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SEWRPC Community Assistance Planning Report No. 378 (4th Edition)

KENOSHA COUNTY HAZARD MITIGATION PLAN UPDATE: 2023-2028

Chapter 3

ANALYSIS OF HAZARD CONDITIONS

To evaluate various potential hazard mitigation alternatives for Kenosha County and select the most effective and feasible hazard mitigation strategies, the existing potential natural weather hazard problems in the County must first be analyzed and the vulnerability to such hazards documented. Accordingly, this chapter provides the following:

- Identification of the hazards likely to affect Kenosha County
- Profiles of the extent and severity of recent hazard events which occurred in the County
- Assessment of the vulnerability and risk associated with each type of hazard
- Identification of the potential for changes in hazard severity and risk under future conditions

The vulnerability assessment focuses on the County and community assets described in Chapter 2.

3.1 HAZARD IDENTIFICATION

The process of identifying those natural weather hazards that should be specifically addressed in the Kenosha County hazard mitigation plan was based upon consideration of a number of factors. The process included input from the Kenosha County Hazard Mitigation Local Planning Team (LPT), including a priority ranking of hazards; review of the hazard identification set forth in the State hazard mitigation plan; review of documentation of past hazard events; and review of related available mapping, plans, and assessments. As part of the updating process, the identification of hazards likely to affect Kenosha County was reviewed and reevaluated. This reevaluation included additional input from the Kenosha County Hazard Mitigation LPT.

As part of the updating process for this third plan update (4th edition), the LPT reevaluated the hazards to be considered using a hazard and vulnerability assessment tool similar to the one used for reviewing hazard identification for the previous plan update. In this survey, members of the LPT indicated the likelihood of each hazard occurring in Kenosha County and evaluated the severity of each hazard on the basis of possible impacts to people, property, and businesses. Finally, the LPT evaluated the relative state of preparedness for each hazard. The ratings given by the LPT for each hazard were used to derive a perceived level of risk posed by each hazard. Following this, the hazards were ranked by perceived level of risk (Table 3.1).

Summary of Hazard Vulnerability and Risk Assessment Survey Results

Methods

The assessment survey was completed at the March 28, 2022, meeting of the Kenosha County Hazard Mitigation Local Planning Team, with 16 surveys returned and analyzed. For each of the hazards, a risk was computed for each survey using the formula:

Risk (in weighted average) = [(Probability) x (Human impact + Property impact + Business impact - Preparedness)]

Probability (likelihood that an event would occur), Human impact (possibility of death or injury), Property impact (physical losses and damages), Business impact (interruption of services), and Preparedness (mitigation or pre-planning) were each assigned a number from 0 to 3, with 0 indicating "not applicable", 1 indicating low, 2 indicating moderate, and 3 indicating high.

The interpretation of the results returned by this formula is that the perceived threat increases with increasing total risk. For each hazard, total risk was calculated using the results of all the returned surveys. The hazards were then ranked by total risk, with a rank of 1 indicating the highest perceived risk.

Results

The results from the assessment survey are summarized in Table 3.1. Hazard events are listed in order of highest perceived risk to lowest perceived risk.

Summary and Ranking of Hazards

There are several ways the Kenosha County hazards can be ranked and summarized to be considered in the County hazard mitigation plan. Current guidance for all hazard mitigation plans promotes comprehensive consideration of all natural hazards. The natural weather hazards have been ranked by consideration of their frequency, amount of damage, and death and injuries incurred, as well as by concerns of, and degree of importance assigned by, the collective judgment of the Kenosha County Hazard Mitigation LPT.

The hazards to be considered in this plan are summarized in Table 3.2[1], along with qualitative information on the hazard severity. As part of the updating process, the hazards considered in the previous plan update were reevaluated based on data related to the occurrence of natural weather hazards since the previous plan update and to the perceived risk associated with each hazard, as summarized in Table 3.1.

Hazard severity can be assessed and ranked in a variety of ways. The purpose of ranking hazards is to help set priorities and direct more resources to address those hazards of the greatest severity. However, the kinds of mitigation actions that will be needed and warranted depend on the type of vulnerability to be addressed. Some hazards, such as excessive heat and lightning, are unlikely to cause a disaster, but they can be fatal and, therefore, are serious hazards. Vulnerability to such hazards can best be addressed by preventative measures, such as public information to encourage hazard awareness and personal protection. Other hazards, such as flooding, are pervasive and devastating, and may require a variety of tools such as mapping, building codes, zoning laws, insurance, elevation or acquisition of flood-prone structures, and public awareness, to effectively reduce the risk of disaster. However, flooding might not result in more fatalities than a heat wave. In general, ranking hazards by the number of deaths that they cause shifts the focus away from major and largely avoidable disasters, such as floods. Weather hazards that have caused past Kenosha County disasters are likely the hazards that will cause future disasters. However, the types of natural hazards that result in fatalities remain a public health and safety concern.

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[1] *The rankings in Table 3.2 were assigned by combining rankings of the natural hazards listed based upon the number of occurrences, amount of damages, numbers of fatalities and injuries reported since 1950, and the perceived risk associated with each hazard as identified by the Local Planning Team and summarized in Table 3.1. It is important to note that some of the natural hazards listed in Table 3.2 represent combinations of hazards listed in Table 3.1. For example, while specific risks associated with thunderstorms, such as hail and lightning are listed separately in Table 3.1, they are combined into one category in Table 3.2.*

The summary listing of hazards in Tables 3.1 and 3.2 does include some hazards that have been found to have minimal chance of occurring or offer only limited applicable mitigation options. The hazards listed below will not be discussed further in this report.

Fog

Fog is low-level moisture caused by many contributing factors, including ice or snowmelt, moist air from Lake Michigan, or rain evaporation with light winds, which may reduce visibility levels, especially in river valleys and other low spots. Dense fog is often seen with clearing skies the day following a heavy rainstorm. Fog is a widespread natural hazard event that usually covers several counties during an episode. There have been 65 fog events reported in and around Kenosha County from 2001 through 2021. Although no deaths or injuries were recorded during that period, fog can affect mobility. Dense fog may persist for several hours or days, reducing visibility and leading to vehicle accidents, flight delays, or cancellations at airports. This natural hazard event does not offer significant mitigation alternatives to warrant individual examination.

Wildfires

A forest fire is an uncontrolled fire occurring on forest or woodlands outside the limits of incorporated villages or cities. A wildfire is any instance of uncontrolled burning in brush, marshes, grasslands or field lands. The causes of these fires include lightning, sparks from trains, human carelessness, or arson. Land use, vegetation, amount of combustible materials present, and weather conditions, such as wind, low humidity, and lack of precipitation, are the chief factors determining the number of fires and acreage burned.

Only about 6.5 percent of the land area in Kenosha County is woodland. Historical agricultural land use and urbanization has reduced the threat of a large-scale forest or wildfire event. According to the Wisconsin Department of Natural Resources (WDNR), Bureau of Forestry, no forest fires or wildfires over 500 acres have occurred in Kenosha County from 2011 through 2021. Based on guidance from the National Association of State Foresters, the WDNR in conjunction with its Federal and tribal partners, developed a Statewide assessment of communities at risk from wildfires. None of the communities in Kenosha County were determined to be at high or very high risk. Considering the low risk and lack of historic incidents, forest and wildfire hazards will not be addressed in later chapters.

Dust Storms

There have been no dust storm events reported in Kenosha County from 2011 through 2021. Natural hazard events that occurred in the past are likely to reoccur in the future, providing the opportunity to plan for them. A dust storm event in Kenosha County would be atypical, therefore, mitigation strategies will not be recommended for this hazard in the current plan.

Land Subsidence

Land subsidence occurs when large amounts of groundwater have been withdrawn from certain types of rocks, such as fine-grained sediments. The rock compacts because the water is partly responsible for holding the ground up. When the water is withdrawn, the rock falls in on itself.[2] Land subsidence is not immediately noticeable because it occurs over large areas over a certain amount of time, unlike sinkholes. Due to the karst terrain of Wisconsin and high groundwater levels, there have been no land subsidence events reports in Kenosha County from 2011 through 2021. A land subsidence event in Kenosha County would be atypical, and therefore, mitigation strategies will not be recommended for this hazard in the current plan.

Inland Landslide

The most frequent and widespread damaging landslides in the U.S. are started by prolonged or heavy rainfall. The majority of rainfall-induced landslides are shallow, small, and move rapidly. Many rainfall-induced landslides transform into debris flows (fast-moving slurries of water, soil, and rock) as they travel down steep slopes, especially those that enter stream channels where they may mix with additional water and sediment.[3] The major concern for the U.S. Geological Survey (USGS) in regard to landslides resides in the State of California. Due to the lack of bare (no plants or trees to hold the soil in place) hills or steep slopes in the County, inland landslides are considered a very low hazard level.[4] There have been no inland landslides reported in Kenosha County from 2011 through 2021. Thus, mitigation strategies for this hazard will not be recommended in the current plan.

Earthquake

An earthquake is a shaking or sometimes violent trembling of the earth that results from the sudden shifting of rock beneath the earth's crust. This sudden shifting releases energy in the form of seismic waves or wave-like movement of the surface of the earth. Earthquakes can strike without warning and may range in intensity from slight tremors to great shocks lasting a few seconds or over five minutes. The actual movement of the ground during earthquakes is seldom the direct cause of injury or death. Casualties may

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[2] *U.S. Geological Survey, "Land Subsidence", Water Science School, June 2018.*

[3] *U.S. Geological Survey, "Overview of Rainfall-Induced Landslides", Landslide Hazards, July 2018.*

[4] *Global Facility for Disaster Reduction and Recovery (GFDRR), "Think Hazard: Wisconsin Landslide", Retrieved May 31, 2022, from www.thinkhazard.org/en/report/3263-united-states-of-america-wisconsin.*

result from falling objects and debris as well as disruption of communications; electrical power supplies; and gas, sewer, and water lines should be expected from earthquakes. The severity of an earthquake can be measured by comparing the peak acceleration associated with the horizontal shaking it produces to the normal acceleration a falling object experiences due to the force of gravity. This is usually expressed as a percentage of g, the acceleration due to gravity. The level of risk due to earthquake can be expressed as the percentage of g, for which there is a 2 percent probability of being exceeded in a 50-year period. Depending on location, sites in Kenosha County have a 2 percent probability of experiencing earthquakes in a 50-year period in which the peak acceleration associated with horizontal shaking exceeds between 4 percent and 8 percent of g.[5] These are low values. While these levels of shaking can be noticeable, they are rarely associated with damages to structures. The earthquake threat to the State and Kenosha County is considered low, therefore earthquakes will not be considered further in subsequent sections of this report.

Past Hazard Experience

Past experiences with disasters are an indication of the potential for future disasters for which Kenosha County would be vulnerable. Accordingly, a review was made of the hazards that Kenosha County has faced in the past. Tables 3.2 through 3.4 detail the history of estimated disaster damages caused by federally declared emergencies, the total number of weather hazard events recorded, and the severe weather history in the County.

As shown in Table 3.3, Kenosha County has had 8 major disaster declarations and 3 emergency disaster declarations between 1993 and 2021. The total documented estimated damages of these 11 events exceeded $76 million.

Since 2001, Kenosha County has experienced 581 weather hazard events, as summarized in Table 3.4. To illustrate the broader hazard damage potential, Table 3.4 summarizes the reported damages associated with the 581 natural hazard events. Those hazard events were estimated to have caused over $91 million in damages.

The historical events summarized in Table 3.4 show that snow and ice are the most frequent weather hazards, followed by high straight-line winds, fog, and extreme temperatures. However, flooding is the most damaging weather hazard, followed by tornadoes and lightning. Extreme temperatures accounted for six documented deaths and high straight-line winds accounted for two documented deaths in Kenosha County.

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[5] *U.S. Geological Survey, "2008 United States National Seismic Hazard Maps", USGS Fact Sheet 2008-3018, April 2008.*

To illustrate the potential frequency of thunderstorms and tornadoes, a review was made of the warnings historically issued by the National Weather Service, as shown in Table 3.5. Over the period of 2001 through 2021, there have been 117 flash flood or flood warnings, 356 thunderstorm-related watches or warnings, and 58 tornado-related watches or warnings.

3.2 DESCRIPTION OF ANALYSIS, METHODS, AND PROCEDURES

In the previous section of this report, the hazards considered applicable to Kenosha County were identified and ranked (Table 3.1). This section of the report develops a vulnerability assessment for the identified hazards. This vulnerability assessment provides the basis for developing mitigation strategies that address the identified vulnerabilities.

The procedures utilized in the vulnerability assessment are based upon guidance provided by the Federal Emergency Management Agency (FEMA) and the Wisconsin Department of Military Affairs, Division of Emergency Management.[6] The analysis includes three components: 1) profile of hazard events, 2) inventory of assets, and 3) estimation of losses. In addition, where applicable, potential changes in vulnerability under future conditions and the variance of vulnerability among the 12 communities within Kenosha County is analyzed. The profiling of hazard events was developed by utilizing the HAZUS methodology, data available on the FEMA and National Oceanic and Atmospheric Administration National Climatic web sites, data provided by the Wisconsin Department of Military Affairs, Division of Emergency Management, and file data available from the Kenosha Division of Emergency Management and SEWRPC.

Data and estimated losses and vulnerability were developed utilizing standard risk assessment methodology as set forth in FEMA and State Division of Emergency Management guidelines for hazard mitigation planning where hazards can be estimated spatially and by order of magnitude over a range of events. For hazards which cannot be quantified, alternative approaches have been used relying on qualitative measures. A vulnerability description has been included for each of the applicable hazards listed in Table 3.2.

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[6] *Federal Emergency Management Agency, State and Local Mitigation Planning How-to Guide, "Understanding Your Risks, Identifying Hazards and Estimating Losses," Publication No. FEMA 386-2, August 2001; Federal Emergency Management Agency, Local Multi-Hazard Mitigation Planning Guidance. July 1, 2008; Federal Emergency Management Agency, Local Mitigation Planning Handbook. March 1, 2013. See also Federal Emergency Management Agency, State and Local Plan Interim Criteria under the Disaster Mitigation Act of 2000, July 11, 2002.*

3.3 HAZARD VULNERABILITY AND RISK ASSESSMENTS

Tornadoes

Wisconsin lies along the northern edge of an area of the United States commonly known as "tornado alley." This area extends northeasterly along an axis extending from Oklahoma and Iowa in the west, to Michigan and Ohio in the east. This corridor accounts for one-fourth of the total tornadoes in a given year, with 758 tornadoes reported in the U.S. during the year 2011. A tornado is defined as a violently rotating column of air extending from the ground up to the thunderstorm base. It generally lasts for only a short period. The tornado appears as a funnel-shaped column with its lower, narrower end touching the ground and upper, broader end extending into the thunderstorm cloud system. In some cases, the visible condensation cloud may not appear to reach the ground, but meanwhile tornado-force winds may be causing severe destruction (rotating winds can be nearly invisible, except for dust and debris). Similar events, not reaching the land surface, are known as funnel clouds. Funnel clouds may be a precursor to a tornado event. In Wisconsin, tornadoes usually occur in company with thunderstorms formed by eastward-moving cold fronts striking warm moist air streaming up from the south. However, it is not possible to predict tornado activity based upon the occurrence of thunderstorms, and, occasionally, multiple outbreaks of tornadoes occur along the thunderstorm frontal boundary, affecting large areas of the State at one time. Tornadoes generally occur near the trailing edge of a thunderstorm and it is not uncommon to see clear, sunlit skies behind a tornado.

Historically, tornadoes have been categorized based upon the most intense damage along their paths using the Fujita Scale. Since February 2007, the Fujita Scale has been replaced by the Enhanced Fujita Scale, which retains the same basic design of its predecessor with six strength categories (see Table 3.6). The newer scale reflects more refined assessments of tornado damage surveys, more standardization, and consideration of damage over a wider range of structures.

The destructive power of a tornado results primarily from its high-wind velocities, wind-driven debris, and uplifting force. These tornado characteristics probably account for 90 percent of tornado-caused damage. Since tornadoes are generally associated with severe storm systems, hail, torrential rain, and intense lightning usually accompany tornado events. In addition, tornadoes may be accompanied by downbursts, events which are characterized by strong downdrafts initiated by a thunderstorm that manifest as straight-line winds on or near the ground. These winds can be powerful, with speeds up to 70 to 100 mph. These winds interact with tornadoes and can affect the path of the tornado event in such a manner as to make tornadoes somewhat unpredictable. Depending on their intensity, tornadoes can uproot trees and crops, down power lines, and damage or destroy buildings and infrastructure. Flying debris can cause serious injury and death to humans, livestock, and wildlife in their path. An approaching cloud of debris can mark the location of a tornado, even if the classic funnel cloud is not visible. Before a tornado hits, the wind may die down and the air may become very still.

The National Weather Service (NWS) monitors severe weather nationwide from its Norman, Oklahoma office. This office is the only entity that can issue a tornado watch. The NWS office in Milwaukee/ Sullivan, and the Kenosha County Division of Emergency Management may issue tornado warnings. A tornado watch means that tornadoes are possible, and that persons within the area for which the watches are issued should remain alert for approaching storms. A tornado warning means that a tornado has been sighted in an area or indicated as likely to have occurred by weather radar. When tornado warnings are issued for an area, persons near and within that designated area are advised to move to a pre-designated place of safety. As discussed previously, Table 3.5 shows the total number of tornado watches and warnings in Kenosha County from 2001 through 2021. The NWS operates a 24-hour weather radio transmitter serving Kenosha and Racine Counties, operating at a frequency 162.450 MHz, from a location at CTH KR and Wood Road, Racine County. Most of Kenosha County is also served by a NWS 24-hour weather radio transmitter located in Delafield, Waukesha County that operates at a frequency of 162.400 MHz.

In addition to tornado watches and warnings, severe thunderstorm watches and warnings indicate severe weather conditions that may generate conditions in which tornadoes may occur. Such watches and warnings may be followed by tornado watches and warnings as weather conditions develop.

Recent Events

In the State of Wisconsin, tornado paths historically have averaged 3.5 miles in length and 50 yards in width, although tornadoes of a mile or more in width and 300 miles in length have been known to occur elsewhere in the U.S. On average, tornadoes in southeastern Wisconsin move across the land surface at speeds of between 25 and 45 miles per hour, although overland speeds of up to 70 mph have been reported. Tornadoes rarely last more than a few minutes over a single spot or more than 15 to 20 minutes in a 10-mile area, but in those few minutes, significant devastation may occur.

The gravity of any particular tornado event is measured in terms of resulting deaths, injuries, and economic losses. The magnitudes of the tornadoes recorded in southeastern Wisconsin have been low, primarily EF0 or EF1 events on the Enhanced Fujita Scale (see Table 3.6). Nevertheless, tornadoes are second only to stormwater damage associated with floods, as the costliest natural hazards to impact southeastern Wisconsin.

On average, there are about 25 tornadoes reported each year within the State of Wisconsin. A total of 14 tornadoes have been recorded in Kenosha County during the 58-year period between July 1963 to December 2021, or about one tornado every four years. Of the tornadoes reported for Kenosha County during that period four were F1 or EF1 events, and one was an F3 event as categorized on the Fujita scale or the Enhanced Fujita scale. The locations of these tornado events are shown on Map 3.1 and documented in terms of their magnitude and impact in Table 3.7. In total, these 14 tornadoes have resulted in about $30.4 million in property damage. About 93 percent of the $30.4 million in total property damage resulted from two tornado events both occurring on January 7, 2008.

On January 7, 2008, a warm, moist, unstable air mass, with temperatures rising into the lower 60s, moved into southeastern Wisconsin, setting the stage for a rare January severe weather event. Thunderstorms formed ahead of a stationary front and produced hail, damaging winds, and a few tornadoes. This storm produced two tornadoes in Kenosha County, the northernmost in an outbreak of 48 tornadoes occurring in an area running from southeastern Wisconsin to eastern Oklahoma. The first January 7, 2008, tornado spun up about two miles northeast of Pell Lake in southeastern Walworth County and tracked to the northeast through the Towns of Wheatland and Brighton. The path of this tornado was about 10.8 miles long, nine of these in Kenosha County. With an estimated duration of 15 minutes, this suggests that the tornado had an average forward speed of 43 miles per hour. The maximum width of the tornado path was about 200 yards. With estimated maximum wind speeds of 150 to 160 miles per hour, this tornado was classified as an EF3 on the Enhanced Fujita Scale. An estimated $17.9 million (2021 dollars) in property damages resulted from this storm. Included in these damages were 29 homes destroyed, 30 homes which sustained major damage, and 28 homes which sustained minor damage. About 160 persons were left homeless due to residential damage. In addition, 15 persons sustained minor injuries.

The second January 7, 2008, tornado spun up just east of the intersection of CTH L and STH 31 and tracked to the east-northeast through the Town of Somers and the City of Kenosha. The path of this tornado was about two miles and had a maximum width of about 75 yards. With estimated maximum wind speeds of 95 miles per hour, this tornado was classified as an EF1 on the Enhanced Fujita Scale. An estimated $10.3 million (2021 dollars) in property damages resulted from this storm. Included in these damages were five homes and one church that were destroyed, seven homes which sustained major damage, and 23 homes which sustained minor damage. In addition, dozens of trees were uprooted and several power lines were toppled. No deaths or injuries were reported to have resulted from this storm.

