	Injuries
2011	5	**8**
2012	7	**0**
2022	2	**0**
Total	14	8

Source: National Weather Service, Milwaukee - Sullivan Office

Vulnerability Assessment

From 2000 through 2024, there were 3 years in which at least one or more persons in Wisconsin died from the effects of excessive heat (Table 5-22). One fatality occurred in Sauk County in 2011. Its likely county residents received medical treatment for heat-related symptoms that are not reported.

In 1995, two heat waves gripped much of the state. The first occurred in mid-June and the second in mid-July. In the second heat wave, the temperature rose to between 100ºF and 108ºF with heat indices of 120ºF to 130ºF.

According to the National Weather Service, the mortality rate from excessive heat in Wisconsin is the highest of all natural disasters.

Intensely urbanized areas feel the effects of heat waves more than rural areas in that the temperature in urban areas is often elevated because radiant energy is stored in pavement and the exterior building surfaces and is released slowly over a period of time. Even during a heat wave, nighttime temperatures typically drop, but less so in urban areas because these heat reservoirs dissipate the
radiant heat collected during the day time. This phenomenon is often referred to as the heat island effect.

Out of all of the natural hazards in Wisconsin, excessive heat is the leading cause of fatalities.

Not only are urban areas heat islands, pollutants often build up in the lower atmosphere during periods of excessive heat, causing respiratory problems, especially for the young, the elderly, and those with respiratory ailments such as asthma.

Table 5-23. Heat-Related Fatalities; United States: 1995

Age	Number	Percent
0 – 19	14	1.4
20 – 29	5	0.5
30 – 39	34	3.3
40 – 49	79	7.7
50 – 59	95	9.3
60 – 69	179	17.5
70 – 79	253	24.8
80 – 89	241	23.6
90 and older	61	6.0
Unknown age	60	6.0
Total	1,021	100 [1]

Source: National Weather Service
Notes:
1. Numbers may not add up to 100 due to rounding

Although the more urban areas of the county experience the heat island effect, the change in the ambient temperature is modest. This is because the urban areas of the county are relatively small and street trees help to deflect solar radiation back into the atmosphere.

Effects on Facilities – Excessive heat does not directly impact critical facilities.

Effects on Population Groups – The elderly are disproportionately affected by heat. For example, during the heat waves of 1995, three-quarters of the fatalities were 60 years of age or older (Table 5-23).

Effects on Economic Sectors – Excessive heat and prolonged periods of warmer temperatures can affect agriculture in a variety of ways (Exhibit 5-17).

Exhibit 5-17. Impacts on Agriculture

- Increased frequency of heat stress on livestock and crops.
- Decreased dairy herd milk production during extreme heat events. *
- Rapid shifts between warm and cold periods in the spring that can damage fruit crops and degrade soil health through freeze/thaw cycles (e.g., pore structure, aggregate stability, etc.).*
- Less reliable winter snow and ice cover causing winter kill of alfalfa and damage to winter cereals (e.g. wheat) and cranberry crops.
- Increased susceptibility to insect pests and pathogens causing increased crop losses, as well as increased pesticide use and reduced pesticide effectiveness.
- Increased weed pressure from natural regeneration of exposed soils following rain events causing increased herbicide use.
- A need to develop and plant crop varieties adapted to longer growing seasons, increased temperatures, and erratic precipitation access.
- Extended the fall planting date and increased the growing season for cover crops.
- Potential to use longer-season crop varieties that have higher input needs.
- Increased risk of drought causing decreased germination and crop loss, especially during fruiting periods. *
- Increased use of groundwater sources for irrigation during extreme heat or drought events. • Increased crop loss due to excessive precipitation, especially during seed germination periods. *
- Increased frequency of waterlogged soils resulting in delayed or missed planting and harvesting, delayed or missed manure and fertilizer applications, a need for adjustments to nutrient management to account for changes in nutrient cycling in wet soils, and potential for soil compaction and reduced time for animals on pasture.
- Increased frequency of extreme rainfall events which intensifies potential for soil erosion and gully formation; nutrient, sediment, and pathogen runoff to surface waters; and challenges for manure management.

Note: * See source for relevant sources cited.