There has only been one reported tornado in Kenosha County between 2011 and 2021, occurring on August 10, 2020. This tornado was categorized as an EF1 and resulted in property damage totaling about $268,000. The tornado started in northwestern Lake County in Illinois where some house and structural damage occurred just south of the Wisconsin/Illinois border. The tornado then crossed into Wisconsin and knocked hundreds of trees down near Camp Lake in the Village of Salem Lakes. Shingle damage was noted on a few houses and some pontoon boats and docks were toppled on Camp Lake. No deaths or injuries were reported to have resulted from this storm.

Vulnerability and Community Impact Assessment

In order to assess the vulnerability of the Kenosha County area to tornado hazards, a review of the community assets described in Chapter 2 was made which indicates the potential for significant tornado impacts to: 1) a variety of residential, commercial, and other developed land uses; 2) agricultural lands; 3) critical community facilities; and 4) historic sites. Significant impacts may also be possible to other infrastructure or utility systems, solid waste disposal sites, or hazardous material storage sites.

Tornado prediction is not an exact science. The National Weather Service can forecast that a line of thunderstorms may be likely to produce tornadoes, but where they form or touch down, and how powerful they might be, remains unpredictable. In addition, tornadoes may form quickly without ample warning since Doppler Radar does not see below the cloud base. As can be seen from the distribution of historic tornado events shown on Map 3.1, the locations of tornado impact areas are widely scattered throughout the County, although the western portion of the County appears to be more susceptible to tornado events than other portions of the County. The historic tornado events have resulted in about $30.4 million of reported damage. On average, the reported tornados have resulted in about $2.2 million of reported property damage per event. It should be noted that two events were responsible for most of these damages, so the average damages per event may not be representative of the damages that could be expected from a tornado event affecting the County. On average, there is one tornado event every 4.1 years (or about 0.24 tornado events per year) in Kenosha County. Over the 1963-2021 period of record, tornado hazards have resulted in an average of about $524,300 in property damages per year.

During a tornado event, homes, businesses, public buildings, and infrastructure may be damaged or destroyed by high winds, rain, and hail. Airborne debris, carried by the tornado and associated high winds, can break windows and doors, allowing winds and rain access to interior spaces. Fixed infrastructure, such as roads and bridges, can also be damaged by exposure to high winds. Although more bridge damage appears to result from washout associated with flash flooding and debris jams, as opposed to direct damage due to contact with funnel clouds. In an extreme tornado event, such as a F4 event, the force of the wind alone can cause tremendous devastation, uprooting trees, toppling power lines, and causing the failure of weak structural elements in homes and buildings. Due to the unpredictability of tornado events, all buildings, infrastructure, and critical facilities within the County are considered at risk.

Future Changes and Conditions

Changes in land use can have an impact on the potential for damage due to tornadoes and related hazards. Such changes relate to the potential future increase in development within the County. Changing land use patterns within Kenosha County, as documented in the adopted VISION 2050 plan and summarized in Chapter 2, indicate a continuing level of moderate risk of tornado damage and related losses in the County. Because of the actions that have been taken by Kenosha County and local units of government and individuals, the current vulnerability to tornadoes and related hazards has generally decreased in recent years. These ongoing mitigation measures are described further in Chapter 5.

The likely effects of climate change on tornado frequency and severity are not clear. The projections based upon downscaled climate model results do not address potential trends in tornado conditions. A recent study found that growth in the human-built environment is projected to outweigh the effects of increased risk of future tornado disaster potential, however, an increase in risk and exposure of tornadoes may lead to a significant increase in the magnitude and disaster impact of tornadoes on that built environment from 2010 to 2100.[7] Additionally, high-risk tornado regions may experience increased disaster probability and historically vulnerable regions may be at greater risk of tornado disaster due to a combination of factors which include increased tornado risk, rapidly amplified exposure, and pre-existing social and physical vulnerabilities.

Multi-Jurisdictional Risk Management

Based upon a review of the historic patterns of tornado events in Kenosha County, there are no specific municipalities that have unusual risks. Rather, the events are considered to be relatively uniform and of a countywide concern.

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[7] Strader, S. M., Ashley, W. S., Pingel, T. J., & Krmenec, A. J. (2017). Projected 21st century changes in tornado exposure, risk, and disaster potential. Climatic Change, 141(2), 301–313. doi.org/10.1007/s10584-017-1905-4.

Flooding

Flooding is a significant hazard in Kenosha County. As described in Chapter 2, There are approximately 110 miles of major streams in Kenosha County, located within four watersheds: the Des Plaines River, Fox (Illinois) River, Pike River, and Root River watersheds. A fifth watershed encompasses those areas adjacent to Lake Michigan which drain directly into the Lake through intermittent streams. There are also 20 major lakes (lakes of 50 acres or more) in Kenosha County. Watershed boundaries, wetlands, and major streams and lakes within the County are shown on Map 3.2.

Floodplains are the wide, gently sloping areas contiguous to, and usually lying on both sides of, a stream channel or lake. For planning and regulatory purposes, floodplains are normally defined as the areas subject to inundation by the 1-percent-annual-probability (100-year recurrence interval) flood event. Floodplain areas are generally not well suited to urban development, not only because of the flood hazard, but also because of the presence of high-water tables and, generally, of soils poorly suited to urban uses. Floodplain areas often contain important natural resources, such as high-value woodlands, wetlands, and wildlife habitat and, therefore, constitute prime locations for parks and open space areas. The floodplains shown on Map 3.2 have been identified by Kenosha County, SEWRPC, and FEMA. Approximately 20,193 acres, not including surface water in lakes and existing stream channels, or about 11 percent of the total area of the County, are located within the 1-percent-annual-probability flood hazard area. The land area within the 1-percent-annual-probability floodplain in each community is given in Table 3.8.

In addition to flooding, stormwater drainage problems exist on a scattered basis throughout Kenosha County. The distinction between stormwater drainage, stormwater management, and flood control is not always clear. For the purpose of this report, flood control is defined as the prevention of damage from the overflow of natural streams and watercourses. Drainage is defined as the control of excess stormwater on the land surface before such water has entered stream channels. The term "stormwater management" encompasses both stormwater drainage and nonpoint source pollution control measures. While the focus of this section is on the flooding hazard, the related stormwater drainage hazards are also considered because of the interrelationship between those two hazard conditions.

Types of Flooding Problems

Aside from riverine flooding, other types of flooding problems to consider in Kenosha County are highlighted below:

Dam Failure

A consideration in flood hazard mitigation is the potential for increased flooding due to dam failures. As indicated in Table 3.9 and Map 3.3, there are 21 dams identified by the WDNR in Kenosha County. Dams built according to accepted engineering principles at the time of construction and dams built without application of engineering principles can both equally fail. When a dam fails, or is subject to overtopping, large quantities of water can rush downstream with great destructive force. In the State of Wisconsin, WDNR inspects and assigns hazard ratings to dams.

The WDNR assigns hazard ratings to large dams within the State. Two factors are considered when assigning hazard ratings: existing land use and land use controls (zoning) downstream of the dam. Dams are classified, by law, into three categories that identify the potential hazard to life and property.[8]

- A **low hazard** rating is assigned to those dams that have no development unrelated to allowable open space use in the dam failure hydraulic shadow and failure would result in no probable loss of human life, low economic losses (losses are principally limited to the owners property), low environmental damage, no significant disruption of lifeline facilities, and have land use controls in place to restrict future development in the hydraulic shadow.

- A **significant hazard** rating is assigned to those dams that have no existing development in the hydraulic shadow that would be inundated to a depth greater than 2 feet and have land use controls in place to restrict future development in the hydraulic shadow. Potential for loss of human life during failure is unlikely. Failure or mis-operation of the dam would result in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities.

- A **high hazard** rating is assigned to those dams that have existing development in the hydraulic shadow that will be inundated to a depth greater than 2 feet or do not have land use controls in place to restrict future development in the hydraulic shadow. This rating is assigned if loss of human life during failure or mis-operation of the dam is probable.

In Kenosha County, two dams are currently assigned high hazard ratings, three have been assigned significant and the remaining 16 have been assigned low hazard ratings. The risk of dam failure is monitored closely by the WDNR.

[8] *Wisconsin Administrative Code, NR 333.06*

Agricultural Flood Damages

Historically, flood damages to agricultural land have been significant in Kenosha County, with crop damages totaling $38.4 million (2021 dollars) over the period of 1950 to 2021. Thus, the average annual reported damages in the County can be approximated at $540,000 per year. There are about 4,516 acres of agricultural land located within the identified flood hazard area. Thus, the average annual flood damage is about $135 per mapped acre. Because these approximations are only based on reported damages, they are assumed to represent an underestimation of actual flood related agricultural damages. It should be noted that localized crop damage can also be expected during smaller storm events.

One particularly flood-prone agricultural area of the County is the agricultural lands lying adjacent to the Des Plaines River in the Village of Bristol and Town of Paris. Specific data on flood damages was developed for these lands under a 2003 watershed study for the area.[9] Based on 1990 land use conditions the average amount of agricultural land that may be expected to be flooded annually is approximately 2,160 acres, or about 2,080 acres of cropland and 80 acres of pasture. The expected average annual flood damage of agricultural land in this watershed was estimated to be $58,000. These damages would be about $87,740 in 2021 dollars.

Stormwater Drainage Problems

Because of the interrelationship between stormwater management and floodland management, stormwater management actions are an important consideration of the flood vulnerability assessment. Small area stormwater drainage problems are known to exist throughout the urbanized portions of the County. These problems are generally addressed by local site-specific planning and stormwater facility design. Stormwater management plans are typically required by Kenosha County and the local municipalities for new developments. This practice should minimize the creation of new stormwater related problems. Stormwater management planning in Kenosha County is described further in the following chapters, and that planning serves as the basis of the assessment of stormwater drainage problem vulnerability. Such problems largely impact community facilities by causing nuisance conditions and are not generally of concern for community health and welfare.

Recent Events

A total of 23 flood events have been recorded in Kenosha County between 2011 and 2021. These events are shown in Table 3.10 and are based upon data published by the National Climatic Data Center. As shown

[9] *SEWRPC Planning Report No. 44,* A Comprehensive Plan for the Des Plaines River Watershed*, June 2003.*

in Table 3.10 these flood events can range from no events per year or up to seven events per year, which demonstrates the likelihood and unpredictability of these events. In total, these flood events did not result in any deaths or injuries but did result in over $5 million in property and crop damages within Kenosha County. See Table 3.10 for a full list of recent flood events. A few examples of recent events from Table 3.10 are noted below.

2017 – On July 11-12, 2017, three to eight inches of rain fell over the County for several hours causing widespread flooding adjacent to the Fox River in the Village of Salem Lakes and Town of Wheatland. The Fox River near New Munster hit a record crest of 17.47 feet on July 13. Many roads were closed or washed-out, including Highway 50 at the Fox River, and floodwaters entered the lower levels of numerous homes (see Figure 3.1). Various road closures continued due to flooding through July 17 and the power was out for much of the area for a few days. Property damages resulting from this flood were estimated to be $4,526,730 and crop damages were estimated at $22,600.

2019 – On March 13, 2019, mild temperatures and some rainfall led to snow melt and excessive runoff on frozen ground. Numerous rivers flooded including flooding in atypical areas due to ice jams. Evacuations were needed in some communities. The Fox River at New Munster reached moderate flood stage, cresting at 13.2 feet. Floodwater reached the lower levels of some homes in the Village of Salem Lakes and Town of Wheatland along Riverside Drive and Shorewood Drive. Rising waters on Lily Lake in the Town of Randall resulted in waterfront properties being surrounded by high water. Property damages resulting from this flood were estimated to be $1,085.

2020 – In the middle of May 2020, a slow-moving low-pressure area brought moderate to heavy rainfall over an 18 to 24 hour period. Three to 6 inches of rain fell, which resulted in river, creek, and lowland flooding. The Fox River at New Munster reached minor flood stage, cresting at 12.97 feet. Floodwater reached the lower levels of some homes in the Village of Salem Lakes and Town of Wheatland along Riverside Drive and Shorewood Drive and water was about 12 inches deep over 77th Street in the Town of Wheatland. Property damages resulting from this flood were estimated to be $5,350.

Vulnerability and Community Impact Assessment

To assess the vulnerability of the Kenosha County area to flooding hazards and related stormwater drainage problems, consideration was specifically given to potential structure flooding, including critical facilities, and cropland flood damages.

The 1-percent-annual-probability floodplain areas for Kenosha County, as well as the source of hydrologic and hydraulic data are shown on Map 3.2. As can be seen from the map, these areas are generally located along the major streams and lakes throughout the County. The majority of the floodplains shown on Map 3.2 were developed for FEMA using detailed modeling and GIS techniques to produce the County Digital Flood Insurance Rate Maps (DFIRMs) and were last updated in June, 2021. It should be noted that several floodplain mapping projects are currently being conducted in Kenosha County that would refine these floodplains and associated data and could potentially change the flood damage estimates. These projects are described in further detail in Chapter 5 of this report.

Damage Estimation Method: Parcel-Based Loss Analysis

SEWRPC staff conducted a parcel-based analysis to estimate the damages that would be sustained by buildings as a result of a 1-percent-annual-probability flood event. GIS was used to identify those parcels that are wholly or partially located in the 1-percent-annual-probability floodplain. The parcels were then examined using both 2015 orthophotography and topography to determine whether a principal building, such as a house, a commercial building, or an industrial building was located within the floodplain. For those parcels in which a principal building was located wholly or partially in the floodplain, the 2022 assessed value of improvements was obtained from Kenosha County land information GIS portal. The information in the assessment was used to classify each principal building as residential (including manufactured homes), commercial, agricultural, governmental, parks and recreational, industrial, utility, or other. For each principal building, the elevation of the ground at the building was determined from the 2015 one-foot contour topographic maps.

Standard assumptions were made as to the elevation of the first floor of a principal building. For a residential building, it was assumed that the first floor was 1.0 feet above the adjacent ground elevation. For the analysis it was also assumed that a residential building had a basement. For manufactured homes it was assumed that the first floor was 2.0 feet above ground elevation. For all other building types, it was assumed that the first floor was 0.5 feet above ground elevation.

Flood elevations for the 1-percent-annual-probability flood event were derived from information in the Flood Insurance Study for the County. These elevations were developed using detailed methods (Zone AE on the digital flood insurance rate map (DFIRM)).

A slightly different methodology was used for those buildings located in floodplains that were developed using approximate methods (Zone A on the DFIRM). A transect was drawn at the building through the floodplain perpendicular to the stream. In most cases, the higher contour elevation at the floodplain edge was used to estimate the flood elevation at the building. In cases where the difference between the elevations at the two edges of the floodplain was greater than 10 feet, the average contour elevations at the floodplain margins was used to estimate the flood elevation.

For each building, the first-floor elevation and flood elevation were compared. The extent of direct damage, which include the costs associated with cleaning, repairing, or replacing the structure, its contents, the land, for each principal building was estimated as a percent of the value of improvements based on standardized flood loss depth-damage curves prepared by FEMA, U.S. Army Corps of Engineers, and SEWRPC. Indirect damages, such as the costs associated with temporary evacuations, relocations, lost wages, lost production and sales, and the incremental costs of traffic detours, were estimated to be a percentage of direct damages for residential, commercial, and industrial buildings.

Impacts of a 1-Percent-Annual-Probability Flood

A review of the community assets described in Chapter 2 indicate the potential for flooding impacts to: 1) a variety of flood-prone residential (including manufactured homes), commercial, and other developed land uses; 2) agricultural, recreational, and lowland areas; 3) roadway systems; and 4) critical community facilities. No significant impacts are expected to other infrastructure or utility systems, solid waste disposal sites, or hazardous material storage sites. The analyses estimating the damages that would result from a 1-percent-annual-probability flood were based on the regulatory floodplains that were available at the time the analyses were conducted.

Based upon the initial review of the parcel-based analysis, there are currently 286 structures estimated to be located within the 1-percent-annual-probability (100-year recurrence interval) flood hazard areas of Kenosha County. The locations of these structures are shown on Map 3.4. There are 270 residential structures (including 29 residential mobile homes), 13 industrial, business, and commercial structures, one agricultural building, one community utility building, and one miscellaneous building. The specific location of each structure and its relationship to the floodplain is shown on the FEMA digital flood insurance rate maps for Kenosha County, which were finalized in 2021.

As of August 2022, there are 32 structures which are considered by FEMA to be repetitive- or substantial-loss properties in Kenosha County. All of these are single-family residences. There are 30 structures considered repetitive loss in the Village of Salem Lakes and one in both the Villages of Paddock Lake and Pleasant Prairie. Repetitive-loss structures are those that have two or more flood insurance claims of at least

$1,000 each. Most of these structures sustained damages during the July 12, 2017, flood event. In addition to the 32 structures identified, 16 structures that were previously identified as repetitive- or substantial-loss properties have been purchased and removed either by Kenosha County, the City of Kenosha, or the Town of Wheatland.

Detailed flood hazard data are available for all flood hazard areas identified. Estimated damages are included in Table 3.11 for a 1-percent-annual-probability (100-year recurrence interval) flood event. In 2021, the total value of the 286 structures (not including land value) which are identified as being subject to flooding or stormwater drainage problems is nearly $62 million. The total market value plus contents within these structures are estimated at over $76 million. Damages expected during a 1-percent-annual-probability flood event are estimated to be about $5.7 million (2021 dollars).

It should be noted that, with a few exceptions, all of these structures were identified as being in the floodplain based upon the best available topographic mapping. Field surveys would be required to determine the precise building relationship to the floodplain. Some structures may be found to be outside the flood hazard areas based upon detailed field survey data.

Maps 3.5 and 3.6 show the location of emergency service structures and critical community facilities relative to the 1-percent-annual-probability floodplain. There are 421 buildings identified as critical community facilities, emergency service structures, and historical sites that are distributed geographically throughout the County. A listing of those facilities can be found in Appendix C. With the exception of two historical sites, none of these facilities are located within the flood hazard, although some are located in the immediate vicinity of the flood hazard area. Because of the need for access to and from these facilities, the flood mitigation plan includes their location and shows the relationship to the flood hazard areas.

Additionally, east to west travel in the County could potentially be restricted during flood events due to overtopping of several arterial streets and highways in the Des Plaines, Fox, and Pike River watersheds. This review of the extent and severity of flooding conditions within Kenosha County indicates that there is a significant community impact due to the damages caused by flooding of buildings and disruption of the transportation system during extreme flooding events.

The stormwater flooding impacts on the community infrastructure and the need to prepare for major evacuations and other emergency actions are not a significant concern given the isolated nature and limited severity of the stormwater flooding problems. However, the ongoing coordinated Kenosha County and local emergency operations planning programs do have provisions for carrying out such actions if necessary. Significant flood-related impacts on the community economy and businesses are of an infrequent and short-term nature.

Another potential impact for emergency and police vehicles to consider is the need to utilize alternative transportation routes when providing services during periods of flooding. In most of the County, this is expected to be a rare occurrence. However, in the municipalities lying within the Fox River and Des Plaines River floodplains, where a major portion of the flood-prone structures exist, there is a need for further review because of the extent of the flooding and emergency vehicle access concerns.

Future Changes and Conditions

Changes in land use can have a direct impact on flood flows and stages and, accordingly, can impact flooding problems. The changes in urban land use in Kenosha County over the 25-year period from 2020 through 2050 are expected to result in an increase in the amounts of impervious surface in these watersheds. In the absence of mitigative measures, this could lead to increases in future flood flows and stages, especially in downstream areas. As is discussed previously in this report, there are a number of programs in place that are intended to mitigate the potential for such increases in flood flows. Nevertheless, it is important that future condition flood flows and stages be considered as mitigative actions are being developed.

Based upon the above, it can be concluded that the extent and severity of the flooding problem within the County has the potential to become more severe to a limited extent in the near future. This conclusion highlights the importance of carrying out and implementing current floodplain and related ordinances and existing and ongoing stormwater management plans and regulations.

Changes in climate are likely to affect the potential for flooding in Kenosha County during the 21st century. As previously described in Chapter 2, model projections show Wisconsin receiving more precipitation and more frequent intense precipitation events. By the mid-21st century, Kenosha County may receive three more precipitation events of two or more inches in 24 hours per decade, roughly a 25 percent increase in the frequency of heavy precipitation events.[10] This is likely to increase the frequency of high flows and high

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[10] *Wisconsin Initiative on Climate Change Impacts, Wisconsin's Changing Climate: Impacts and Adaptation, Nelson Institute for Environmental Studies, University of Wisconsin-Madison and Wisconsin Department of Natural Resources, 2021.*

water levels and potentially increase the frequency and severity of flooding. In particular, the expected increases in the magnitude and frequency of large rainfall events will likely increase flood magnitudes in streams and rivers in Wisconsin, although the amount of increase will vary from place to place. The amount of precipitation that falls as rain during winter and early spring months is expected to significantly increase. Winter rain can create stormwater management problems due to icing and runoff over frozen ground which may also lead to increased risk of flooding.