Source: (2023). Climate Change Impacts on Wisconsin Agriculture. Ames, Iowa: United States Department of Agriculture Climate Hubs, University of Wisconsin-Madison, Clean Wisconsin, and Great Lakes Research Integrated Science Assessment.

Additionally, some businesses may close or reduce production to minimize heat effects on employees.

Effects on New Development – Most new homes that are being constructed in the area have central air conditioning. As such, those people living in new dwelling units will be less affected by extreme heat than those living in the existing housing stock, some of which do not have air conditioning.

Estimated Damage

Aside from health consequences for county residents, excessive heat does not cause a definable economic loss unless it occurs during a drought. Climate change can be expected to lead to more frequent, and longer periods of excessive heat.

14. Extreme Cold

Profile

Periods of extreme cold temperature are common during the winter months in Wisconsin.

History of Past Occurrences

Since 1950, the National Weather Service documented 5 periods of extreme cold, all of which occurring from December through mid-February. The lowest recorded temperature in Sauk County (-45°F) was recorded on January 30, 1951 at the Baraboo weather station (#470516). Based on data collected at the Baraboo weather station, there are on average 25 days with temperatures at or below zero degrees Fahrenheit (Table 5-24).

Vulnerability Assessment

Effects on Facilities – Excessive cold does not directly impact most critical facilities. There may be instances where an extended period of cold causes water pipes in buildings to freeze, and if not corrected, to burst. Underground water laterals often leak because of extreme cold temperatures as the surrounding soil materials expand and contract.

Effects on Population Groups – The elderly are disproportionately affected by cold temperatures. They are often times confined to their home during extended cold periods.

Effects on Economic Sectors – Excessively cold temperatures can accompany winter storm events; which compounds a generally difficult time. Because cold temperatures do not last for an extended period, the effects of excessively cold temperatures are short lived.

Effects on New Development – Periods of extreme cold will not disproportionately affect new development.

Estimated Damage

Aside from health consequences for county residents, excessively cold temperatures do not cause a definable economic loss.

Table 5-24. Temperature Extremes; Sauk Weather Station: 1971-2000

Month	Number of Days ≥90°F	Number of Days ≤0°F
January	0.0	13.1
February	0.0	8.2
March	0.0	2.4
April	0.0	0.0
May	0.2	0.0
June	2.3	0.0
July	4.4	0.0
August	1.9	0.0
September	0.5	0.0
October	0.0	0.0
November	0.0	0.7
December	0.0	6.9

Source: http://mrcc.sws.uiuc.edu/climate_midwest/historical/temp/wi/470516_tsum.html

15. Drought

Profile

A drought is an extended period of time when rainfall is significantly below normal amounts. Unlike other natural disasters, it is not known until much later in time, when a drought begins. A drought could last for months, several years, and in extreme conditions, much longer. Droughts are typically accompanied by higher-than-normal temperatures and lower-than-normal relative humidity levels. Some droughts cover entire regions of a continent or can affect a sub-region as small as several counties.

A number of methodologies have been developed to measure droughts from a purely meteorological standpoint. Droughts can also be defined based on the consequences which result. For the purposes of this plan, two types of drought are considered: agricultural and hydrologic. An agricultural drought causes a noticeable drop in crop yields and a hydrological drought causes a drop in lake and stream levels and lowers the height of the ground water table.

Although these two types of droughts can occur at the same time, the negative effects of a drought are first seen on crop production. Hydrologic droughts characteristically lag behind an agricultural drought because it takes time for the lack of precipitation to lower surface and ground water levels. As a result, it is possible for an area to experience a hydrologic drought long after the end of an agricultural drought.

History of Past Occurrences

Agricultural and hydrologic droughts occur in Wisconsin on a regular basis. Since the Dust Bowl, short-lived droughts have occurred on an interval of about once in every ten years. Long-term droughts are more infrequent. Since the Dust Bowl, there have been four significant droughts in the state: 1987-1988, 1976-1977, 1955-1959, and 1948-1950. The most recent occurrence to cause damages in Sauk County occurred during the months of June and July in 2007. During this episode $100,000 in losses were recorded. The most damaging drought in Sauk County and surrounding region occurred in 2002 when $4.4 million was reported in lost crops.