These changes may lead to several flood and stormwater related impacts. Increased rainfall and shifting precipitation patterns that favor more rain during periods of low infiltration and evapotranspiration may lead to more frequent and severe stream and river flooding. Increased precipitation during winter and spring may also result in increased occurrence of inland lake flooding. Increased cold-weather precipitation and increased variability in frost conditions may cause a rise in water tables in some areas leading to an increase in groundwater flows into basements.

The projected increase in the magnitude and frequency of heavy storms could also affect the performance of existing and planned stormwater management and flood mitigation systems. This increase could also expand flood hazard areas, such as the 1-percent-annual-probability flood hazard area, beyond their existing boundaries, potentially encompassing more existing development. This could lead to an increase in the risk of flood damages and a need for larger stormwater management facilities and programs.

The magnitudes of potential increases in flooding are unknown, and there is a complex interrelationship between the climatological factors that will be affected by climate change and the features of watersheds that produce runoff. In some cases, climate change-induced modifications to certain climatological factors may offset the changes in other factors relative to their effects on flood flows. In other cases, the effects will reinforce one another. Thus, it is very important to continue to improve methods for downscaling climatological data, to expand the climatological parameters for which downscaled data can be developed, and to apply hydrologic and hydraulic simulation models to quantify the potential effects on flooding resulting from climate change.

Multi-Jurisdictional Risk Management

Flooding and associated stormwater drainage problems have been identified as a significant risk in Kenosha County. As noted earlier and shown on Map 3.4, structures within flood hazard areas have been identified within all of the 12 general-purpose local units of government in the County, except for the Towns of Brighton and Paris. In addition, there are related stormwater drainage problems in selected areas of many communities. Based upon the number of structures potentially impacted (see Map 3.4), the extent of the agricultural flood damage potential, and the extent of roadway flooding, 11 of the 12 communities will require special consideration with regard to the selection of mitigation measures for flooding and related stormwater problems. Those communities are noted in Table 3.12, along with the basis of special consideration over and above the countywide consideration.

Severe Weather Events (Thunderstorms, Strong Winds, Hail, and Lightning)

NOAA's National Center for Environmental Information (NCEI) defines severe weather as "destructive storm or weather" that is "usually applied to local, intense, often damaging storms such as thunderstorms, hailstorms, and tornadoes." While this definition can cover a variety of hazards beyond what is listed, thunderstorms, tornadoes, high winds, hail, and lightning are the most prevalent in Wisconsin. Thunderstorms and their related strong or straight-line winds, lightning, hail hazards, and non-thunderstorm high winds are covered within this section.

Thunderstorms

Compared to other natural hazards within the State of Wisconsin, thunderstorms are the most common type of severe weather event. A thunderstorm is defined as a severe and violent form of convection produced when warm, moist air is overrun by dry, cool air. As the warm air rises, thunderheads (cumulonimbus clouds) form. These thunderheads produce the strong winds, lightning, thunder, hail, and heavy rain that are associated with these storm events. The thunderheads may be a towering mass averaging 15 miles in diameter and reach up to 40,000 to 50,000 feet in height. These storm systems may contain as much as 1.5 million tons of water and enormous amounts of energy that often are released in one of several destructive forms, such as high winds, lightning, hail, excessive rains, and tornadoes. However, excessive rains that cause flash flooding, such as occurred in the summer storm events in 1998, 2000, 2007, and 2008 when the request for Presidential disaster declaration was approved (see Vulnerability Assessment for Flooding and Associated Stormwater Drainage Problems) and tornadoes are covered separately from this hazard analysis (see Vulnerability Assessment for Tornadoes).

A thunderstorm often lasts approximately 30 minutes in a given location, because an individual thunderstorm cell frequently moves at an average velocity that ranges between 30 to 50 miles per hour (mph). However, strong frontal systems may produce more than one squall line composed of many individual thunderstorm cells. In Wisconsin, these fronts can often be tracked across the entire State from west to east.[11] Thunderstorms may occur individually, form clusters, or as a portion of a large line of storms. Therefore, it is possible that several thunderstorms may affect one particular area in the course of a few hours, as well as larger areas of the State or County, within a relatively short period of time.

All thunderstorms are potentially dangerous. However, only about 10 percent of the thunderstorms that occur each year nationwide are classified as severe. According to the National Weather Service, a thunderstorm is considered severe if it produces hail sizes at least one-inch in diameter, wind speeds equal to or greater than 58 miles per hour (measured or implied by tree and/or structural damage), or a tornado. A thunderstorm with wind speeds equal to or greater than 40 mph or hail at least 0.5 inch in diameter is defined as approaching severe. Severe weather event statistics in the State of Wisconsin for the period 1982-2008 indicate that about 56 percent of thunderstorm events are characterized by damaging straight-line winds, 38 percent are hail events, and the remaining 6 percent are tornado events. Severe thunderstorms can cause injury or death and can also result in substantial property and crop damage. They may cause power outages, disrupt telephone service, and severely affect radio communications, as well as surface and air transportation, which may seriously impair the emergency management capabilities of the impacted areas.

The National Weather Service (NWS) monitors severe weather for 20 southern Wisconsin counties, including Kenosha County, from its Milwaukee/Sullivan office.[12] A thunderstorm watch indicates that conditions are favorable for severe weather, and that persons within the area for which the watches are issued should remain alert for approaching storms. A severe thunderstorm warning indicates that severe weather has been sighted in an area or indicated by weather radar and persons should seek shelter immediately. These severe thunderstorm watch and warning bulletins and advisories are disseminated over a number of telecommunication channels, including the NOAA Weather Radio, the NOAA Weather Wire, and the State Law Enforcement TIME System. NOAA Weather Radio is available to any individual with a weather alert radio. This system and the other sources are routinely monitored by local media which rebroadcast the weather bulletins over public and private television stations, radio stations, and mobile alert applications on cell phones. In addition, the NWS operates a 24-hour weather radio transmitter serving Kenosha and Racine Counties, operating at a frequency 162.450 MHz, from a location at CTH KR and Wood Road, Racine County. Most of the County is also served by a 24-hour weather radio transmitter located in Delafield, Waukesha County which is operated by the NWS at a frequency of 162.400 MHz.

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[11] *National Weather Service Forecast Office.*

[12] *National Weather Service, Milwaukee/Sullivan Weather Forecast Office.*

To convey the severity and potential impacts from thunderstorm winds, the NWS recently added a new "damage threat" to Severe Thunderstorm Warnings. A summary of the three classifications is below:[13]

- **Destructive** damage threat is at least 2.75-inch diameter (baseball sized) hail and/or 80 mph thunderstorm winds. Warnings with this tag will automatically activate a Wireless Emergency Alert (WEA) on smartphones within the warned area.

- **Considerable** damage threat is at least 1.75-inch diameter (golf ball-sized) hail and/or 70 mph thunderstorm winds. This will not activate a WEA.

- **Baseline** or **"base"** severe thunderstorm warning remains unchanged, which is1.00-inch (quarter-sized) hail and/or 58 mph thunderstorm winds. This will not activate a WEA.

Types of Thunderstorm-Related Problems

Thunderstorm Winds

High-velocity, straight-line winds that are produced by thunderstorms and widespread non-thunderstorm high winds are a very destructive natural hazard in Wisconsin and are responsible for most wind-related damages to property.[14] Damaging winds are classified as those exceeding 50-60 mph. As with severe thunderstorms, the peak season for severe thunderstorm winds is April through August. During the period of 2011 to 2021, Kenosha County experienced one event with hurricane force winds (74 mph or higher) and 39 thunderstorm wind events (greater than 50 mph) (see Table 3.13).

Although distinctly different from tornadoes, straight-line winds produced by thunderstorms can be very powerful, are fairly common, and can cause damage similar to that of a tornado event. Depending upon their intensity, thunderstorm winds can uproot trees and crops, down power lines, and damage or destroy buildings and infrastructure. Flying debris can cause serious injury and death to humans, livestock, and wildlife in their path. Boats, mobile homes, and airplanes are also extremely vulnerable to damage from thunderstorm winds. During the period from 1982 to 2015, in the State of Wisconsin, 17 fatalities and dozens of injuries were attributed to wind from severe thunderstorms.

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[13] *Wisconsin Department of Emergency Management and Military Affairs, State of Wisconsin Hazard Mitigation Plan, December 2021.*

[14] *Wisconsin Emergency Management Department of Military Affairs, State of Wisconsin Hazard Mitigation Plan, December 2021.*

Non-Thunderstorm High Winds

High winds are also produced in the absence of thunderstorms. Non-thunderstorm high winds tend to be less forceful than thunderstorm winds but are typically more sustained and widespread. These high winds can affect a region for hours, or even several days. Longer lasting windstorms have two main causes: large differences in atmospheric pressure across a region, and strong jet-stream winds overhead. Horizontal pressure differences can accelerate the surface winds substantially as air travels from a region of higher atmospheric pressure to one of lower pressure. Intense winter storms can also cause long-lasting and damaging high winds. Cold fronts associated with intense low-pressure systems can produce high winds both as they pass and for a period afterward as colder air flows overhead. High winds in the winter can produce dangerous wind chills when air temperatures are cold. Severe wind chills are discussed further in the extreme temperature section below.

Like thunderstorm winds, non-thunderstorm high winds can uproot trees and crops, cause widespread power outages, damage buildings, and make travel treacherous. Non-thunderstorm high winds tend to be more sustained and widespread, leading to more damage over a whole region, as compared to thunderstorm winds. During the period of 2011 to 2021, 32 non-thunderstorm high wind events were reported in Kenosha County (Table 3.13).

Hail

Hailstorms are also associated with thunderstorms and are the fourth most destructive type of weather hazard in the State of Wisconsin. A hailstorm is a product of strong thunderstorms and unique weather condition where atmospheric water particles form into rounded or irregular masses of ice that fall to earth. Hail normally falls near the center of the moving storm along with the heaviest rain. In some instances, strong winds at high altitudes can blow the hailstones away from the storm center, causing unexpected hazards at places that otherwise might not appear threatened. Hailstones normally range from the size of a pea to the size of a golf ball, but hailstones 1.5 inches or larger in diameter are not uncommon in the State of Wisconsin. When strong underlying, updraft winds no longer can support the hailstone weight, they fall earthward. Hail tends to fall in swaths that may be 20 to 115 miles long and five to 30 miles wide and can fall continuously or sporadically in a series of hail strikes. Hail strikes are typically one-half mile wide and five miles long. They may partially overlap, but often leave completely undamaged gaps between them.

Hailstorms are considered formidable among the weather and climatic hazards to property and farm crops, because they dent vehicles and structures, break windows, damage roofs, and batter crops to the point that significant agricultural losses result. Falling hailstones can also cause serious injury and loss of human life and livestock, however these occurrences are rare. In addition to impact damage, thick hail combined with heavy rain can clog storm sewers and contribute to stormwater flooding. Hail sufficiently thick to cover a road will pose a traffic hazard. The peak season for hailstorms is May through September with approximately 85 percent of hailstorms occurring during this period. This coincides with the growing and harvesting seasons for most crops in the state. From 2011 through 2021, 16 hailstorms were reported in Kenosha County (Table 3.13).

Lightning

After floods, lightning kills the most people on average each year. Nationally, lightning has the highest total fatalities since 1940 out of all the severe weather hazards. However, in Wisconsin, there have been no reported lightning fatalities since 2017.[15]

Lightning is defined as a sudden and violent discharge of electricity from within a thunderstorm due to a difference in electrical charges and represents a flow of electrical current from cloud to cloud or cloud to ground. Water and ice particles also affect the distribution of electrical charge. Lightning bolts can travel 20 miles before striking the ground. The air near a lightning bolt can be heated to 50,000 degrees Fahrenheit (°F), which is five times hotter than the surface of the sun. The rapid heating and cooling of the air near the lightning channel causes a shock wave that results in thunder.

Lightning is a significant hazard associated with any thunderstorm and can cause extensive damage to buildings and structures, kill or injure people and livestock, start forest fires and wildfires, and damage electrical and electronic equipment. Lightning is a major cause of damage to farm buildings and equipment, responsible for more than 80 percent of all livestock losses, and is the number one cause of farm fires. From 2000 to 2015, Wisconsin had nearly $55 million in property and crop damages from lightning. Also, from 2007 to 2015, Wisconsin reported six fatalities and 11 injuries caused by lightning.[16]

Kenosha County reported two lightning events during the period of 2011 to 2021 causing a reported $6,000 in property damage (Table 3.13). Counties in southern Wisconsin experience a higher number of lightning

[15] *Wisconsin Department of Emergency Management and Military Affairs, State of Wisconsin Hazard Mitigation Plan, December 2021.*

[16] *Wisconsin Department of Emergency Management and Military Affairs, State of Wisconsin Hazard Mitigation Plan, December 2016.*

events than other parts of the State due to higher thunderstorm frequency and more thorough documentation by the local media. Statistics have also shown that 92 percent of lightning-related fatalities occur during May through September, and 73 percent of these events occur during the afternoon and early evening. Approximately 30 percent of persons struck by lightning die and 74 percent of lightning strike survivors have permanent disabilities.

Recent Events (2011-2021)

A total of 94 severe weather events have been recorded in Kenosha County between 2011 and 2021. This total includes thunderstorm winds, strong winds, hail, and lightning. These events are documented in Table 3.13, based upon data published by the National Climatic Data Center. As shown in Table 3.13 these storms can range from one to two events per year or up to 10 events per year, which demonstrates the high unpredictability of these storms. In total, these severe thunderstorm events have resulted in 2 deaths, 2 injuries, and over $868,000 in property and crop damages within Kenosha County. A few examples of recent events from Table 3.13 are noted below.

2011 – A large supercell thunderstorm, just offshore over Lake Michigan, produced strong outflow winds that moved into far southeastern Milwaukee County, and eastern sections of Racine and Kenosha counties during the evening of June 30, 2011. Law enforcement officials reported numerous trees and power lines down across far eastern Kenosha County from severe thunderstorm winds that gusted up to 75 mph as estimated by a trained spotter. A 31-year-old man riding a motorcycle was killed when a tree blew over on him in the 7600 block of 25th Avenue in the City of Kenosha. A Pleasant Prairie woman injured her hip when she was struck by debris from a shed. Two other residents of the City of Kenosha were injured when they touched live wires brought down by the strong winds. Many large branches were also broken off by the powerful winds, which also damaged several homes. Officials estimate 500 to 800 trees were destroyed or badly damaged by the winds. At one point, over 27,000 customers were without power in southeastern Wisconsin, many for several days. Property damages from this storm were estimated at over $123,000 (2021 dollars).

2013 – On November 17th, strong west winds along and behind a cold front gusted to 35 to 55 mph across southern Wisconsin. A man was killed in Kenosha County when a strong wind gust forced him to lose control of his motorcycle. No property damage from this storm was reported.

2014 – On July 12th, a small segment bow echo ahead of a cold front accelerated east across Kenosha County. A mesovortex developed along the leading edge of the bow echo and produced a 3.6 mile west to east path of significant straight line wind damage. The most concentrated damage was just south of Highway 50 and east of Green Bay Road. Numerous large trees snapped and uprooted. A large tree fell on a home, many privacy fences were destroyed, and shingle damage to approximately eight homes was reported. Property damages from this storm were estimated at over $83,000 (2021 dollars).

Vulnerability and Community Impact Assessment

The National Weather Service can forecast and track a line of thunderstorms that may be likely to produce severe high winds, hail, lightning, and tornadoes, but where these related hazards form or touch down and how powerful they might be, remains unpredictable and the locations of storm impact points are widely scattered throughout the County.

In order to assess the vulnerability of the Kenosha County area to severe thunderstorm-related hazards, a review of the community assets described in Chapter 2 indicate the potential for significant thunderstorm and related hazard impacts to: 1) a variety of residential, commercial, and other developed land uses; 2) agricultural lands; 3) roadway transportation system; 4) utilities; 5) critical community facilities; and 6) historic sites. Significant impacts may also be possible to other infrastructure or utility systems, or hazardous material storage sites.

On average, the events occurring over the period of 2011-2021 have resulted in about $9,240 of total reported damages per event in the County. However, many events had no damages reported to the NCDC, and very few events have been responsible for a large percentage of the total damages. Thus, the average damage cost is considered to be only a very approximate measure of potential damages. On average, there are 8.5 thunderstorm and related storm events per year in Kenosha County. Over this same period, thunderstorms and related storm hazards have resulted in an average of about $78,961 in property damages per year (2021 dollars). Due to the unpredictability of severe thunderstorms that include high straight-line winds, hail, and lightning events, all buildings, infrastructure, and critical facilities within the County are considered at risk.

Future Changes and Conditions

Based upon recent historical data from the period 2011-2021, Kenosha County can expect to experience averages of 3.6 thunderstorm wind events per year, 1.5 hail events per year, and 2.9 non-thunderstorm high-wind events per year somewhere in the County. It should be noted that the historical record shows considerable variation among years in the numbers of these events that occurred. While it would be expected that in some years the County will experience either fewer events or more events than the average number, the average annual number of events is not expected to change.

The likely effect of climate change on severe weather events is not clear. While projections based upon downscaled climate model results indicate that the magnitude and frequency of heavy precipitation events are likely to increase by the middle of the 21st century, they do not address potential trends in wind, hail, or lightning conditions. Modeling studies utilizing the output of multiple climate models suggest that number of days per year in which atmospheric environments that are known to support the formation of severe thunderstorms under current climatic conditions will increase between now and the end of the 21st century.[17] It should also be noted that wind strengths over the Great Lakes have increased and are expected to continue increasing in the future.[18] Surface wind speeds above the Lakes are increasing by about 5 percent per decade, exceeding trends in wind speed over land.

Changes in land use can have an impact on the potential for damage to occur from severe weather events. Such changes relate to the potential future increase in development within the County. Changing land use patterns within Kenosha County, as documented in the adopted regional land use plan and County land and water resource management plan and summarized in Chapter 2, indicate a potential increased risk of thunderstorm-related damage and related losses in the expanding urbanized areas within the County. Because of the actions that have been taken by the County and local units of government and individuals, the current vulnerability to thunderstorms and related hazards has decreased in recent years. These ongoing mitigation measures are described further in Chapter 5.

Multi-Jurisdictional Risk Management

Based upon a review of the historic patterns of severe thunderstorm-related hazards that include high straight-line wind, hail, and lightning events in Kenosha County, there are no specific municipalities that have unusual risks. Rather, the events are considered to be relatively uniform and of countywide concern.

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[17] Noah S. Diffenbaugh, Martin Scherer, and Robert J. Trapp, "Robust Increases in Severe Thunderstorm Environments in Response to Greenhouse Forcing," Proceedings of the National Academy of Sciences, Volume 110, pages 16,361-16366, 2013.

[18] Ankur R. Desai, Jay A. Austin, Val Bennington, and Galen A. McKinley, "Stronger Winds Over a Large Lake in Response to Weakening Air-to-Lake Temperature Gradient," Nature Geoscience, Volume 2, pages 855-858, 2009.

Extreme Heat

The Centers for Disease Control and Prevention (CDC) reports that nationwide between 2018 and 2020, a total of 3,066 heat-related deaths occurred.[19] Excessive heat has become the deadliest hazard in Wisconsin. According to the National Weather Service, 22 people have died in Wisconsin directly as a result of heat waves from 2011 to 2021. Temperature data for two selected observation stations in the Cities of Kenosha in Kenosha County and Burlington in neighboring Racine County are shown in Table 3.14. The table shows extreme high and low temperatures and the departure from average annual temperatures recorded in the period from 2011 through 2021. The average high and low extreme temperatures for these two stations for the period 2011-2021 are 95.7°F and -9.3°F for the City of Kenosha and 93.2°F and -11.1°F for the City of Burlington during this period. Prolonged exposure to these extreme temperatures could present a significant danger. It should be noted that Lake Michigan may be exerting some effect on average annual temperatures but does not appear to be reducing the average extreme high temperature.

Heat and humidity together can create the most severe problems to human health. High humidity makes heat more dangerous because it slows the evaporation of perspiration, which is the body's natural cooling process. The Heat Index (HI) is a measure of discomfort and the level of risk posed to people in high-risk groups by heat and humidity. The HI is expressed in degrees Fahrenheit (°F) and incorporates an adjustment to the air temperature for relative humidity (RH). For example, if the air temperature is 94°F and the RH is 55 percent, the HI would equal about 106°F (see Figure 3.2). Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. The level of risk to people in high-risk groups associated with different levels of the HI is shown in Table 3.15. The NWS will initiate alert procedures (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat wave determines whether advisories or warnings are issued. High temperature periods are often also accompanied by the related air quality problems related to ground-level ozone which can be harmful, especially to sensitive groups, such as active children and adults with respiratory problems.

The following definitions/criteria for extreme heat events are used for the 20 counties in south-central and southeastern Wisconsin served by the Milwaukee/Sullivan Weather Forecast Office.

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[19] Merianne R. Spencer and Matthew F. Garnett., "QuickStats: Percentage Distribution of Heat-Related Deaths, by Age Group – National Vital Statistics System, United States, 2018-2020". MMWR Morbidity and Mortal Weekly Rep 2022; 71:808. June 17, 2022.

- **Outlook Statement**—Issued two to seven days prior to the time that minimal Heat Advisory or Excessive Heat Warning conditions are expected. Serves as a long-term "heads-up" message.