Table 5-25. Locations in and Near Sauk County with the Lowest Annual Statewide Precipitation Levels: 1895-2008

Year	Statewide Average (Inches)	Lowest Recorded Precipitation Levels			
		Precipitation (Inches)	Difference (Inches)	Geneal Location	County
1888	28.24	23.07	5.17	Madison	Dane
1895	22.60	13.54	9.06	Madison	Dane
1905	35.44	25.49	9.95	Madison	Dane
1958	24.18	15.41	8.77	Hillsboro	Vernon
1962	28.47	18.79	9.68	Madison	Dane
1966	26.62	18.52	8.1	Hillsboro	Vernon
1975	32.40	25.04	7.36	Lone Rock	Sauk
1983	34.57	24.81	9.76	Stoughton	Dane
2002	35.22	25.36	9.86	Dodgeville	Iowa

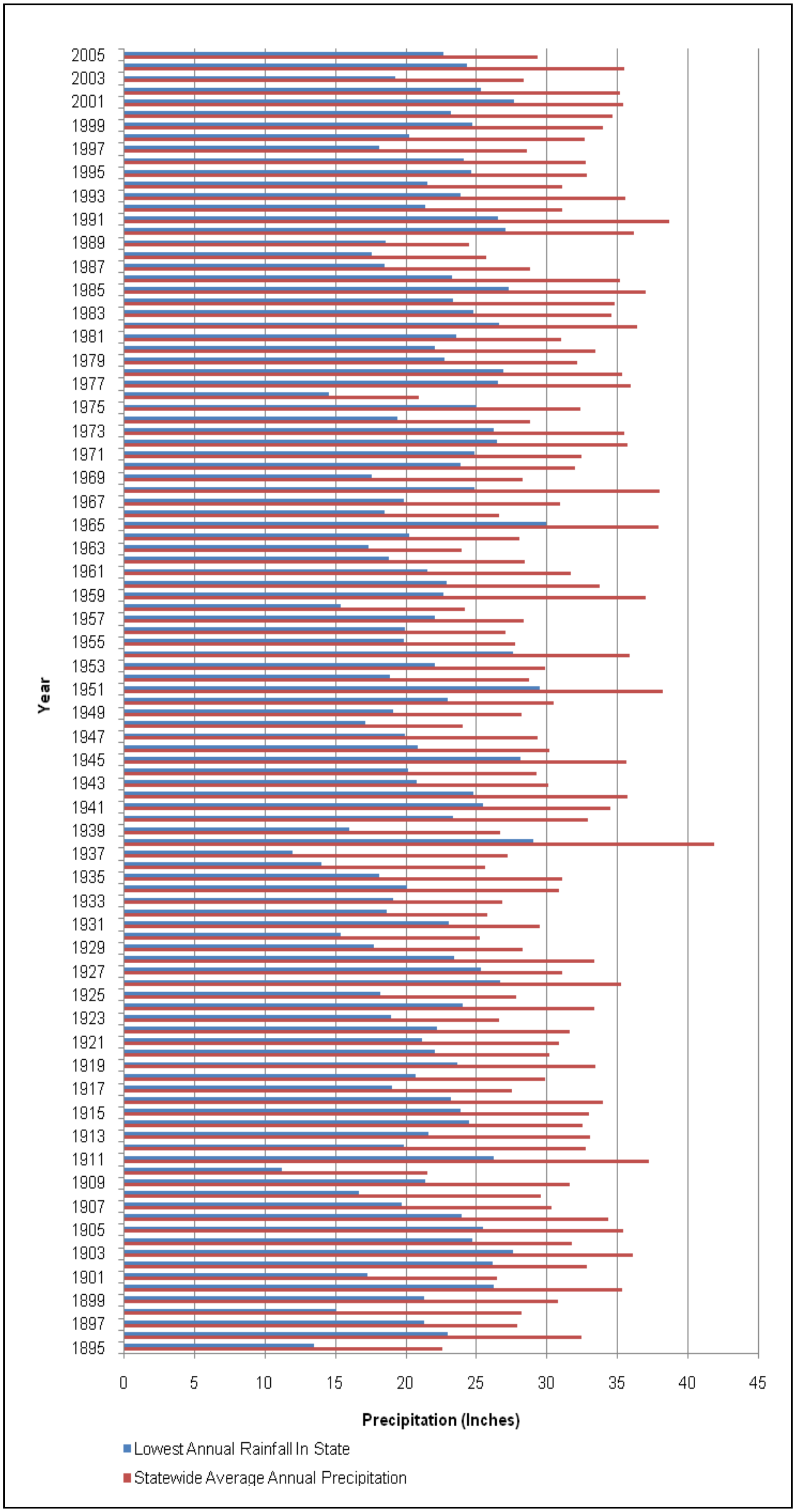
Source: Wisconsin State Climatology Office www.aos.wisc.edu/~sco/clim-history/state/4700-RN-EX.html and www.aos.wisc.edu/~sco/clim-history/state/4700-R.html