- **Excessive Heat Watch**—Issued 24 to 48 hours in advance when Excessive Heat Warning conditions are expected.

- **Heat Advisory**—Issued six to 24 hours in advance of any 24-hour period in which daytime heat indices are expected to be 100° to 104°F, or 95°-99°F for four or more consecutive days, and nighttime heat indices are greater than or equal to 75°F. Advisories are issued for less serious conditions that cause significant inconvenience and, if caution is not exercised, could lead to situations that may threaten life.

- **Excessive Heat Warning**—Issued six to 24 hours in advance of any 48-hour period in which daytime heat indices are expected to exceed 105°F for three or more hours, and nighttime heat indices are greater than or equal to 75°F. In addition, if Heat Advisory conditions are expected to persist for four or more days, then an Excessive Heat Warning will be issued. Warnings are issued for weather conditions posing a threat to life.

During extended periods of very high temperature, coupled with high humidity levels, individuals can suffer a variety of ailments, including heat cramps (muscular pains and spasms due to heavy exertion). Although heat cramps are the least severe heat-related ailment, they are an early signal that the body is having trouble with the high temperatures. Heat exhaustion typically occurs when people exercise heavily or work in a hot, humid place where body fluids are lost through heavy sweating. Blood flow to the skin increases, causing blood flow to decrease to the vital organs. This results in a form of mild shock. If not treated, the victim may suffer heat stroke. Heat stroke is life threatening and requires immediate medical attention. The victim's temperature control system, which produces sweating to cool the body, stops working. The body temperature can rise so high that brain damage and death may result if the body is not cooled quickly. Sunstroke is another term for heat stroke. In addition to posing a public health hazard, periods of excessive heat usually result in high electrical consumption for air conditioning, which can cause power outages and brown outs.

Most heat-related deaths occur in cities. Large urban areas become "heat islands." Brick buildings, asphalt streets, and tar roofs store and radiate heat like a slow burning furnace. Heat builds up in a city during the day and cities are slower than rural areas to cool down at night. The amount of sunshine is an important contributing factor in urban heat waves. In addition, the stagnant atmospheric conditions associated with a heat wave trap ozone and other pollutants in urban areas. The worst heat disasters, in terms of loss of life, happen in large cities when a combination of high daytime temperatures, high humidity, warm nighttime temperatures, and an abundance of sunshine occurs for a period of several days. There are also socioeconomic problems that make some urban populations at greater risk. The elderly, disabled, and debilitated are especially susceptible to heat-related illness and death.

Recent Events

Extreme heat that affects Kenosha County are not localized events, as they usually encompass the entire south-central to southeastern portion of the State and may continue for several days or weeks. Table 3.16 lists the extreme heat events in southeastern Wisconsin from 2011-2021. A few examples of recent events from Table 3.16 are noted below.

2012 – The July 3 through 6, 2012, heat wave was one of the three worst heat waves to affect Wisconsin. Locally a hot air mass settled over southern Wisconsin on July 3, bringing 100-degree heat to many locations for multiple days. While humidity levels were relatively low, maximum heat indices reached between 100°F and 115°F during this hot spell. Daily maximums temperatures at the Kenosha Regional Airport reached 105ºF on July 4, 106ºF on July 5, and 102ºF on July 6. Numerous new daily record highs were set as well as record high daily minimum temperatures. Deaths directly related to the heat were reported in Dane and Milwaukee Counties and deaths in which heat was a contributing factor were reported in Rock and Walworth Counties. Based on news reports hundreds of people received medical treatment at hospitals or clinics due to heat-related illnesses; however, the exact number is unknown. Buckled road pavements were noted and wildlife specialists reported some fish and bird die-offs as water temperatures in inland lakes and rivers increased.

Another round of dangerous heat affected southern Wisconsin on July 25, 2012. High temperatures of between 98° and 101°F combined with dew points near 70 to produce heat index values between 100° and 108°F across all of south-central and southeastern Wisconsin. This heat wave resulted in the sixth day in 2012 with maximum temperatures reaching or exceeding 100°F in several counties. The maximum heat index value in Kenosha County reached 109°F.

2018 – On June 29th, hot and humid conditions produced heat index values ranging from 100° to 110°F. Numerous cooling centers were opened by local communities throughout southern Wisconsin. Some public swimming pools hours were extended due to the heat. The heatwave continued into July 1st.

Vulnerability and Community Impact Assessment

Heat extremes are primarily a public health concern. The poor and elderly are much more susceptible to temperature-related deaths and injury. Education, improved social awareness, and community outreach programs have likely helped to reduce the number of individuals killed or injured by extreme temperature events. Those at greatest risk are the very young, the very old, and the sick. Most deaths during a heat wave are the result of heat stroke. Large and highly urbanized cities can create an island of heat that can raise the area temperature by 3ºF to 5ºF. Therefore, urban communities with substantial populations of elderly, disabled, and debilitated people could face a significant medical emergency during an extended period of excessive heat. Some residents in high crime areas, especially the elderly, are afraid to open windows or go out to cooling shelters. As neighborhoods change, some older residents become isolated because of cultural, ethnic, and language differences.

The Building Resilience Against Climate Effects (BRACE) program in the Wisconsin Department of Health Services has compiled heat vulnerability index maps for the State and each county. The results of the Kenosha County heat vulnerability index are shown in Figure 3.3. The heat vulnerability index is based on multiple indicators associated with risk for heat-related illnesses and mortality including health factors, demographic and household characteristics, natural and built environment factors, and population density. As indicated in Figure 3.3, areas within Kenosha County that have the highest vulnerability to an extreme heat event include portions of the City of Kenosha, Village of Pleasant Prairie, and Village of Somers.

High demands for electricity can result in black outs and brown outs. Loss of water pressure can result from opening of fire hydrants in urban areas. Stagnant atmospheric conditions that occur with heat waves are also favorable for trapping ozone and other pollutants in urban areas. Pets and livestock can suffer from prolonged exposure to excessive heat. Although there has been no reported deaths, injuries, or damages between 2011 and 2021, on average, there are about 1.3 extreme heat events per year in Kenosha County that can still have an impact on people, pets, and other forms of life.

A review of the community assets described in Chapter 2 indicate the potential for extreme heat hazard events to impact: 1) residents at a countywide level, especially the poor, elderly, and sick, 2) agricultural croplands; 3) pets and livestock; 4) municipal water and electric utilities; and 5) natural surface and groundwater reserves.

Future Changes and Conditions

Based upon recent historical data, Kenosha County can expect to experience an average of 1.3 extreme heat events per year. It should be noted that the historical record shows considerable variation among years in the numbers of these events that occurred. While it would be expected that in some years the County will experience either fewer events or more events than the average number, the average annual number of events is not expected to change over the five-year term of this plan update.

The projections based on downscaled results from climate models indicate that there will likely be substantial changes in the frequencies of extreme heat events over the 21st century. Extreme heat events are likely to occur more frequently and to be more severe by the middle of the century. As previously described in Chapter 2, average summertime temperatures in Kenosha County are projected to increase by 6.0°F to 7.0°F by year 2055.[20] The number of days per year in which temperatures in southern Wisconsin exceed 90°F is expected to triple by 2055. Given that much of the documented increases in average temperature since 1950 have occurred through increases in night-time low temperatures, it is likely that there will be fewer night-time breaks in the heat during extreme heat events in the future. This could result in some extreme heat events persisting longer. Heat waves have direct impacts on human health, especially among sensitive populations such as the young children and the elderly. In the absence of mitigative measures, the projected increase in the frequency, duration, and severity of heat waves will be likely to cause increases in fatalities and illnesses related to extreme heat.

Multi-Jurisdictional Risk Management

Based upon a review of the historic patterns of extreme heat events in Kenosha County, there are no specific municipalities that have unusual risks. Rather, the events are of a uniform countywide concern.

Extreme Cold

Like extreme heat, extreme cold is also a deadly hazard. The CDC reports that the death rate of excessive cold as the underlying cause ranges from 1 to 2.5 deaths per million people and over 19,000 people have died from exposure to cold since 1979.[21] Exposure to extreme cold temperatures can also cause a number of health conditions and can lead to loss of fingers and toes; or cause permanent kidney, pancreas, and liver injury, and even death. These health impacts often result from a combination of cold temperatures, winds, and precipitation. As a result, winter storms can pose substantial risks because they can last for several days

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[20] *Wisconsin Initiative on Climate Change Impacts, 2021, op. cit.*

[21] *CDC, 2018.*

and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. In addition, when deaths and injuries due to cold-related vehicle accidents and fatalities, fires due to dangerous use of heaters, carbon monoxide poisoning due to use of nontraditional sources of heat such as cooking ovens, and other winter weather fatalities are considered, the impact of severe cold periods becomes even greater.

Frostbite and hypothermia are two major health risks associated with severe cold. Frostbite is an injury caused by freezing of the skin and underlying tissues. Frostbite causes a loss of feeling and a white or pale appearance in extremities. Severe frostbite can damage skin and underlying tissues and requires medical attention. Potential complications of severe frostbite include infection and nerve damage. Frostbite is most common on fingers, toes, nose, ears, face, and chin. While exposed skin in cold, windy weather is most vulnerable to frostbite, this injury can also occur on skin covered by gloves or other clothing.

Hypothermia is a condition brought on when the core body temperature drops to less than 95°F. It occurs when the body loses heat more quickly than it is able to produce it. As with frostbite, wind or wetness can contribute to producing hypothermia. Symptoms of moderate to severe hypothermia include lack of coordination, slurred speech, confusion, drowsiness, progressive loss of consciousness, weak pulse, and shallow breathing. Hypothermia may cause lasting kidney, liver, and pancreas problems or death. Members of certain populations are particularly vulnerable to hypothermia. These include older adults, infants and very young children, the homeless, persons consuming alcohol or other drugs, and persons taking certain medications.

Wind chill is an index used to evaluate the risk posed by the combination of cold temperatures and wind. It is based on temperature and wind speed. Table 3.17 shows the wind chill table used by the National Weather Service. Wind chill is not the actual temperature, but rather a measure of how the combination of wind and cold feel on exposed skin. As the wind increases, heat is carried away from the body at an accelerated rate, driving down the body temperature. This combination can strongly affect the risks associated with exposure to extreme cold. For example, a wind chill of -20°F will cause frostbite on exposed skin in just 30 minutes.

The National Weather Service issues wind chill advisories when wind chill temperatures are potentially hazardous and wind chill warnings when wind chill temperatures are life threatening. The exact criteria of a wind chill advisory and warning varies from state to state. A wind chill advisory in Wisconsin is issued when wind chill values reach -20°F to -34°F, with wind speeds of 4 mph or more. A wind chill warning in Wisconsin is issued when wind chill values will reach -35°F or colder, with wind speeds of at least four mph for three hours or more. In addition, a wind chill watch is issued 12 to 48 hours before these conditions are expected to occur.

What constitutes extreme cold varies in different parts of the country. In the south, near freezing temperatures are considered extreme cold. Freezing temperatures can cause severe damage to citrus fruit crops and other vegetation. Pipes may freeze and burst in homes that are poorly insulated or without heat. In the north, extreme cold means temperatures well below zero. Winter residents in Kenosha County may see heavy snow, strong winds/blizzards, extreme wind chill, lake-effect snow, and ice storms. The public can stay informed by listening to NOAA Weather Radio, commercial radio or television for the latest winter storm warnings and watches.

Recent Events

Extreme cold that affects Kenosha County are not localized events, as they usually encompass the entire south-central to southeastern portion of the State and may continue for several days or weeks. Between 2011 and 2021, three deaths and no injuries were reported in the County as a result of extreme cold temperatures. Table 3.18 lists the extreme cold events in Kenosha County from 2011-2021. A few examples of recent events from Table 3.18 are noted below.

2013 – On January 21st, arctic air spread into southern Wisconsin behind deep low pressure that tracked to the north of the state. High winds combined with surface temperatures in the single digits below zero to produce wind chills between -20°F to -30°F. The frigid wind chills began the morning of January 21 and continued into the morning hours of January 22. This was one of the relatively few times Milwaukee recorded a low temperature below zero without having a snow cover.

2014 – On January 27th, an arctic cold wave affected southern Wisconsin. West to northwest winds of 10 to 20 mph with the passage of an arctic cold front brought wind chill temperatures of -20°F to 38°F beginning in the early morning of January 27. These wind chills did not end until the morning of January 29. The coldest period was the morning of January 28 when wind chills ranged from -30°F to -38°F. Widespread school and business closings occurred during this time. The Governor declared a state of emergency due to a propane shortage across the state. Numerous water main breaks and frozen laterals continued to occur throughout the entire month of January.

2019 – On January 29th, a surge of historically cold arctic air settled over southern Wisconsin. Windy conditions and low temperatures in the -20s°F to -30s°F resulted in wind chill temperatures of 35 below to

55 below zero for much of this period. Widespread government, school, and business closings were common on January 30-31st. The United States Postal Service suspended mail delivery on January 29-30th. Many water main breaks and power outages occurred.

Vulnerability and Community Impact Assessment

Similar to extreme heat, extreme cold is primarily a public health concern, with the poor and elderly being much more susceptible to extreme temperature-related deaths and injury. Pets and livestock can also suffer from prolonged exposure to excessive cold. Severe cold temperatures can cause breaks in water mains that can interrupt water supply. The impacts of a water main break depend on the size and location of the main. Frozen service laterals can also interrupt water supply to individual buildings. Water main breaks can be costly to municipalities. On average, there are about 1.5 extreme cold events per year in Kenosha County.

A review of the community assets described in Chapter 2 indicate the potential for extreme cold hazard events to impact: 1) residents at a countywide level, especially the poor, elderly, and sick, 2) agricultural croplands; 3) pets and livestock; 4) municipal water and electric utilities; and 5) natural surface and groundwater reserves.

Future Changes and Conditions

As mentioned previously, Kenosha County can expect to experience an average of 1.5 extreme cold events per year. It should be noted that the historical record shows considerable variation among years in the numbers of these events that occurred. While it would be expected that in some years the County will experience either fewer events or more events than the average number, the average annual number of events is not expected to change over the five-year term of this plan update.

The projections based on downscaled results from climate models indicate that there will likely be substantial changes in the frequencies of extreme cold events over the 21st century.[22] The frequency of extreme cold events may decrease by the middle of the century. Projected warming trends are expected to be greatest during the winter with average winter temperatures in Kenosha County projected to increase by about 7.5°F. This may result in a reduction of some risks associated with extreme cold.

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[22] *Wisconsin Initiative on Climate Change Impacts, 2021, op. cit.*

Multi-Jurisdictional Risk Management

Based upon a review of the historic patterns of extreme temperature events in Kenosha County, there are no specific municipalities that have unusual risks. Rather, the events are of a uniform countywide concern.

Lake Michigan Coastal Hazards

The Lake Michigan coast of Kenosha County consists of about 15.4 miles of shoreline, encompassing portions of three local units of government, including the City of Kenosha and the Villages of Pleasant Prairie and Somers. The portion of the Lake Michigan shoreline lying within the jurisdiction of each of these general-purpose local units of government is shown in Table 3.19.

There are three types of Lake Michigan coastal hazards of concern that pose risk to Kenosha County:

- **Erosion of Coastal bluffs, beaches, and near shore lake beds**

- **Coastal Flooding** from high Lake Michigan levels and/or storm surge and storm-induced waves (i.e., wave run-up) causing damage to structures such as residences, businesses, and public facilities

- **Damage and failure of shoreline protection structures** (revetments[23], seawalls, and groins[24]) from wave action, storm surge, and varying lake levels

The main focus of this vulnerability assessment will be on the first two types of coastal hazards noted above: erosion of coastal bluffs and beaches and coastal flooding from high Lake levels and/or storm surge. With regard to the third hazard listed above for damage and failure of shoreline protection structures, there are assets in the County, primarily in the City of Kenosha, that are protected by riprap revetments, groin-beach systems, bulkheads, and breakwater systems. However, the designs of these shore protection structures, most notably those protecting the City sewage treatment and water plants and the marina facilities, have

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[23] Revetments are sloping structures placed on banks or cliffs in such a way as to absorb the energy of incoming water (i.e., wave impact). Many materials may be used such as wooden piles, loose-piled boulders (i.e., riprap), concrete shapes, or geotextile fabric sandbags.

[24] A groin is a narrow structure (i.e., breakwater and/or jetty) built out into the water from a beach in order to prevent beach erosion or to trap and accumulate sediments that would otherwise drift along the beach face. A groin can be successful in stabilizing a beach on the up-drift side, but erosion tends to be aggravated on the down-drift side.

applied standards suitable for major public and private facilities. In addition, the structures are maintained as needed.

It is important to note that shoreline protection structures have been known to contribute to coastal problems by decreasing, or preventing, natural erosion of littoral material (lake bottom near shore) such as sand and gravel from existing shorelines. Additionally, these structures can disrupt the natural flow and deposition of those sediments along the lake shore, affecting beach ecosystems. Some shoreline protection structures may redirect wave energy to adjacent shorelines, which can increase the potential for erosion at neighboring sites.[25]

Nearly 80 percent of Wisconsin's Lake Michigan shoreline is affected by coastal erosion and bluff recession to some degree, and recurring erosion presents a significant risk in almost every coastal county. The terms recession and erosion are often used interchangeably. Recession is the landward movement of a land feature, such as a bluff crest, while erosion is the wearing away of land. Recession is expressed as distance or a change in distance, while erosion is expressed as a volume or change in volume. Recession can be thought of as a consequence of erosion. Shoreline recession rates are usually determined by comparing aerial photographs taken on different dates.

The rate at which coastal erosion occurs is dependent on a variety of factors including Lake Michigan level fluctuations, disruption of the transport of beach-building sediments, elevated groundwater levels, storms, and surface stormwater runoff. Additional contributing factors to coastal erosion can include soil composition, vertical cracks in the upper slope of the soil, shoreline ice cover, freezing and thawing cycles, shoreline orientation, beach composition, beach width and slope, the presence or absence of shore protection, and the type of shore protection.[26] Shores that have cohesive materials, such as clay, till, and bedrock have strong binding forces. Shores that have non-cohesive materials, such as sand and/or gravel have weak or no binding forces. Like most of the Great Lakes Region, the soils in Kenosha County are composed of sand, gravel, clay, and clay-like material known as glacial till. Much of the bluffs along the

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[25] *University of Wisconsin Sea Grant,* Great Lakes Coastal Shore Protection Structures and Their Effects on Coastal Processes, *2013*.

[26] *U.S. Army Corps of Engineers-Detroit District, University of Wisconsin Sea Grant,* Living on the Coast: Protecting Investments in Shore Property on the Great Lakes, *2003*.

Kenosha County coast are relatively high (50-200 feet) and are prone to landslides, slumping, surface rill erosion, and soil creep.[27]

Lake Level Fluctuations

Lake level can be a significant factor in determining the rate of erosion along the Wisconsin Lake Michigan coasts. As mentioned above, high Lake levels and increased wave action can worsen both coastal erosion and coastal flooding issues. As Lake levels rise, bluff recession rates can also increase. Major storm events can also lead to high erosion rates because of increased wave action on the shoreline. The effects of wave-induced erosion are usually greater during periods of high Lake levels. Conversely, low Lake levels pose problems for facilities that are dependent on constant access to water, such as ports, marinas, and nearshore water utility intakes. Low water levels can also cause problems with shore protection structures, such as normally submerged timber pilings being exposed to air.

Water levels in the Great Lakes fluctuate seasonally, annually, and over multi-decade cycles. Seasonally, the lakes are at their lowest levels during the winter, when much of the precipitation is held on land in the form of snow and ice, and evaporation occurs only over open water. The highest seasonal levels are typically during the summer when snowmelt from the spring thaw and summer rains contribute to the Lake water supply. For Lake Michigan in the 30-year-period between 1991-2021, the average difference between summer high water levels and winter low water levels has been about one foot.[28] Long-term variations in Lake levels (over multi decades) depend on climatic factors such as precipitation, the presence or absence of ice cover on the Lake during the winter, and evaporation of water from the Lake.

Coastal hazard problems have been most evident in southeastern Wisconsin and Kenosha County during high water periods. These have occurred in recent history on Lake Michigan in the early 1950s, the early 1970s, and the mid-1980s, with water levels in 2019 approaching the record set in 1986. As of November 2021, Lake Michigan water levels continued their seasonal decline, decreasing by about 3 inches from October to November. Though Lake Michigan is about 25 inches below the highest monthly water level recorded for November in 1986, the Lake is still about 13 inches above the long-term average water level

[27] Soil creep (also known as downhill creep, or creep) is the slow and subtle downward progression of rock and soil down a low grade slope.

[28] This is a calculated average from monthly water levels obtained from the National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory.

as of November 2021. Water levels are expected to continue their seasonal decline through the early winter but remain above the long-term average.[29]

Shoreline Recession and Bluff Stability Conditions

An inventory of the shoreline conditions and bluff stability within the entire Southeastern Wisconsin Region was conducted in 1977[30] by a number of coastal technical consultants under the Wisconsin Coastal Management Program (WCMP) and again in 1995 for a study done by SEWRPC in conjunction with the WCMP.[31] The latter study found bluff recession rates of up to nine feet per year over the period 1963 to 1995, with an average of 1.8 feet per year. Similarly, erosion rates of up to eight feet per year, with an average of 1.1 feet per year were found for the period 1975 to 1995. In general, the study found bluff stability had improved compared to 1977 conditions. This is likely due to the construction of shoreline protection measures in areas of development. The 1997 study also reported relatively stable conditions for the most part in areas where shoreline development exists in Kenosha County. However, there is the potential for shoreline and bluff erosion to impact structures over the long term. One area with an unstable bluff was found to be located on the shoreline in the northern part of the County. In addition, during severe climatic conditions, such as high water levels or saturated ground conditions, larger episodic bluff erosion events could occur. The 1997 study also noted the importance of offshore lake depths, as increases in offshore depths can cause increased shore erosion problems. At the five sites in Kenosha County where offshore bathymetry was measured in 1995 and compared to 1977 data, changes in depths were not definitive. However, at the seven sites in neighboring northern Racine County where offshore bathymetry was measured, four sites showed significant improvement in shore erosion conditions with decreases in depth, while the others showed little change.

Wisconsin Shoreline and Oblique Photo Viewer

WCMP, the Association of State Floodplain Managers (ASFPM), and Geo-Professional Consultants, LLC have developed a web mapping tool to view shoreline conditions along most of Wisconsin's Great Lakes coast.

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[29] *Collaborative Action for Lake Michigan (CALM) Coastal Resilience Monthly Newsletter, November 2021.*

[30] *D.M. Mickelson, L. Acomb, N. Brouwer, T.B. Edil, C. Fricke, B. Haas, D. Hadley, C. Hess, R. Klauk, N. Lasca, and A.F. Schneider,* Technical Report, Shoreline Erosion and Bluff Stability Along Lake Michigan and Lake Superior Shorelines of Wisconsin, *Wisconsin Coastal Management Program, February 1977.*

[31] *SEWRPC Technical Report No. 36,* Lake Michigan Shoreline Recession and Bluff Stability in Southeastern Wisconsin: 1995, *December 1997.*

The Wisconsin Shoreline Inventory and Oblique Photo Viewer (shoreline viewer tool)[32] can be used to view and compare assessments on shoreline protection and shore and bluff conditions. Shoreline characteristics and conditions were derived from interpretation of oblique aerial photography of the Lake Michigan coastline taken in 1976 and 2007, performed by David M. Mickelson.[33] It should be noted that these interpretations represent conditions on the date that these photographs were taken and are limited by what can be seen in the photos.

In addition, geotagged oblique images can be viewed and compared on the shoreline viewer tool from 1976, 2007, 2010, 2017, 2018, 2019, 2020, and 2021. These images can be used with the interactive mapping tool to understand and evaluate how bluffs along the Kenosha County coast have changed over time.

Map 3.8 summarizes an assessment of the types of shore protection in the County in 2018-2019, as provided on the shoreline viewer tool. Nearly 17 percent of the shoreline in Kenosha County was unprotected in 2018-2019. The most common type of shore protection in the County was revetment (43.4 percent); followed by poorly organized rip-rap or rubble (30.1 percent); public marina (7.3 percent); seawall or bulkhead (2.5 percent); and private marina (0.1 percent).

The shoreline viewer tool also provides insight into current general conditions of Lake Michigan bluffs in 2018, as shown in Map 3.9. In 2018, 77.9 percent of the Kenosha County shoreline did not contain bluffs, and 9.9 percent of the shoreline was considered to have moderately unstable to unstable/failing bluffs (as shown in black and red on Map 3.9). According to the assessment, bluffs considered to be unstable or failing were all located in the Village of Somers. Map 3.10 specifies the types of bluff failure that were occurring at the time of the 2018-2019 assessment. Shallow slides were the most common type of bluff failure, occurring at 13.3 percent of the assessed County shoreline, followed by creep failure (0.3 percent), and 8.4 percent of the coastline showed no obvious failures.

Long-Term and Short-Term Bluff Toe and Bluff Crest Recession

A recent analysis by the University of Wisconsin-Madison Coastal Sustainability and Environmental Fluid Mechanics Laboratory is also available to view on the shoreline viewer tool. The study measured long-term (1956-2015) and short term (1995-2015) bluff toe recession, bluff crest recession, and general shoreline

[32] *Floodatlas.org/asfpm/oblique viewer.*

[33] *Mickleson, D and Stone J,* Wisconsin's Lake Superior and Lake Michigan Shoreline Oblique Photography: Analysis of Changes 1976 (78) to 2007 (08), A Report to the Wisconsin Coastal Management Program, *2012*.

recession along the shores of Kenosha, Milwaukee, Ozaukee, and Racine Counties.[34] Bluff recession distances were measured from historical aerial photos in Geographic Information Systems (GIS) software. The bluff crest, bluff toe, and shoreline were carefully traced on each aerial photo. The bluff crest is identified as the break in slope between the upland and the bluff slope; the bluff toe is identified as the break in slope between the bluff slope and the beach; and the shoreline is defined as the location that appears as the interface between the water and land at the time the photo was taken (see Figure 3.4). Data in Maps 3.11 through 3.14 show recession distances that have been spatially averaged along 300-foot sections of the coast. The data therefore represent average recession over a distance wider than a typical parcel or shoreline frontage and should not be interpreted as recession at a specific property.

This recession analysis can provide useful insights into the historic migration of the Lake Michigan coast in Kenosha County. It should be noted that bluff recession can be sporadic. A bluff crest that remained unchanged for decades can recede many feet almost instantly due to a bluff collapse. This analysis represents how the bluffs have responded to historical environmental conditions and human actions over a specific time period. There will always be uncertainty in how bluff and shoreline recession will respond to future conditions.

Long-Term Bluff Toe and Crest Recession

As shown in Map 3.11, about 7.1 percent of the bluff toe in Kenosha County has experienced at least some recession in the 59-year long term period from 1956 to 2015. Furthermore, about 1.8 percent of the County's bluff toe was estimated to have experienced significant recession of at least 20 feet, mostly observed in the in Village of Somers in the northern portion of the County. It is estimated that about 92.9 percent of the bluff toe in the County has experienced accretion, or has moved towards the Lake. It should be noted that accretion or small bluff toe recession distances may represent areas where the bluff crest has slumped towards the shoreline or where the construction of shore protection structures has advanced the bluff toe lakeward.

Map 3.12 shows long term bluff crest recession distances in the County. About 22.2 percent of the bluff crest in Kenosha County has experienced at least some recession, with 13.0 percent experiencing at least 20 feet of retreat, and 1.8 percent experiencing more than 60 feet of recession, mostly observed in the

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[34] This study was funded by the Wisconsin Coastal Management Program and the National Oceanic and Atmospheric Administration, Office for Coastal Management.

Village of Somers. About 77.8 percent of the bluff crest in the County has had no recession or has experienced accretion, possibly due to fill added to the bluff in a slope stabilization project.

Short-Term Bluff Toe and Crest Recession

As shown in Map 3.13, about 43.9 percent of the bluff toe in Kenosha County has experienced at least some recession in the 20-year period from 1995 to 2015, with most of that percentage experiencing 0 to 10 feet of bluff toe retreat. It is estimated that 5.3 percent of bluff toe in the County has not seen any recession and 50.8 percent has experienced accretion. Again, it should be noted that bluff toe accretion may represent areas where material has slumped from the bluff crest above.

Map 3.14 shows short term bluff crest recession distances in Kenosha County. About 9.3 percent of bluff crest data collected in the County has shown at least some recession in the 20-year short term period, and 3.7 percent has experienced at least 10 feet of recession. Conversely, 18.5 percent of the bluff crest in Kenosha County has experienced no recession and 72.2 percent has experienced accretion during this short-term period.

Coastal Flooding

Coastal flooding tends to be most serious in the low-lying areas.[35] The risk of coastal flooding is reduced when lake levels are low, however other factors such as storm-induced winds and wave run-up can cause or exacerbate coastal flooding. Likewise, when lake levels are high, storm surge, wave height, and wave run-up also influence the severity of coastal flooding. Communities positioned on low terraces are at a medium risk of flooding, whereas communities in the County located on high bluff areas are not vulnerable to coastal flooding.[36]

Based on a SEWRPC parcel-based analysis, there were seven parcels with structures (all residential and located in the Village of Pleasant Prairie) identified within the Lake Michigan 100-year recurrence interval floodplain (special flood hazard area). The assessed value of these structures in 2021 was estimated at about $1.6 million and more than $2.3 million when the value of contents is considered. The location of the parcels with structures within the flood hazard areas are shown on Map 3.15. Because of their proximity to the Lake and low lying position, these identified structures are vulnerable to coastal flooding and its associated hazards such as storm-induced winds or wave run-up. It is estimated that in the event of 100-year recurrence

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[35] *State of Wisconsin Hazard Mitigation Plan, December 2016, op. cit.*

[36] Ibid.

interval coastal flood, these structures would sustain about $290,000 in damages ($252,000 in direct damages, and $38,000 in indirect damages) (2021 dollars).

The Great Lakes Coastal Flood Study (GLCFS) is an on-going collaboration between FEMA and the U.S. Army Corps of Engineers (USACE) and will soon complete mapping for coastal flood velocity zones (V Zones) for the Great Lakes. Currently, the Lake Michigan coast has flood Zones A or AE along much of its coast, including Kenosha County. Zones A and AE are typically inland (i.e., lakes and rivers) flood zones that do not account for wave action greater than 3 feet or storm surge. Zones V and VE represent the area along the coast that is subject to inundation by the 1-percent-annual-probability flood along with additional hazards associated with wave run-up greater than 3 feet above the base flood elevation (BFE). Zones AE and VE have detailed hydraulic studies to determine the BFE (i.e., elevation data), while Zones A and V do not and are approximate flood zones. Digital Flood Insurance Rate Maps (DFIRMs) showing the new coastal V and VE Zones for Kenosha County should be available within the life span of this plan.[37]

Recent Events

2013 – Lake Michigan water levels were up an average of more than three feet since January 2013, its highest level since 1998 according to the National Weather Service. The large amount of ice cover in the winters of 2013-14 has led to less evapotranspiration, contributing to rising Lake levels.

2014 – Strengthening low pressure over the lower peninsula of Michigan in conjunction with a strong push of cold air over the relatively warm waters of Lake Michigan resulted in strong winds affecting the nearshore waters of Lake Michigan on October 31st. Wind gusts were frequently between 39 and 49 miles per hour over nearshore waters, with gusts of 54 miles per hour being reported at the City of Kenosha. These winds produced 20-foot high waves which caused considerable damage along the lakefront in the City of Kenosha. The waves pushed rocks and debris onto Kennedy Drive. While City crews were able to clean up the area, some sections of the revetment needed to have larger boulders restacked in order to obtain the required height. The cost of construction for doing this was estimated at $59,000 to $89,000 (2021 dollars). At Southport Marina, waves undermined a boat storage facility, causing its concrete floor to collapse. Waves also damaged a concrete overlook at HarborPark and a cobblestone walkway along the harbor. The costs of construction for repairing the overlook were estimated at $178,000 (2021 dollars). The greatest damage occurred at Southport Park, where waves impacted about 500 feet of shoreline. Damages included dislodging of riprap, severe erosion, and the failure of a stone revetment wall. The estimated cost to rebuild

[37] *State of Wisconsin Hazard Mitigation Plan, December 2016, op.cit.*

about 450 feet of stone revetment wall and install additional protection against erosion at Southport Park was about $600,000 to $650,000 (2021 dollars).

2018 – On April 15th, a prolonged period of strong and gusty onshore northeast winds resulted in high waves crashing into the western shore of Lake Michigan from April 13th through the 14th, and into the early morning of April 15th. Northeast winds were persistent 20 to 30 mph with frequent gusts of 35 to 45 mph for about a 24 hour period. Waves were estimated to reach 15 feet in height as they crashed into shore. These waves and high Lake levels resulted in areas of lakeshore erosion and damage from Port Washington south to Kenosha with the most erosion in the Racine and Kenosha County lake shore areas.

2019 – In the fall of 2019, lakefront erosion in the Village of Somers reached a threatening level. One home had dealt with bluff erosion along Lake Michigan for one and a half years. According to Kenosha News, an excessive amount of rain and near record Lake water levels caused a portion of the basement to slide off the bluff. Demolition of the entire property occurred the following week and cost approximately $50,000 (2021 dollars). This event was not isolated to a single home, however. Other parts of Somers experienced lakefront erosion during the multi-year high Lake level.

2020 – On January 10th, a winter storm created significant damage along the Lake Michigan shoreline. Near record high Lake Michigan water levels along with strong winds and resultant high waves peaking at 10 to 15 feet caused considerable erosion and lakeshore flood damage. Kemper Center County Park in the City of Kenosha was severely damaged due to high winds and waves. The shoreline between 71st and 76th Streets in the City of Kenosha was damaged. A sinkhole developed and caused the shoreline to collapse in two locations. Damage also occurred on the Kenosha Harbor walls and promenade due to high waves of at least 10 feet. Lakeshore flooding also closed Kenosha streets including First Avenue, 50th Street, Fourth Avenue, and 45th Street. The Village of Pleasant Prairie sustained lakeshore damage on Lake Shore Drive between 107th Street and 113th Street, impacting about 1,300 feet of shoreline. A stream outlet just north of 110th Street was buried by lakeshore flooding and erosion, which resulted in flooding on upstream properties. A 15-inch corrugated metal culvert end section required emergency excavation to alleviate the riverine flooding. Damage was also done at the South Beach area, Chiwaukee Beach, and Prairie Shores Beach. Lakeshore erosion also caused a Pleasant Prairie home to teeter on the edge of the bluff overlooking Lake Michigan. As a result of the storm, Governor Tony Evers declared a major disaster for the State of Wisconsin on February 10, 2020.

Vulnerability and Community Impact Assessment

In 2021, Wisconsin Emergency Management (WEM) conducted a county-level coastal erosion risk and vulnerability assessment for the State as part of the Threat and Hazard Identification and Risk Assessment (THIRA). WEM used the statewide parcel inventory (Wisconsin Statewide Parcel Database) as the basis for estimating the existing potential losses from Lake Michigan coastal erosion. Each parcel contained information such as total parcel value, improvement value, and property class. A GIS buffer analysis was conducted to identify parcels within one-quarter and one-half mile of the Lake Michigan coastline. Parcels within one-quarter of a mile from the coast were considered to be in a High Risk Erosion Zone, while parcels within one-half mile were considered to be in a Low Risk Erosion Zone. As a result, a total of 7,289 parcels were determined to be within the coastal risk erosion zones (see Table 3.20). Of those 7,289 total identified parcels, 6,689 were classified as residential, 587 as commercial, and 13 as manufacturing. The low-risk zone has an estimated value of improvements of nearly $790 million, while the high-risk zone has a value of improvements of more than $459 million, for a combined total value of improvements around $1.25 billion. It should be noted that the high and low risk coastal zones are solely based on distance from the Lake Michigan shoreline. Steps already taken, such as shoreline protection structures, likely have reduced the coastal hazard risk to many of these structures.

Some low-lying areas in the southern portion of the County, where bluffs are not present, have been susceptible to recent beach erosion and contain structures vulnerable to a 1-percent annual flood hazard event. Ordinances that require property owners to stabilize the bluffs along their property before building has reduced the chance of property damage in many parts of the County. As discussed above, the seven structures identified as a possible risk to coastal flooding along the low-lying coastline in the Village of Pleasant Prairie had an estimated $252,000 of potential direct damages and $38,000 potential indirect damages, for an estimated total of $290,000 in total damages for a 100-year recurrence interval storm event (2021 dollars).

A review of the community assets described in Chapter 2 indicate the potential for coastal hazard impacts to: 1) flood prone residential, commercial, and other developed land uses; 2) agricultural lands; 3) a limited extent of the roadway transportation system; 4) utilities associated with the potentially impacted roadways and structures; and 5) some utilities located immediately along the lakeshore.

A review of the Lake Michigan coastal erosion conditions in Kenosha County indicates that there is a significant potential community impact as a result of the potential loss of land improvements and infrastructure in selected areas due to lakeshore erosion. A potential utility problem relates to the potential impact of extreme high lake levels on the City of Kenosha wastewater treatment plant outfall and related facility hydraulic capacity. In addition to major facility impacts, it is possible that local utilities located in road rights-of-way could be impacted if Lake erosion were to be severe enough to endanger portions of the street. No significant impacts are expected to other infrastructure or utility systems, solid waste disposal sites, or hazardous material storage sites.

A review of coastal flooding conditions within Kenosha County indicates that there is a moderate potential community impact as indicated from the potential damages to structures within the 1-percent-annual-probability flood hazard area along the southern coast of the County. However, with proper surveillance, the need to prepare for major evacuations and other emergency actions are not a significant concern given the isolated nature and the limited severity of the problems.

Future Changes and Conditions

Changes in land use can have an impact on the potential for coastal erosion hazards to occur. Such changes relate to the potential future increase in development within the erosion hazard areas, particularly when not accompanied by proper shore protection measures. Enforcement of the current zoning procedures that are in place in the coastal communities of Kenosha County call for the use of shoreline protection, bluff stabilization structural measures, and bluff setbacks for new development along portions of the Lake Michigan shoreline where urban shoreline development exists, or is envisioned, and for areas of limited development where no structural protection measures are envisioned.

As discussed in the sections above, Lake Michigan is about 13 inches above the long-term average water level as of November 2021, causing some residents in the Village of Somers to experience significant erosion and bluff recession issues. In addition, climate change may lead to more drastic fluctuations in Lake Michigan water levels. Over the five-year period covered by this plan update, Lake Michigan water levels are expected to continue to fluctuate. Potential future fluctuations in Lake Michigan water levels could lead to continued bluff failures, particularly in areas that have no shoreline protection, where shoreline protection structures are not maintained adequately, or where shoreline protection structures are not built to sufficient specifications to protect against fluctuating water levels. Mitigation measures to protect areas along the Lake Michigan coast are described further in Chapter 5.

Changes over the 20th century and projections based on downscaled results from climate models indicate that there will likely be changes affecting coastal conditions over the 21st century. Coastal areas have experienced, and are projected to experience, increases in air temperatures, increases in precipitation, especially during fall, winter, and spring months, and increases in the frequency of heavy precipitation events.[38] Wind strengths have increased over the Great Lakes and are expected to continue increasing into the future.[39] In addition, wind patterns over Lake Michigan have altered. Prevailing winds during summer months have shifted from coming from the southwest during the 1980s to coming from the east after 1990.[40] These climatic changes are expected to influence lake levels, coastal erosion, flooding, and shoreline stability, sometimes in complex ways. According to the NOAA Office for Coastal Management in 2015, "recent climate studies, along with the large spread in existing modeling results, indicate that projections of Great Lakes water levels represent evolving research and are still subject to considerable uncertainty."

For example, Lake Michigan is likely to be impacted by trends that act both to increase and to decrease water levels. Increased precipitation will increase water contributions to the Lake. At the same time, increases in temperatures will lead to increases in evaporation of water from the Lake. The projected temperature increase will also result in reduced ice cover over the winter. This affects evaporation because ice cover on the Lake acts as a cap, reducing evaporation by preventing water vapor from escaping into the air. As a result of both of these processes, evaporation from the Lake is projected to increase.[41] It should be noted that water levels in the Lake vary widely around their average, with high-water and low-water decades occurring. This variability is expected to continue.

While the hazard impacts associated with water level variations should be similar in type to those impacts currently resulting from water level variations, there may be some increase in the magnitude of these impacts. While low water levels may allow beaches and beach ridges to build and beach-anchoring vegetation to move toward the Lake, they may also adversely impact shipping, power generation, and tourism. It should be noted that long periods of low water levels may lead to erosion of the lakebed, which may allow storm-generated waves to reach farther inland when water levels rise. While high water levels may benefit communities, businesses, and industries that depend upon Great Lakes waters for commercial shipping, hydro power, recreational boating, and tourism, higher water levels with increased storm frequency and intensity could increase shoreline and bank erosion. This could increase damages to lakefront property and reduce the area of beaches.

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[38] *Wisconsin Initiative on Climate Change Impacts, 2021, op. cit.*

[39] *Desai, Austin, Bennington, and McKinnley, 2009, op.cit.*

[40] *James T. Waples and J. Val Klump, "Biophysical Effects of a Decadal Shift in Summer Wind Direction over the Laurentian Great Lakes," Geophysical Research Letters, Volume 29, pages 43-1 through 43-4, 2009.*

[41] *Wisconsin Initiative on Climate Change Impacts, 2021, op. cit.*

Several other elements of climate change may also act to intensify shoreline erosional processes. Increases in wind strength over the Lake and changes in prevailing wind direction would be likely to lead to greater offshore wave development. This would produce higher waves along the coast. Changes in several elements of climate may affect the stability of bluffs along the lakeshore. The amount of water contained in bluff soils is an important factor determining their stability. Friction between soil particles hold them in place. As water fills the spaces between these particles the friction between soil particles decreases, causing the soil to become more fluid and less stable. Higher lake levels and increases in 1) precipitation, 2) the frequency of heavy storms, and 3) the number of freeze-thaw cycles may all contribute to shoreline bluffs becoming less stable and more susceptible to slumping. Prolonged dry periods and droughts may also contribute to reduced stability of coastal bluffs. As bluff soils dry out, cracks in the soil can form, weakening the surface soil. During long-term droughts, these cracks can develop into deep fractures. Such fractures can allow surface water to penetrate deep into bluff soils. If heavy rainfall events occur following a drought, they may cause rapid saturation of dry, fractured bluff soils which could cause a major slope failure.