In 2005, 2006, and 2007 Governor Doyle declared a statewide drought emergency by executive order so that the Department of Natural Resources could expedite farmers' requests to use water from lakes and streams for irrigation. Also in 2007, the governor asked the U.S. Secretary of Agriculture to declare 52 counties, including Sauk County, as disaster areas.

Exhibit 5-12 shows the statewide average annual precipitation between 1895 and 2008 and the lowest annual precipitation recorded in the state for the same period. Over this period, the average annual precipitation was 31.4 inches per year on a statewide basis. There were 56 years when precipitation was below the average and 7 years when precipitation was less than 25 inches. The lowest average annual precipitation occurred in 1976 with 20.9 inches of precipitation.

On a more localized level, there have been 88 years when an area of the state with the lowest precipitation level received less than 25 inches of precipitation. As shown in Table 5-25, the lowest statewide precipitation levels occurred in Sauk County or an adjoining county on nine occasions.

Exhibit 5-12. Wisconsin Average Annual Precipitation: 1895-2006



Source: Wisconsin State Climatology Office

Vulnerability Assessment

By most accounts, the 1987-1988 drought in Wisconsin was the most severe and is estimated to have a recurrence interval of about 75 years. All Wisconsin counties were eligible for drought assistance. Agricultural losses throughout the state totaled $1.3 billion. More than half of the farms in the state suffered crop losses of 50 percent or more, with 14 percent experiencing a crop loss of 70 percent or more.

Potential for Future Losses

Effects on Facilities and Population Groups – Unlike many of the other natural disasters addressed in this plan, drought conditions do not cause direct physical harm to people or destroy buildings and other structures.

Effects on Economic Sectors -- The two main concerns with drought relate to economic losses to agricultural crops and livestock and effects on ground water supplies available to both private and public water wells.

Farmers in the county produce a variety of products, including dairy, grain, cattle and calves, hogs and pigs, vegetables, nursery and greenhouse stock, and Christmas trees. In 2009, farm operators owned and managed more than 358,919 acres of land. Droughts would therefore affect a significant portion of the county and a significant economic sector.

During extended droughts, municipalities often see an increased water usage due primarily to increased use for lawns and gardens. It is important that municipal wells are properly sized for the number of residents they are intended to serve. At times it may be necessary to impose water restrictions when there is concern that the available water supply may not be sufficient to meet basic needs.

Because municipal wells are generally concentrated in a relatively small area, extended droughts can affect the level of the water table. With decreased rainfall, the water table will naturally drop. Most public water wells draw from the deep aquifers and typically are not negatively affected. However, those wells serving an individual household are comparatively shallow and are more susceptible to a dropping water table, especially when located near a municipal well. It is estimated that about two-thirds of county residents receive their drinking water from a municipal system and the remaining one-third from a private well.

Effects on New Development – Aside from the potential of limiting the use of potable water for certain uses during drought periods, new development will be no more susceptible to drought than exists now.

Climate Change – Climate change can be expected to lead to rising average annual temperatures. The increased heat will fuel more extreme weather of all types, including excessive heat which is already one of the deadliest hazards in Wisconsin. Drought conditions will become more frequent and persistent.

Estimated Damage

It is estimated that a short-term drought over the course of a year would cause a loss in agricultural production in the range of $5,000 to $50,000. The upper end of this estimate is based on an average loss of $300 per acre over 166 acres.

16. Summary of Risk by Jurisdiction

Table 5-26 presents a summary of current risk for each jurisdiction in Sauk County.