Multi-Jurisdictional Risk Management

Shoreline erosion, bluff failure, and coastal flooding, when combined, present a moderate risk in Kenosha County. As discussed above, coastal hazard risks are present in all three local units of government in Kenosha County along Lake Michigan. Areas of recent active erosion have been identified within the City of Kenosha and the Villages of Pleasant Prairie and Somers. Those communities are noted in Table 3.21 along with the basis of special consideration over and above the countywide consideration.

Severe Winter Storms

Winter storms can vary in size and strength and include heavy snowstorms, blizzards, freezing rain, sleet, ice storms, and blowing and drifting snow conditions. Extremely cold temperatures accompanied by strong winds can result in wind chills that cause bodily injury, such as frostbite and death. A variety of weather phenomena and conditions can occur during winter storms. For clarification, the following are National Weather Service approved descriptions of winter storm elements.

- **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**—An occurrence of sustained wind or frequent gusts 35 mph or higher accompanied by falling or blowing snow, and visibilities of one-quarter mile or less, for three or more hours.

- **Ice Storm**—An occurrence of rain falling from warmer upper layers of the atmosphere to the colder ground, freezing upon contact with the ground and exposed surfaces, resulting in ice accumulations of one-quarter inch or more within 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°F 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.

- **Wind Chill**—An apparent temperature that describes the combined effect of wind and low air temperatures on exposed skin.

Much of the snowfall in Wisconsin occurs in small amounts of between one and three inches per occurrence. Heavy snowfalls that produce at least eight to 10 inches of widespread accumulation happen on the average only once per winter season across southern Wisconsin. In addition, a snowfall event of six to eight inches usually occurs once per winter. The northwestern portion of Wisconsin receives most of its snow during early and late season storms, while southwestern and southeastern counties receive heavy snows more often in mid-winter. Snowfall amounts in Kenosha County average between 30 and 40 inches per season.

Lake Michigan can have both an enhancement effect and a dampening effect on snowfall totals in the County. Warmer water temperatures in the Lake can keep winter air temperatures on land near the lakeshore warm enough for precipitation to fall as rain where it may fall as snow only a mile further inland. On the other hand, lake effect snow bands can drop significant amounts of snow on nearshore communities, while areas slightly further inland may see no snow at all. Lake effect snow occurs when cold air moves across the relatively warm open waters of Lake Michigan, causing warm air and moisture to transfer into the lowest portion of the atmosphere, forming snow producing clouds.

Blizzard-like conditions often can occur during heavy snowstorms when gusty winds cause severe blowing and drifting of snow, even if the conditions did not last long enough to be considered a true blizzard. True blizzards are not common in Wisconsin. However, when they do occur, they tend to affect the eastern counties near Lake Michigan. Due to less frictional drag over Lake Michigan, northeast windstorms can reach higher speeds. According to the NCDC and shown in Table 3.22, Kenosha County has experienced two blizzard events from 2011 to 2021.

Freezing rain, ice, and sleet storms can occur at any time from October into April. In a typical winter season, there are three to five light freezing rain events in the southeastern Wisconsin region. On average, a major ice storm occurs about once every other year somewhere in the State and once every seven years over southeastern Wisconsin. If one-half inch of rain freezes on trees and utility wires, extensive damage can occur, especially if accompanied by high winds that compound the effects of the added weight of the ice. There are also between three and five instances of glazing (less than one-quarter of an inch of ice) throughout the State during a normal winter.

Recent Events

Generally, the winter storm season in Wisconsin runs from October through March. Severe winter weather has occurred, however, as early as September and as late as the latter half of April and into May in some locations in the State. The average annual duration of snow cover in Kenosha County is approximately 85 days. Table 3.22 lists the recent winter storm events that have occurred in Kenosha County from 2011 to 2021. A few examples of recent events from Table 3.22 are noted below.

2011 – During the overnight hours of February 1 to February 2, 2011, a powerful low pressure center passing south of Wisconsin produced blizzard conditions across much of southern Wisconsin (the Groundhog Day Blizzard of 2011). Snow associated with the system began in the mid-afternoon hours in far southern Wisconsin and pushed northward into the State through the evening. Twenty-four hour snowfall totals were between 20 and 26 inches, with 24 inches of snow reported by a cooperative observer near the City of Kenosha. This was in addition to several inches of snow that had fallen on January 31. In Kenosha, this storm set new two-day and three-day snowfall records, with snowfalls of 25.3 inches and 27.3 inches, respectively. Very strong winds were associated with this storm for an extended period of time. Sustained northeast winds of 30 to 40 mph were common throughout the event, with peak wind gusts between 45 and 65 mph. Strong wind gusts were reported near Lake Michigan, with the lakeshore observation site at Kenosha reporting a gust of 64 mph. The combination of high winds and heavy snow created widespread sustained visibilities of less than one-quarter mile, with frequent whiteout conditions and near zero visibilities. Many locations saw blizzard conditions beginning early during the evening of February 1 and continuing through the early morning hours of February 2. Snow drifts of three to 10 feet were common, with reports of some drifts reaching 12 to 15 feet in open rural areas. Drifting snow closed highways and roads with many stranded motorists having to be rescued from vehicles buried in the drifting snow. Due to the large number of vehicles and operators caught in the storm on February 2, the Kenosha Police Department and the National Guard collaborated in assisting stranded motorists. Officers responded to over 121 calls from motorists for assistance. This represents about 61 percent of the calls that the Department received on that day. About 100 National Guardsman were mobilized statewide to help rescue motorists and run emergency shelters at armories in response to the Governor's emergency declaration for 29 counties. At the height of the storm, We Energies reported 5,200 customers were without power across southeastern Wisconsin. A presidential disaster declaration was issued for 11 Wisconsin Counties, including Kenosha County, as a result of the Groundhog Day Blizzard of 2011. Kenosha County received about $640,000 in public assistance under this declaration.

2015 – Intensifying low pressure tracked from the central Great Plains to southeast Indiana the night of January 31st into the evening of February 1st. This resulted in a long duration winter storm and blizzard over portions of southern Wisconsin. Snowfall of 6 to 14 inches accumulated over far southern and eastern Wisconsin. Winds gusted from 30 to 40 mph with blizzard conditions and included frequent whiteouts from heavy and blowing snow in Kenosha and Racine Counties. Vehicle slide-offs and accidents were prevalent. The Milwaukee County Medical Examiner Office reported the death of three men who died after collapsing from shoveling snow.

Vulnerability and Community Impact Assessment

Between 2011 and 2021, 94 winter weather events have affected Kenosha County. Based on this, it is estimated that Kenosha County experiences an average of 8.5 winter weather events per year. It should be noted that during this time period there has been considerable variation around this average, with the County experiencing as few as four winter storm events in some years and as many as 14 winter storm events in other years (Table 3.22).

The NCEI database contains few reports of property damages and crop damages for winter storms for Kenosha County. Between 2011 and 2021, about $30,000 (2021 dollars) in property damages have been reported as having been caused by winter storms affecting Kenosha County. Given that the County received over $640,000 in public assistance under the disaster declaration related to the Groundhog Day blizzard of 2011, the reported damages in the NCEI database clearly represent an underestimate of the potential damages associated with severe winter storms impacting Kenosha County. Records of crop insurance indemnities from the U.S. Department of Agriculture Risk Management Agency show that about $12,000 (2021 dollars) have been paid out between 2011 and 2021 due to damage caused by winter related weather, such as frost, freeze, or snow in Kenosha County.

The NCEI database contains no reports of property damages or crop damages for winter storms. For Washington County, records of crop insurance indemnities from the U.S. Department of Agriculture Risk

Management Agency show that about $487,084 have been paid out between 2011 and 2021 due to damage caused by winter related weather, such as frost, freeze, or snow. Since 2001, about $39,798 in property damages have been reported as having been caused by winter weather events in Washington County.

Winter storms present a serious threat to the health and safety of affected citizens and can result in significant damage to property. Snow and ice are the major hazards associated with winter storms which are the eighth most destructive natural hazard in Wisconsin. Snow and ice can cause traffic accidents, bring down telephone and power lines, damage trees, impede transportation, burst water pipes, and can tax the public's capabilities for snow removal during heavy storms. A major winter storm can have a serious impact on a community. Loss of heat and mobility are key complications that contribute to winter storm fatalities.

Ice storms and freezing rain are less common than snow for Kenosha County but produce road conditions that can make travel hazardous. Even fog or mist on cold roads can produce a glaze of ice that makes travel slippery and dangerous. Accumulated ice can cause the structural collapse of buildings, bring down trees and power lines, causing property damage, loss of power, and isolate people from assistance or services.

Future Changes and Conditions

Based upon recent historical data from the period 2011-2021, Kenosha County can expect to experience an average of 8.5 winter storm events per year. It should be noted that the historical record shows considerable variation among years in the numbers of these events that occurred. While it would be expected that in some years the County will experience either fewer events or more events than the average number, over the five-year term of this plan update the average annual number of events is not expected to change.

Changes in the 20th century and projections based on downscaled results from climate models indicate that there will likely be changes in winter storm conditions affecting Kenosha County over the 21st century. It is projected that by 2055, the average amount of precipitation that Kenosha County receives during the winter will increase by about 0.5 to 1.0 inch (measured as water), an increase of about 25 percent.[42] Due to increasing winter temperatures, the amount of precipitation that falls as rain during the winter rather than as snow is projected to increase significantly. It is also projected that freezing rain will be more likely to occur.

[42] *Wisconsin Initiative on Climate Change Impacts, 2021, op. cit.*

It should also be noted that the likelihood of lake effect snow occurring could be impacted by climate change. Rising temperatures during the winter will reduce the frequency and extent of ice cover over the Lake. A lack of ice cover over Lake Michigan during the winter may promote the development of lake effect snow. But the increase in temperature may also result in some of this precipitation falling as rain, so it is unclear how higher temperatures will impact lake effect events.

Multi-Jurisdictional Risk Management

Based upon a review of the historic patterns of winter storm events in Kenosha County, there are no specific municipalities that have unusual risks. Rather, the events are of a uniform countywide concern.

Drought

Drought is the result of a natural decline in the expected precipitation over an extended period of time, and occurs in virtually every climate on the planet, including areas of high and low precipitation. The severity of drought can be aggravated by other climatic factors, such as prolonged high winds, high temperatures, and low relative humidity. Drought is a complex natural hazard which is reflected in the following four definitions commonly used to describe it.

- **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

- **Meteorological drought**—The degree of dryness, expressed as a departure of actual precipitation from expected average or normal amount, based on monthly, seasonal, or annual time scales

- **Agricultural drought**— Soil moisture deficiencies relative to water demands of crop life

- **Socioeconomic drought (or water management drought)**—Occurs when the demand for water exceeds the water supply, resulting in a water shortage

The severity of a drought depends on several factors, including its duration, its intensity, its geographic extent, and the demands for water for use by humans, wildlife, and vegetation.

Drought can be difficult to define in exact terms. This is partly due to its multi-dimensional nature and partly due to the ways it differs from other natural hazards. There is no exact and universally accepted definition of what constitutes a drought. The onset and end of a drought are difficult to determine due to the slow accumulation of its impacts and its lingering effects after ending. The impacts of drought are less obvious than those of some other hazards and may be spread over a larger geographic area. These characteristics have hindered the preparation of drought contingency or mitigation plans by many governments and can make it difficult to perform an accurate risk assessment analysis.

Droughts can have several impacts. They can reduce water levels and flows in surface waterbodies and groundwater. This can cause shortages of water for human and industrial consumption, hydroelectric power, recreation, and navigation. Water quality may also decline, and the number and severity of wildfires may increase during a drought. Severe droughts may result in reduced yields or the loss of agricultural crops and forest products, undernourished wildlife and livestock, and lower land values.

One method to measure the magnitude of a drought is by using the Palmer Drought Severity Index. This method considers factors like temperature, soil moisture, and precipitation, which are entered into an algorithm that returns results between -5 (extreme drought) and 4 (extremely moist) with zero being normal conditions. The U.S. Drought Monitor uses the Palmer Index, along with other indicators, to rate drought conditions into categories, as described in Figure 3.5.

Wisconsin is vulnerable to agricultural drought. The State has approximately 14.2 million acres of farmland on 64,100 farms.[43] Even small droughts of limited duration can significantly reduce crop growth and yields, adversely affecting farm incomes and local economies. Droughts significantly increase the risk of forest fires and wildfires. Additionally, the loss of vegetation in the absence of sufficient water to maintain it can result in flooding, even from average rainfall.

Estimates of agricultural losses experienced in Kenosha County due to drought over the period 2011 to 2021 are shown in Table 3.23. Due to inconsistent reporting with NCDC data, these estimates come from records of indemnities paid to agricultural operators by Federal crop insurance programs.[44] The loss estimates reflect several factors. First, crop losses often go unreported. Second, Federal crop insurance policies offer coverage to only certain types of crops in any particular year. Third, agricultural operators generally insure only a portion of their crops when purchasing Federal crop insurance. Thus, crop loss estimates are likely to be underestimates of actual losses. It should be noted that indemnities for drought related losses were paid out in most years. This probably reflects variability in rainfall causing localized crop

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[43] *State of Wisconsin Department of Agriculture, Trade and Consumer Protection, 2022 Wisconsin Agricultural Statistics.*

[44] *Payments of crop insurance indemnities are reported by the U.S. Department of Agriculture Risk Management Agency.*

losses. Based on these sources, it is estimated that Kenosha County experienced crop damages of nearly $1.2 million between 2011 and 2021 (2021 dollars). Based on this, average annual crop losses due to drought in Kenosha County are estimated to be about $107,500.

Small droughts of shortened duration have occurred in Wisconsin at an interval of about every 10 years since the 1930s. Extended, widespread droughts have been infrequent in Wisconsin. The five most significant droughts, in terms of severity and duration, are 1929-1934, 1948-1950, 1955-1959, 1976-1977, and 1987-1988.

The 1929-1934 drought probably was the most significant in Wisconsin history considering its duration, as well as its severity. This drought affected a large majority of the United States and contributed to the Dust Bowl period that greatly damaged agriculture throughout the County (see Figure 3.6) Wisconsin experienced at least a 75-year recurrence drought interval in most of the State and over 100-year recurrence drought interval in certain areas. The severe economic impact of the Depression compounded the effect of this drought period. The drought continued with somewhat decreased effect until the early 1940s in some parts of the State.

Recent Events

The only drought event that has occurred recently between 2011 and 2021 took place in 2012. A lack of rain over south central and southeastern Wisconsin during June 2012 allowed a drought to slowly develop and the intensity increased rapidly. By July 10, conditions in Kenosha County had progressed from abnormally dry to moderate drought. By July 17, Kenosha County was experiencing extreme drought. The drought was moderated by several rounds of thunderstorms that moved through the area during the latter half of July; however, this rain came too late for much of the corn crop, which had passed the critical pollination stage. In addition, not enough precipitation was deposited by these storms to end the drought. Severe drought conditions continued in Kenosha County until late August and moderate drought conditions persisted until the end of October. Conditions remained abnormally dry in Kenosha County into March 2013. This drought reduced crop yields. Agricultural operators in Kenosha County received nearly $900,000 in crop insurance indemnities in 2012 due to drought (Table 3.22). The drought also forced sell offs of some dairy and beef cattle herds. Farmers also reported that heat impacts to cows reduced milk production, in some instances by as much as 20 percent. In response to this drought, the Governor declared a drought emergency and authorized the WDNR to expedite permit applications for water withdrawals from lakes and streams for the emergency purpose of watering crops.

Vulnerability and Community Impact Assessment

Kenosha County is vulnerable to agricultural drought. There are about 79,385 acres of farmland on 415 farms.[45] Even small droughts of limited duration can significantly reduce crop growth and yields, adversely affecting farm income. More substantial events can decimate croplands and result in total loss, hurting the local economy. Due to the importance of agriculture to the Kenosha County economy and the potential for large crop losses, drought is a major natural hazard threat. There are also 110 miles of major streams, 20 major and numerous smaller lakes, and nearly 19,000 acres of wetlands which can also be negatively impacted by drought conditions. In addition, groundwater levels can be impacted by drought conditions. This is most important in the portion of the County west of IH 94, as well as limited areas of development east of IH 94, which rely on groundwater as a source of water supply. Severe droughts may only happen on average every 25 or 50 years, but they can be devastating to agriculture, damaging to the local economy, and negatively impact natural surface waters and the groundwater supply system.

In 2017, the most recent year for which data are available, the market value of agricultural products sold by farms in Kenosha County was about $59.9 million. This was comprised of about $40.4 million in crops and $19.5 million in livestock, poultry, and their products.[46] Based on the current average estimate of $107,500 in crop losses per year, it can be expected that approximately 0.27 percent of the market value of all crops, or about 0.18 percent of the market value of all agricultural products sold by farms in the County, will be lost to drought each year. It is also expected that there will be considerable variation among years in the amount of losses experienced.

The ample supply of fresh water available in the Great Lakes and the Mississippi River basins help to minimize water supply problems in Kenosha County. However, during a severe drought some wells, mainly private wells, will go dry. It is agriculture that is most vulnerable to drought, as many farms in Kenosha County do not irrigate.

A review of the community assets described in Chapter 2 indicate the potential for drought hazard events to impact: 1) residents at a countywide level, 2) agricultural croplands, 3) livestock, 4) municipal water utilities, and 5) natural surface and groundwater reserves.

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[45] *United States Department of Agriculture, National Agricultural Statistics Service, 2017 Census of Agriculture.*

[46] *U.S. Department of Agriculture National Agricultural Statistics Service op. cit.*

Future Changes and Conditions

Based upon recent historical data, Kenosha County has about a 40 percent probability of drought conditions occurring during a portion of any given year. Some of these episodes are likely to be of short duration. The statewide historical record indicates that severe droughts can be expected to occur at roughly 10-year intervals. As can be seen in Figure 3.7, southeastern Wisconsin regularly experienced drought to at least a moderate level two to three times every ten years from 1895 to 2022.[47] It is not expected that the probability of drought will change during the five-year term of this plan update.

Historical changes over the 20th century and projections based on downscaled results from climate models indicate that there will likely be changes in drought conditions affecting Kenosha County over the 21st century. By mid-century, average temperatures are projected to rise, leading to longer summers and shorter winters. The temperature increase will also lead to a longer growing season and increased rates of evapotranspiration during summer and early fall months. While the amount of rain during the summer is not projected to change, a greater proportion of precipitation is projected to fall in heavy rainfall events. This will result in a greater number of dry days during the summer. More dry days, coupled with higher summer temperatures and increases in evapotranspiration rates, will increase the likelihood of summer droughts occurring.[48]

Multi-Jurisdictional Risk Management

Based upon a review of the potential impacts of droughts in Kenosha County, the areas most susceptible to hazard conditions are the agricultural communities, the municipalities served by public water supply which use groundwater as a source of supply, and those communities which have the largest numbers of private wells. This water supply impact includes all communities in the County, except the City of Kenosha and portions of the Villages of Pleasant Prairie and Somers. Drought events are of a uniform countywide concern, with those communities with largely agricultural land uses being the most vulnerable to risk.

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[47] *University of Wisconsin-Madison, Atmospheric and Oceanic Sciences, www.aos.wisc.edu.*

[48] *Wisconsin Initiative on Climate Change Impacts, 2021, op. cit.*

SEWRPC Community Assistance Planning Report No. 378 (4th Edition)

KENOSHA COUNTY HAZARD MITIGATION PLAN UPDATE: 2023-2028

Chapter 3

ANALYSIS OF HAZARD CONDITIONS

TABLES

#265431-2 – Kenosha Co HMP Table 3.1
500-1148
CDP/mid
2/8/23; 12/14/22

Table 3.1
Perceived Risks of Hazards as Determined by Hazard Vulnerability and Risk Assessment Survey: 2022

Hazard	Probability[a] *Likelihood this will occur*	Human Impact[a] *Possibility of death or injury*	Property Impact[a] *Physical losses and damages*	Business & Agency Impact[a] *Interruption of services*	Preparedness[a] *Mitigation or pre-planning*	Total Risk[b] *Relative threat*	Rank[c]
Tornado	1.750	2.438	2.688	2.438	2.188	9.406	1
Stormwater Flooding	2.500	1.813	2.125	1.875	2.188	9.063	2
Ice Storm	2.375	2.063	1.688	2.063	2.250	8.461	3
Lake Michigan Erosion	2.250	1.563	1.938	1.313	1.063	8.438	4
Heavy Snowstorm	2.625	1.750	1.625	2.188	2.375	8.367	5
Blizzard	2.375	2.063	1.625	2.188	2.500	8.016	6
Extreme Cold	2.500	1.938	1.375	1.688	2.063	7.344	7
Thunderstorm	2.813	1.250	1.563	1.563	2.438	5.449	8
Extreme Heat	1.750	1.875	2.063	1.625	1.938	5.250	9
Riverine Flooding	1.500	1.875	2.063	1.625	2.125	5.156	10
Lightning	2.750	1.438	1.438	1.375	2.438	4.984	11
Hail	2.375	1.250	1.563	1.438	2.188	4.898	12
High Straight-Line Wind	1.375	1.688	2.125	1.875	2.250	4.727	13
Inland Lake Flooding	1.375	1.313	1.813	1.188	1.563	3.781	14
Fog	2.188	1.375	0.875	1.250	2.000	3.281	15
Wildfire	1.000	1.563	1.625	1.375	1.438	3.125	16
Drought	1.375	0.813	1.063	1.250	1.563	2.148	17
Dam Failure	0.625	1.313	1.688	1.688	1.563	1.953	18
Inland Landslide	0.563	0.813	1.438	1.000	1.250	1.125	19
Earthquake	0.313	1.250	0.875	1.625	1.188	0.801	20
Land Subsidence	0.563	0.750	1.188	1.000	1.563	0.773	21
Dust Storm	0.688	0.750	0.813	0.750	1.313	0.688	22

Note: Value is based on the weighted average of the number of votes received for each score of No Available information (NA/0), low (1), moderate (2), or high (3).

[a] *Severity = Sum of Impact – Preparedness*

[b] *Total Risk = Probability x Severity*

[c] *Perceived threat/rank is based on Total Risk score.*

Source: SEWRPC

Table 3.2
Summary of Hazards to be Considered in the Kenosha County Hazard Mitigation Plan

Hazard	Risk of Occurrence (high, medium, or low)	Damage to Property (high, medium, or low)	Threat to Life Safety (high, medium, or low)	Duration of Impact (long, moderate, or short)	Size of Area Affected (large, medium, or small)
Tornadoes	Low	High	High	Short	Small
Flooding and Stormwater Drainage Problems	High	High	Low	Moderate	Large
Thunderstorm, High Winds, Hail, Lightning	High	High	Medium	Long	Large
Temperature Extremes	Medium	Low	Medium	Long	Large
Coastal Hazards	High	Medium	Low	Long	Small
Winter Storms	High	Low	Medium	Moderate	Large
Drought	Medium	Low	Low	Long	Large

Note: Some of the natural hazards listed in this table represent combinations of hazards listed in Table 3.1. For example, while specific risks associated with thunderstorms, such as hail and lightning are listed separately in Table 3.1, here they are combined into one category.

Source: Kenosha County LPT and SEWRPC

#265432-2 – Kenosha Co HMP Table 3.3
500-1148
CDP/mid
2/8/23; 1/4/2023

Table 3.3
Summary of Estimated Disaster Damages and Assistance in Kenosha County for Federally Declared Disaster Emergencies: 1993-2021

Date of Disaster and Event(s)	Estimated Property and Crop Damages ($)	Public Assistance[a] ($)	Individual Assistance[b] ($)
1993 – Severe Storms, Flooding, & Tornadoes (DR-994)	550,000	816,175	1,400
2000 – Heavy Rains, Severe Storms & Flooding (DR-1332)	18,350,000	1,072,372	77,685
2000 – Snow (EM-3163)	--	334,804	--
2004 – Severe Storms & Flooding (DR-1526)	26,825,000	571,636	146,165
2007 – Severe Storms & Flooding (DR-1719)	900,000	--	225,418
2008 – Record Snow & Near Record Snow (EM-3285)	--	617,849	--
2008 – Severe Storms, Flooding, & Tornadoes (DR-1768)	21,640,000	611,567	439,524
2011 – Severe Winter Storm & Snowstorms (DR-1966)	20,000	747,096	--
2012 – Drought[c]	736,504	--	--
2017 – Flooding	4,000,000	1,873,278[d]	--
2020 – Severe Winter Storm & Flooding (DR-4477)	3,300,000	367,112	--
Total	76,321,504	7,011,889	890,192

Note: Damage amounts ($) are associated with the year that the event took place.

[a] *Public assistance includes assistance to local units of government and nonprofit organizations.*

[b] *Individual assistance includes disaster assistance through FEMA programs and disaster loans from the U.S. Small Business Administration to individuals, households, and businesses.*

[c] *USDA Secretarial disaster declaration issued by the U.S. Secretary of Agriculture.*

[d] *The July 11, 2017, flooding event was not part of a Federally declared disaster. However, Kenosha County was awarded $1,873,278 in grants through the Hazard Mitigation Grant Program (HMGP) under disasters DR-4276, DR-4288, DR-4343, and DR 4402 to mitigate damage resulting from this event. These disaster declarations occurred in other counties throughout the State from 2016-2018, but Kenosha County was eligible to apply for remaining funds awarded but not spent by the counties designated under those declarations.*

Source: National Climatic Data Center, U.S. Department of Agriculture Risk Management Agency, Wisconsin Emergency Management, Kenosha County Division of Emergency Management, and SEWRPC

#265433 – Kenosha Co HMP Table 3.4
500-1148
CDP/mid
2/10/2023; 1/4/2023

Table 3.4
Historical Hazard Events Recorded in Kenosha County: 2001-2021

Event	Number of Events	Deaths	Injuries	Property Damages ($)[a]	Crop Damages ($)[a]
Dust Storms	0	0	0	0	0
Wildfires/Forest Fires	0	0	0	0	0
Drought	17	0	0	0	3,727,414
Tornado	7	0	15	22,002,000	0
Lightning	12	0	5	15,254,000	0
Flood	54	0	0	30,912,653	16,692,018
Temperature Extremes	60	6	0	6,637	11,842
High Straight-Line Winds	156	2	1	2,199,304	4,000
Fog	68	0	0	0	0
Hail	44	0	0	265,480	0
Snow and Ice	163	0	0	68,973	0
Total	581	8	21	70,709,047	20,435,274

[a] *Dollar values were adjusted to year 2021 by using the average Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: The National Climatic Data Center (NCDC), National Oceanic and Atmospheric Administration (NOAA), and the National Environmental Satellite, Data and Information Service (NESDIS), and the U.S. Department of Agriculture Risk Management Agency

Table 3.5
Kenosha County Severe Weather Warning History: 2001-2021

Year	Flash Flood Warning	Flood Warning	Severe Thunderstorm		Tornado	
			Watch	Warning	Watch	Warning
2001	0	0	10	13	1	0
2002	0	0	7	4	1	0
2003	1	0	9	5	3	0
2004	3	0	15	14	5	0
2005	0	0	11	5	0	1
2006	3	0	20	11	3	0
2007	4	4	3	8	3	0
2008	4	12	10	15	7	4
2009	2	8	8	7	1	1
2010	1	7	11	7	8	1
2011	0	5	14	10	2	0
2012	0	1	7	7	0	0
2013	1	10	6	5	2	2
2014	1	6	8	8	1	1
2015	2	4	5	14	2	2
2016	1	2	7	6	0	0
2017	2	9	10	13	2	0
2018	0	8	4	5	1	0
2019	1	10	8	6	0	0
2020	0	5	5	5	2	2
2021	0	0	4	6	0	0
Total	26	91	182	174	44	14

Source: National Oceanic and Atmospheric Administration, National Weather Service, and Iowa State University College of Agriculture – Department of Agronomy, "Iowa Environmental Mesonet"

#265436 – Kenosha Co HMP Table 3.6
500-1148
CDP/mid
2/10/2023; 10/19/2022

Table 3.6
Enhanced Fujita Scale Characteristics

EF-Scale	Wind Speed (miles per hour)[a]	Character of Damage	Relative Frequency (percent)
EF0 (weak)	65-85	Light	53
EF1 (weak)	86-110	Moderate	32
EF2 (strong)	111-135	Considerable	11
EF3 (strong)	136-165	Severe	3
EF4 (violent)	166-200	Devastating	1
EF5 (violent)	>200	Incredible (rare)	<1

[a] *Equivalent wind speeds associated with the Enhanced Fujita Scale represent a three-second gust of wind.*

Source: National Oceanic and Atmospheric Administration

Table 3.7
Tornado Events in Kenosha County: 1963 Through 2021

Date	Location	Magnitude (Fujita)	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
July 19, 1963	Village of Twin Lakes	F0	0	0	229,683	--
June 9, 1974	Town of Somers	F1	0	0	1,426,036	--
March 28, 1994	Kenosha County	N/A	0	0	--	--
July 24, 1996	Wilmot – Town of Salem	F0	0	0	--	--
July 18, 1997	Wilmot – Town of Salem	N/A	0	0	--	--
July 18, 1997	Village of Twin Lakes	N/A	0	0	--	--
June 6, 1999	Town of Salem	N/A	0	0	--	--
August 25, 2001	Town of Paris	F0	0	0	157,171	--
January 7, 2008	Town of Wheatland	EF3	0	15	17,885,101	--
January 7, 2008	Town of Somers	EF1	0	0	10,313,306	--
June 19, 2009	City of Kenosha	EF0	0	0	--	--
October 26, 2010	Town of Somers	EF1	0	0	128,910	--
November 22, 2010	Town of Brighton	EF0	0	0	2,578	--
August 10, 2020	Village of Salem Lakes	EF1	0	0	267,591	--
		Total	0	15	30,410,376	--

Note: Dollar Values were adjusted to year 2021 by the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics. N/A indicates data not available.

Source: National Centers for Environmental Information and U.S. Department of Agriculture Risk Management Agency

#265437-2 – Kenosha Co HMP Table 3.8
500-1148
CDP/mid
2/10/2023; 2/8/23; 12/19/2022

Table 3.8
Areal Extent of 1-Percent-Annual-Probability Floodplain by Community in Kenosha County: 2022

Community	Area (acres)
Cities	
Kenosha	843.2
Villages	
Bristol	3,226.5
Paddock Lake	239.4
Pleasant Prairie	3,714.9
Salem Lakes	3,778.0
Somers	1,939.5
Twin Lakes	1,192.4
Towns	
Brighton	1,051.5
Paris	1,405.7
Randall	698.5
Somers	285.4
Wheatland	1,817.5
Total	20,192.5

Source: Federal Emergency Management Agency and SEWRPC

#265438-2 – Kenosha Co HMP Table 3.9
500-1148
CDP/mid
2/10/2023; 2/8/23; 12/19/22

Table 3.9
Wisconsin Department of Natural Resources Dam Inventory Information: 2022

Count	Community	Dam Name		Owner Organization	Size	Structural Height (feet)	Hazard Potential
		Official	Local				
1	Bristol	Lake Shangri-La	--	Village of Bristol	Large	16.0	High
2	Salem Lakes	Rock Lake	--	Linda Valentine	Large	8.0	Low
3	Brighton	Bong Recreation Area 8	Wolf Lake Dam	WDNR	Large	10.0	Low
4	Twin Lakes	Hawke	--	Robert K. Hawke	Small	--	--
5	Salem Lakes	Hooker Lake	Carl Bryzek	Carl Bryzek Farm, LLC	Small	3.0	Low
6	Salem Lakes	Camp Lake	Camp Lake	Kenosha County	Large	7.2	Low
7	Paddock Lake	Paddock Lake 3	--	Paddock Lake Cottages, LLC	Small	3.0	Low
8	Salem Lakes	Silver Lake	Jack Erb	Brian Sullivan	Small	2.0	Low
9	Salem Lakes	Cross Lake	B. J. Corbin	Sam Samra	Small	4.0	Significant
10	Bristol	Lake George	John Haterlein	George Wronowski	Small	6.0	Low
11	Salem Lakes	Voltz Lake	--	Unknown	Small	5.0	Significant
12	Salem Lakes	Center Lake	Center Lake Conservation & Sports Club	Camp and Center Lake Rehabilitation District	Small	3.0	Low
13	Wheatland	Dyer Lake	--	Kenosha Boys Scouts of America	Small	6.0	Significant
14	Brighton	Bong Recreation Area 2	--	WDNR	Small	9.4	Low
15	Brighton	Bong Recreation Area 7	--	WDNR	Small	2.0	Low
16	Kenosha	Pike Creek	--	City of Kenosha	Small	7.0	Low
17	Kenosha	Charles Yandre	--	Charles Yandre	Small	8.0	Low
18	Randall	New Munster Wildlife Area	--	WDNR	Small	7.0	Low
19	Pleasant Prairie	Pleasant Prairie	Lake Andrea	Village of Pleasant Prairie	Small	4.7	Low
20	Wheatland	Meyer Material KD Pit	--	Kenosha County	Large	21.5	High
21	Somers	Marescalco	--	--	Small	--	Low

Source: Wisconsin Department of Natural Resources and SEWRPC

#265439-2 – Kenosha Co HMP Table 3.10
500-1148
CDP/mid
2/10/2023; 2/8/23; 12/19/2022

Table 3.10
Recent Flood Events in Kenosha County: 2011-2021

Date	Location	Type[a]	Deaths	Injuries	Property Damages ($)[a]	Crop Damages ($)[a]
3/11/2013	Wheatland/Salem Lakes	Flood	--	--	5,982	1,196
4/9/2013	Wheatland/Salem Lakes	Flood	--	--	5,982	1,196
6/30/2013	Wheatland/Salem Lakes	Flood	--	--	5,982	3,589
5/12/2014	Brighton	Flash Flood	--	--	1,187	--
5/12/2014	Paris	Flash Flood	--	--	1,187	--
7/10/2017	Kenosha	Flash Flood	--	--	282,733	--
7/10/2017	Paddock Lake	Flash Flood	--	--	113,095	16,964
7/12/2017	Wheatland/Salem Lakes	Flood	--	--	4,526,730	22,619
2/20/2018	Wheatland/Salem Lakes	Flood	--	--	11,097	--
2/20/2018	Twin Lakes	Flood	--	--	5,549	--
5/14/2018	Wheatland/Salem Lakes	Flood	--	--	5,549	--
6/20/2018	Wheatland/Salem Lakes	Flood	--	--	1,110	5,549
10/2/2018	Wheatland/Salem Lakes	Flood	--	--	11,097	--
2/6/2019	Wheatland/Salem Lakes	Flood	--	--	1,085	--
3/13/2019	Wheatland/Salem Lakes	Flood	--	--	1,085	--
9/11/2019	Twin Lakes	Flash Flood	--	--	5,425	--
9/13/2019	Kenosha	Flash Flood	--	--	5,425	--
9/13/2019	Paddock Lake	Flood	--	--	--	--
9/13/2019	Wheatland/Salem Lakes	Flood	--	--	10,849	--
10/2/2019	Wheatland/Salem Lakes	Flood	--	--	10,849	--
4/30/2020	Wheatland/Salem Lakes	Flood	--	--	2,141	--
5/1/2020	Wheatland/Salem Lakes	Flood	--	--	3,211	--
5/17/2020	Wheatland/Salem Lakes	Flash Flood	--	--	5,352	--
		Total	0	0	5,017,355	51,113

Note: Dollar Values were adjusted to year 2021 by the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.

[a] *National Weather Service determines the type of event bason on report narratives from local officials.*

Source: The National Climatic Data Center (NCDC), National Oceanic and Atmospheric Administration (NOAA)

#265440-2 – Kenosha Co HMP Table 3.11
500-1148
CDP/mid
2/10/2023; 2/8/23; 12/14/2022

Table 3.11
Estimated Flood Damages for a 1-Percent-Annual-Probability Flood in Kenosha County: 2021

Municipality	Number of Structures in Floodplain	Flood Damages		
		Direct ($)	Indirect ($)	Total ($)
Cities				
Kenosha	11	643,890	167,500	811,390
Villages				
Bristol	9	212,120	63,130	275,250
Paddock Lake	13	165,770	24,880	190,650
Pleasant Prairie	21	492,300	81,090	573,390
Salem Lakes	155	2,300,310	432,160	2,732,470
Somers	18	373,400	80,010	453,410
Twin Lakes	4	20,690	8,000	28,690
Towns				
Brighton	0	0	0	0
Paris	0	0	0	0
Randall	9	90,010	26,690	116,700
Somers	18	79,090	13,690	92,780
Wheatland	28	376,470	65,910	442,380
Total	286	4,754,050	963,060	5,717,110

Note: Estimated damages are based on assessed improvement values in 2021.

Source: Wisconsin Department of Natural Resources and SEWRPC

Table 3.12
Communities in Kenosha County with Special Flood and Related Stormwater Drainage Considerations

Community	Reason for Consideration
City of Kenosha	11 structures in flood hazard area
Village of Bristol	9 structures in flood hazard area
Village of Paddock Lake	13 structures in flood hazard area and one repetitive loss property
Village of Pleasant Prairie	21 structures in flood hazard area and one repetitive loss property
Village of Salem Lakes	155 structures in flood hazard area and 29 repetitive loss properties. Substantial agricultural flood damages. Localized stormwater drainage problems related to new development on narrow lake-frontage lots, and need for stormwater management planning to address existing and planned development
Village of Somers	18 structures in the flood hazard area
Village of Twin Lakes	4 structures in flood hazard area and one repetitive loss property
Town of Paris	Substantial agricultural flood damages
Town of Randall	9 structures in flood hazard area
Town of Somers	18 structures in flood hazard area
Town of Wheatland	28 structures in the flood hazard area

Source: SEWRPC

Table 3.13
Recent Severe Weather Events in Kenosha County: 2011-2021

				Reported Damages[a]			
Date	**Location**	**Event Type**	**Magnitude**	Deaths	Injuries	Property Damages ($)	Crop Damages ($)
January 1, 2011	Kenosha County	Strong Wind	38 mph	--	--	4,942	--
February 18, 2011	Kenosha County	Strong Wind	27 mph	--	--	2,471	--
April 15, 2011	Kenosha County	Strong Wind	35 mph	--	--	3,706	--
May 15, 2011	Kenosha County	Strong Wind	30 mph	--	--	6,177	--
May 22, 2011	Silver Lake	Thunderstorm Wind	70 mph	--	--	123,543	--
June 15, 2011	Kenosha County	High Wind	58 mph	--	--	12,354	--
June 30, 2011	Somers	Thunderstorm Wind	65 mph	1	1	123,543	--
July 11, 2011	Salem Lakes	Thunderstorm Wind	56 mph	--	--	--	--
July 11, 2011	Downtown Kenosha	Thunderstorm Wind	53 mph	--	--	--	--
August 2, 2011	Twin Lakes	Thunderstorm Wind	50 mph	--	--	--	--
August 2, 2011	Pleasant Prairie	Thunderstorm Wind	55 mph	--	--	--	--
September 29, 2011	Kenosha County	Strong Wind	46 mph	--	--	2,471	--
October 19, 2011	Kenosha County	High Wind	53 mph	--	--	12,354	--
November 13, 2011	Kenosha County	Strong Wind	43 mph	--	--	1,235	--
November 29, 2011	Kenosha County	Strong Wind	40 mph	--	--	1,235	--
January 1, 2012	Kenosha County	Strong Wind	39 mph	--	--	2,429	--
March 10, 2012	Kenosha County	Strong Wind	39 mph	--	--	2,429	--
April 15, 2012	Kenosha County	Strong Wind	43 mph	--	--	1,214	--
April 16, 2012	Kenosha County	Strong Wind	41 mph	--	--	1,214	--
April 16, 2012	Kenosha County	Strong Wind	43 mph	--	--	1,214	--
April 16, 2012	Kenosha County	Strong Wind	41 mph	--	--	1,214	--
June 18, 2012	Kenosha County	Strong Wind	39 mph	--	--	12,143	--
September 4, 2012	Wheatland	Thunderstorm Wind	52 mph	--	--	6,071	--
September 4, 2012	Benet Lake	Thunderstorm Wind	52 mph	--	--	6,071	--
October 30, 2012	Kenosha County	Strong Wind	38 mph	--	--	6,071	--
November 11, 2012	Kenosha County	Strong Wind	43 mph	--	--	3,643	--
January 18, 2013	Kenosha County	Strong Wind	39 mph	--	--	5,982	--
January 19, 2013	Kenosha County	High Wind	50 mph	--	--	17,945	--
April 11, 2013	Kenosha County	Strong Wind	38 mph	--	--	4,785	--
August 30, 2013	Twin Lakes	Thunderstorm Wind	55 mph	--	--	3,589	--

Table continued on next page.