Since the last plan, there have been some minor shifts, primarily to flood risk. For example, the villages of Rock Springs and La Valle have experienced multiple flood events in a span of a few years and are in the early stages of defining a long-term solution including relocating existing business to more protected areas. In a similar way, some jurisdictions have seen minor shifts as lands are being annexed to cities and villages and removed from towns. As more buildings are constructed the potential for storm damage increases incrementally as well. While most of the municipalities have grown in population, the following have experienced population decline in the last few years: Towns of La Valle, Reedsburg, and Troy; Villages of La Valle and Rock Springs; and City of Wisconsin Dells.

Table 5-26. Summary of Risk by Jurisdiction: 2024

Town	Dam Failure	Flooding [2]	Dense Fog	Tornado	Hail-storm	Thunder-storm	Temp. Extremes	Drought
Baraboo	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Bear Creek	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Dellona	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Delton	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Excelsior	Low	High	Low	Medium	Medium	Medium	Medium	Low
Fairfield	Low	High	Low	Medium	Medium	Medium	Medium	Low
Franklin	Medium	Medium	Low	Medium	Medium	Medium	Medium	Low
Freedom	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Greenfield	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Honey Creek	Medium	Medium	Low	Medium	Medium	Medium	Medium	Low
Ironton	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
La Valle	Medium	High	Low	Medium	Medium	Medium	Medium	Low
Merrimac	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Prairie du Sac	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Reedsburg	Medium	Medium	Low	Medium	Medium	Medium	Medium	Low
Spring Green	Low	High	Medium	Medium	Medium	Medium	Medium	Low
Sumpter	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Troy	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Washington	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Westfield	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Winfield	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Woodland	Medium	Medium	Low	Medium	Medium	Medium	Medium	Low
Village								
Cazenovia [1]	Low	Low	Low	Medium	Medium	Medium	Medium	Low
Ironton	Low	Low	Low	Medium	Medium	Medium	Medium	Low
Lake Delton	Low	Medium	Low	High	Medium	High	Medium	Low
La Valle	Low	High	Low	Medium	Medium	Medium	Medium	Low
Lime Ridge	Low	Low	Low	Medium	Medium	Medium	Medium	Low
Loganville	Low	Low	Low	Medium	Medium	Medium	Medium	Low
Merrimac	Low	Low	Low	Medium	Medium	Medium	Medium	Low
North Freedom	Low	High	Low	Medium	Medium	Medium	Medium	Low
Plain	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
Prairie du Sac	Low	Low	Low	Medium	Medium	Medium	Medium	Low
Rock Springs	Low	High	Low	Medium	Medium	Medium	Medium	Low
Sauk City	Low	Low	Low	Medium	Medium	Medium	Medium	Low
Spring Green	Low	High	Medium	Medium	Medium	Medium	Medium	Low
West Baraboo	Low	Medium	Low	Medium	Medium	Medium	Medium	Low
City								
Baraboo	Low	High	Low	Medium	Medium	Medium	Medium	Low
Reedsburg	Medium	High	Low	Medium	Medium	Medium	Medium	Low
Wisconsin Dells [1]	Medium	Low	Low	High	Medium	High	Medium	Low

17. Summary of Damage Estimates

Table 5-27 lists damage estimates for the various natural hazards reviewed in this chapter.

Table 5-27. Damage Estimates for Natural Hazards; Sauk County

Natural Hazard	Damage Estimate
Dam failure	Unknown
Flooding [1]	$53.2 million (building loss)
Dense fog [2]	Minimal
Tornado – EF1	$55,000
Tornado – EF2	$1,225,000
Hail storm [2]	$1,500
Thunderstorm [2]	$13,300 property; $6,000 crop
Winter storm [2,3]	Minimal
Extreme temperature – heat	Minimal
Extreme temperature – cold	Minimal
Drought - short-lived	0 property; $25,000 to $50,000 crop
Drought - long-lived	0 property; $100,000 to $200,000 crop

Notes:
1. Based on a 100-year flood; 2010 HAZUS-MH analysis
2. Estimates do not include damage to motor vehicles or other accident-related costs
3. Estimate does not include snow plowing/removal costs. While potentially significant, these costs are included in local government budgets.