Table 3.13 (Continued)

Date	Location	Event Type	Magnitude	Reported Damages[a]			
				Deaths	Injuries	Property Damages ($)	Crop Damages ($)
August 30, 2013	Paddock Lake	Thunderstorm Wind	50 mph	--	--	1,196	--
October 5, 2013	Downtown Kenosha	Heavy Rain		--	--	--	--
November 17, 2013	Bristol	Thunderstorm Wind	51 mph	--	--	33,497	--
November 17, 2013	Kenosha County	Strong Wind	45 mph	1	--	--	--
February 20, 2014	Kenosha County	High Wind	36 mph	--	--	--	--
April 12, 2014	Downtown Kenosha	Hail	0.88 inch	--	--	--	--
April 13, 2014	Wheatland	Hail	0.75 inch	--	--	--	--
May 12, 2014	Carol Beach	Heavy Rain		--	--	--	--
June 30, 2014	Downtown Kenosha	Thunderstorm Wind	50 mph	--	--	3,562	--
July 12, 2014	Truesdell	Thunderstorm Wind	87 mph	--	--	83,114	--
July 29, 2014	Salem Lakes	Thunderstorm Wind	50 mph	--	--	3,562	--
August 26, 2014	Salem Lakes	Lightning		--	--	5,937	--
June 8, 2015	Silver Lake	Hail	1 inch	--	--	--	--
June 8, 2015	Trevor	Hail	1 inch	--	--	--	--
June 8, 2015	Salem	Hail	1.25 inch	--	--	--	--
June 8, 2015	Trevor	Hail	1.75 inch	--	--	--	--
June 8, 2015	Pleasant Prairie	Hail	0.75 inch	--	--	--	--
July 13, 2015	Brighton	Thunderstorm Wind	54 mph	--	--	23,575	--
July 18, 2015	Twin Lakes	Thunderstorm Wind	50 mph	--	--	5,894	--
August 2, 2015	Brighton	Thunderstorm Wind	65 mph	--	--	11,787	--
August 2, 2015	Kenosha Airport	Thunderstorm Wind	55 mph	--	--	5,894	--
August 2, 2015	Downtown Kenosha	Hail	1.00 inch	--	--	--	--
September 17, 2015	Salem	Thunderstorm Wind	60 mph	--	--	2,357	--
December 23, 2015	Kenosha County	Strong Wind	47 mph	--	--	1,179	--
February 19, 2016	Kenosha County	High Wind	55 mph	--	--	115,478	--
March 16, 2016	Kenosha County	High Wind	51 mph	--	--	9,238	--
March 31, 2016	New Munster	Hail	1 inch	--	--	--	--
April 25, 2016	Twin Lakes	Hail	0.75 inch	--	--	--	--
April 25, 2016	Trevor	Hail	0.88 inch	--	--	--	--
July 6, 2016	Twin Lakes	Thunderstorm Wind	52 mph	--	--	4,619	--
March 7, 2017	Kenosha Airport	Thunderstorm Wind	51 mph	--	--	--	--
March 8, 2017	Kenosha County	High Wind	53 mph	--	--	28,273	--
April 10, 2017	Brighton	Hail	0.88 inch	--	--	--	--
June 28, 2017	Twin Lakes	Thunderstorm Wind	52 mph	--	--	28,273	--
June 28, 2017	Carol Beach	Thunderstorm Wind	52 mph	--	--	11,309	--
July 6, 2017	Paris	Thunderstorm Wind	56 mph	--	--	4,524	--

Table continued on next page.

Table 3.13 (Continued)

Date	Location	Event Type	Magnitude	Reported Damages[a]			
				Deaths	Injuries	Property Damages ($)	Crop Damages ($)
July 12, 2017	Bassett	Hail	1 inch	--	--	--	--
August 3, 2017	Downtown Kenosha	Hail	0.88 inch	--	--	--	--
December 4, 2017	Kenosha County	High Wind	50 mph	--	--	7,917	--
May 2, 2018	Twin Lakes	Hail	2.9 inch	--	--	--	--
May 14, 2018	Twin Lakes	Hail	0.88 inch	--	--	--	--
June 18, 2018	Slades Corners	Thunderstorm Wind	50 mph	--	--	7,768	--
July 19, 2018	Twin Lakes	Lightning		--	1	--	--
October 20, 2018	Kenosha County	Strong Wind	41 mph	--	--	1,110	--
February 24, 2019	Kenosha County	High Wind	52 mph	--	--	2,170	--
June 30, 2019	Wheatland	Thunderstorm Wind	50 mph	--	--	1,085	--
June 30, 2019	Salem	Thunderstorm Wind	50 mph	--	--	2,170	--
June 30, 2019	Silver Lake	Thunderstorm Wind	61 mph	--	--	10,849	--
August 7, 2019	Twin Lakes	Thunderstorm Wind	50 mph	--	--	542	--
August 18, 2019	Downtown Kenosha	Thunderstorm Wind	50 mph	--	--	16,274	--
November 27, 2019	Kenosha County	Strong Wind	49 mph	--	--	10,849	--
April 20, 2020	Kenosha Airport	Thunderstorm Wind	52 mph	--	--	--	--
April 29, 2020	Paris	Heavy Rain		--	--	535	--
July 26, 2020	Somers	Heavy Rain		--	--	--	--
August 10, 2020	Powers Lake	Thunderstorm Wind	52 mph	--	--	--	--
August 10, 2020	Powers Lake	Thunderstorm Wind	56 mph	--	--	3,211	--
August 10, 2020	Downtown Kenosha	Thunderstorm Wind	50 mph	--	--	6,422	--
November 10, 2020	Truesdell	Thunderstorm Wind	56 mph	--	--	5,352	--
November 10, 2020	Tobin Road	Thunderstorm Wind	56 mph	--	--	--	--
November 10, 2020	Kenosha Airport	Thunderstorm Wind	52 mph	--	--	--	--
August 6, 2021	Downtown Kenosha	Thunderstorm Wind	52 mph	--	--	20,000	3,000
August 10, 2021	Downtown Kenosha	Thunderstorm Wind	52 mph	--	--	--	1,000
August 11, 2021	Kenosha Airport	Thunderstorm Wind	50 mph	--	--	--	--
December 15, 2021	Kenosha County	High Wind	56 mph	--	--	15,000	--
			Total	2	2	864,567	4,000

Note: In many instances damages from hazard events go unreported. This table represents estimated losses and should not be considered an exact documentation of damages and losses incurred from a particular event or time period.

[a] *Dollar values were adjusted to year 2021 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: The National Climatic Data Center (NCDC), National Oceanic and Atmospheric Administration (NOAA), and the National Environmental Satellite, Data and Information Service (NESDIS), and the U.S. Department of Agriculture Risk Management Agency

#265443-2 –Kenosha Co HMP Table 3.14
500-1148
CDP/mid
2/10/2023; 2/8/23; 12/19/22

Table 3.14
Extreme Temperature and Departure from Average Temperature Within Kenosha County: 2011-2021

	Burlington Inland Site				Kenosha Lakeshore Site			
Year	Max High Temperature (°F)	Max Low Temperature (°F)	Average Annual Temperature (°F)	Departure from Average Temperature (°F)[a]	Max High Temperature (°F)	Max Low Temperature (°F)	Average Annual Temperature (°F)	Departure from Average Temperature (°F)[a]
2011	97.0	-14.0	46.4[a]	+0.2	100.0	-9.0	48.6[b]	-0.1
2012	102.0	-4.0	48.6[a]	+2.4	105.0	0.0	51.8	+3.1
2013	94.0	-10.0	44.2[a]	-2.0	96.0	-5.0	46.6[b]	-2.1
2014	87.0	-19.0	42.6	-3.6	91.0	-14.0	44.8	-3.9
2015	91.0	-15.0	46.4	+0.2	93.0	-9.0	48.0	-0.7
2016	91.0	-14.0	48.1	+1.9	95.0	-9.0	50.4	+1.7
2017	92.0	-10.0	45.9	-0.3	91.0	-6.0	49.7	+1.0
2018	93.0	-13.0	45.7	-0.5	95.0	-9.0	47.8	-0.9
2019	94.0	-27.0	45.0	-1.2	95.0	-27.0	47.5	-1.2
2020	92.0	20.0	47.4	+1.2	97.0	-5.0	50.0	+1.3
2021	92.0	-16.0	47.9	+1.7	95.0	-9.0	50.9	+2.2
Average	93.2	-11.1	46.2	--	95.7	-9.3	48.7	--

[a] *The average temperature is the average annual temperature for the County for the period 2011 through 2021.*

[b] *Average and/or total values computed with one to nine daily values missing.*

Source: National Weather Service and National Oceanic and Atmospheric Administration NOWData

#265444-2 – Kenosha Co HMP Table 3.15
500-1148
CDP/mid
2/10/2023; 2/8/23; 10/19/22

Table 3.15
Level of Risk for Persons in High-Risk Groups Associated with the Heat Index

Heat Index (°F)	Category	Possible Heat Disorders for Persons in High-Risk Groups
80-90	Caution	Fatigue possible with prolonged exposure and/or physical activity
90-105	Extreme Caution	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity
105-129	Danger	Sunstroke, muscle cramps and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity
130 or above	Extreme Danger	Heat stroke or sunstroke likely

Source: National Weather Service

Table 3.16
Recent Extreme Heat Events in Kenosha County: 2011-2021

Date	Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
July 17, 2011	Heat	0	0	--	--
July 20, 2011	Heat	0	0	--	--
June 28, 2012	Heat	0	0	--	--
July 3, 2012	Excessive Heat	0	0	--	--
July 16, 2012	Heat	0	0	--	--
July 23, 2012	Heat	0	0	--	--
July 25, 2012	Heat	0	0	--	--
July 16, 2013	Excessive Heat	0	0	--	--
August 30, 2013	Heat	0	0	--	--
July 21, 2016	Heat	0	0	--	--
June 17, 2018	Heat	0	0	--	--
June 29, 2018	Excessive Heat	0	0	--	--
July 1, 2018	Excessive Heat	0	0	--	--
July 4, 2018	Heat	0	0	--	--
July 19, 2019	Excessive Heat	0	0	--	--
	Total	0	0	--	--

Source: National Climatic Data Center and U.S. Department of Agriculture Risk Management Agency.

#265446-2 – Kenosha Co HMP Table 3.17
500-1148
CDP/mid
2/10/2023; 2/8/23; 10/19/2022

Table 3.17
Wind Chill Temperatures[a]

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

[a] *Wind Chill (°F) = $35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$, where T = air temperature (°F) and V = wind speed (mph). The wind chill temperature is only defined for temperatures at or below 50°F and wind speeds above 3 mph. Bright sunshine may increase wind chill temperature by 10°F to 18°F.*

Frostbite times associated with wind chills:

30 minutes

10 minutes

5 minutes

Source: National Weather Service

Table 3.18
Recent Extreme Cold Events in Kenosha County: 2011-2021

Date	Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
January 1, 2011	Cold/wind chill	0	0	--	--
January 21, 2013	Cold/wind chill	0	0	--	--
January 6, 2014	Extreme cold/wind chill	0	0	--	55
January 27, 2014	Cold/wind chill	0	0	--	--
January 7, 2015	Cold/wind chill	0	0	--	--
January 9, 2015	Cold/wind chill	0	0	--	--
February 28, 2015	Cold/wind chill	1	0	--	--
January 11, 2016	Cold/wind chill	1	0	--	--
December 14, 2016	Cold/wind chill	0	0	--	--
December 18, 2016	Cold/wind chill	0	0	--	--
November 16, 2017	Cold/wind chill	1	0	--	--
December 25, 2017	Cold/wind chill	0	0	--	--
January 1, 2018	Cold/wind chill	0	0	--	--
January 29, 2019	Extreme cold/wind chill	0	0	--	--
February 7, 2021	Cold/wind chill	0	0	--	--
February 13, 2021	Cold/wind chill	0	0	--	11,842
	Total	3	0	--	11,897

Source: National Climatic Data Center and U.S. Department of Agriculture Risk Management Agency

#265448-2 – Kenosha Co HMP Table 3.19
500-1148
CDP/mid
2/10/2023; 2/8/23; 12/20/22

Table 3.19
Lake Michigan Shoreline Length of Communities in Kenosha County

Community	Lake Michigan Shoreline Length (miles)	Percent of County Total
City of Kenosha	7.00	45.5
Village Pleasant Prairie	5.31	34.5
Village of Somers	3.07	20.0
Total	15.38	100.0

Source: SEWRPC

#265449-2 – Kenosha Co HMP Table 3.20
500-1148
CDP/mid
2/8/23; 1/3/23

Table 3.20
Parcels Within the Low- and High-Risk Coastal Erosion Zones in Kenosha County: 2021

	Improved Parcels in Erosion Risk Zone				Value of Improvements ($)[a]			
Kenosha County	Residential	Commercial	Manufacturing	Total	Residential	Commercial	Manufacturing	Total
Low-Risk Zone (within 0.5 miles)	4,286	454	11	4,751	568,748,200	215,881,600	4,760,400	789,390,200
High-Risk Zone (within 0.25 miles)	2,403	133	2	2,538	377,573,100	81,545,800	667,100	459,786,000
Total	6,689	587	13	7,289	946,321,300	297,427,400	5,427,500	1,249,176,200

[a] *2021 dollars.*

Source: Wisconsin Emergency Management

Table 3.21
Communities in Kenosha County with Special Coastal Hazard Conditions

Community	Reason for Special Consideration
City of Kenosha	Portions of the shoreline have been shown to recede one to two feet per year Damming of the mouth of the Pike River by littoral drift in Lake Michigan
Village of Pleasant Prairie	Portions of the shoreline have been shown to recede one to two feet per year Low-lying coastal areas contain residential structures within the 1-percent annual flood hazard area
Village of Somers	Unstable or failing bluffs; Short-term bluff toe recession rates of over one foot per year and crest recession rates up to one foot per year

Source: SEWRPC

#265451-2 – Kenosha Co HMP Table 3.22
500-1148
CDP/mid
2/8/23; 12/19/22

Table 3.22
Recent Winter Events in Kenosha County: 2011-2021

Date	Type[a]	Deaths	Injuries	Property Damages ($)	Crop Damages ($)
January 17, 2011	Winter Weather	--	--	--	--
February 1, 2011	Blizzard	--	--	24,709	--
February 21, 2011	Winter Weather	--	--	--	--
December 29, 2011	Winter Weather	--	--	--	--
January 12, 2012	Winter Weather	--	5	--	--
January 17, 2012	Winter Weather	--	--	--	--
January 20, 2012	Winter Weather	--	--	--	--
February 23, 2012	Winter Weather	--	--	--	--
March 2, 2012	Winter Storm	--	3	--	--
January 27, 2013	Winter Weather	--	--	--	--
January 30, 2013	Winter Weather	--	--	--	--
February 7, 2013	Winter Storm	--	--	--	--
February 22, 2013	Winter Weather	--	--	--	--
February 26, 2013	Winter Storm	--	--	--	--
March 5, 2013	Winter Storm	--	--	--	--
March 18, 2013	Winter Weather	--	--	--	--
November 25, 2013	Winter Weather	--	--	--	--
December 8, 2013	Winter Weather	--	--	--	--
December 19, 2013	Winter Weather	--	--	--	--
December 22, 2013	Winter Storm	--	--	--	--
December 31, 2013	Winter Weather	--	--	--	--
January 1, 2014	Winter Weather	--	--	--	--
January 10, 2014	Winter Weather	--	--	--	--
January 14, 2014	Winter Weather	--	--	--	--
January 24, 2014	Winter Weather	--	--	--	--
January 26, 2014	Winter Weather	--	--	--	--
January 26, 2014	Winter Weather	--	--	--	--
February 4, 2014	Winter Weather	--	--	--	--
February 13, 2014	Winter Weather	--	--	--	--
February 17, 2014	Winter Storm	--	--	--	--
March 4, 2014	Winter Weather	--	--	--	--
November 22, 2014	Winter Weather	--	--	--	--
January 8, 2015	Winter Weather	--	--	--	--
February 1, 2015	Blizzard	--	--	--	--
February 25, 2015	Winter Weather	--	--	--	--
March 3, 2015	Winter Weather	--	--	--	--
March 23, 2015	Winter Weather	--	--	--	--
November 20, 2015	Winter Storm	--	--	--	--
December 28, 2015	Winter Storm	--	--	--	--
February 29, 2016	Winter Weather	--	--	--	--
March 1, 2016	Winter Weather	--	--	--	--
March 24, 2016	Winter Weather	--	--	--	--
April 2, 2016	Winter Weather	--	--	--	--
April 8, 2016	Winter Weather	--	--	--	--
December 4, 2016	Winter Weather	--	--	--	--
December 10, 2016	Winter Storm	--	--	--	--
December 16, 2016	Winter Storm	--	--	--	--
January 10, 2017	Winter Weather	--	--	--	--

Table continued on next page.

Table 3.22 (Continued)

Date	Type[a]	Deaths	Injuries	Property Damages ($)	Crop Damages ($)
January 11, 2017	Winter Weather	--	--	--	--
January 16, 2017	Winter Weather	--	--	--	--
February 24, 2017	Winter Weather	--	--	--	--
March 12, 2017	Lake-Effect Snow	--	--	--	--
January 7, 2018	Winter Weather	--	--	--	--
January 14, 2018	Winter Weather	--	--	--	--
January 22, 2018	Winter Storm	--	--	--	--
February 3, 2018	Winter Weather	--	--	--	--
February 5, 2018	Winter Weather	--	--	--	--
February 8, 2018	Winter Storm	--	--	--	--
February 11, 2018	Winter Weather	--	--	--	--
March 5, 2018	Winter Weather	--	--	--	--
April 3, 2018	Winter Weather	--	--	--	--
April 15, 2018	Winter Weather	--	--	--	--
April 18, 2018	Winter Weather	--	--	--	--
November 15, 2018	Winter Weather	--	--	--	--
November 25, 2018	Winter Storm	--	--	5,549	--
December 28, 2018	Winter Weather	--	--	--	--
January 18, 2019	Winter Storm	--	--	--	--
January 22, 2019	Winter Weather	--	--	--	--
January 27, 2019	Winter Storm	--	--	--	--
February 5, 2019	Winter Weather	--	--	--	--
February 7, 2019	Winter Weather	--	--	--	--
February 11, 2019	Winter Weather	--	--	--	--
February 17, 2019	Winter Weather	--	--	--	--
February 26, 2019	Winter Weather	--	--	--	--
April 14, 2019	Winter Storm	--	--	--	--
April 27, 2019	Winter Weather	--	--	--	--
October 30, 2019	Winter Weather	--	--	--	--
November 10, 2019	Winter Weather	--	--	--	--
January 11, 2020	Winter Weather	--	--	--	--
January 17, 2020	Winter Weather	--	--	--	--
January 24, 2020	Winter Weather	--	--	--	--
January 31, 2020	Winter Weather	--	--	--	--
February 9, 2020	Winter Weather	--	--	--	--
February 12, 2020	Winter Weather	--	--	--	--
December 29, 2020	Winter Weather	--	--	--	--
January 1, 2021	Winter Weather	--	--	--	--
January 26, 2021	Winter Storm	--	--	--	--
January 30, 2021	Winter Storm	--	--	--	--
February 4, 2021	Winter Weather	--	--	--	--
February 11, 2021	Winter Weather	--	--	--	--
February 13, 2021	Winter Weather	--	--	--	11,842
February 15, 2021	Winter Storm	--	--	--	--
March 15, 2021	Winter Weather	--	--	--	--
December 28, 2021	Winter Weather	--	--	--	--
	Total	0	8	30,258	11,842

Note: The data presented in this table only accounts for damages, injuries, and deaths that are directly caused by each winter storm event. Damages, injuries, and deaths that occur indirectly as the result of traffic accidents, slips and falls, or health issues associated with winter storms are not included in this table.

Dollar values were adjusted to year 2021 by the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics

Table continued on next page.

Table 3.22 (Continued)

[a] *NWS defines the following types of events:*

- *Blizzard as a winter storm which produces the following conditions for three consecutive hours or longer: (1) sustained winds or frequent gusts 30 knots (35 mph) or greater, and (2) falling and/or blowing snow reducing visibility frequently to less than 1/4 mile.*
- *Winter Storm is an event that has more than one significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet and ice) and meets or exceeds locally/regionally defined 12 and/or 24-hour warning criteria for at least one of the precipitation elements.*
- *Winter Weather as an event that causes a death, injury, or a significant impact to commerce or transportation, but does not meet locally/regionally defined warning criteria. Such an event could result from one or more winter precipitation types (snow, or blowing/drifting snow, or freezing rain/drizzle). The Winter Weather event can also be used to document out-of-season and other unusual or rare occurrences of snow, or blowing/drifting snow, or freezing rain/drizzle.*

Source: National Centers for Environmental Information and U.S. Department of Agriculture Risk Management Agency

#265452-2 – Kenosha Co HMP Table 3.23
500-1148
CDP/mid
2/8/23; 12/19/2022

Table 3.23
Estimates of Crop Losses Due to Drought in Kenosha County: 2011-2021

Year	Crop Insurance Indemnity Paid ($)[a]
2011	472
2012	894,329
2013	92,386
2014	0
2015	557
2016	13,396
2017	1,305
2018	0
2019	0
2020	87,253
2021	92,596
Total	1,182,294

[a] *Dollar values were adjusted to year 2021 by using the average Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: National Climatic Data Center (NCDC), the U.S. Department of Agriculture Risk Management Agency, and SEWRPC

SEWRPC Community Assistance Planning Report No. 378 (4th Edition)

KENOSHA COUNTY HAZARD MITIGATION PLAN UPDATE: 2023-2028

Chapter 3

ANALYSIS OF HAZARD CONDITIONS

FIGURES

#266285 – Kenosha Co HMP Figure 3.1
500-1148
CDP/mid
2/13/2023; 1/4/23

Figure 3.1
July 12, 2017, Flooding: Fox River in the Town of Wheatland

Floodwaters submerging the Highway 50 bridge over the Fox River in the Town of Wheatland

Residential flooding in the Town of Wheatland

Source: SEWRPC

#265917 – Kenosha Co HMP Figure 3.2
500-1148
CDP/mid
2/13/2023; 11/29/2022

Figure 3.2
Heat Index Chart

Relative Humidity (%)	Temperature (°F)															
	80	82	84	86	88	90	92	94	96	98	100	102	104	106	180	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

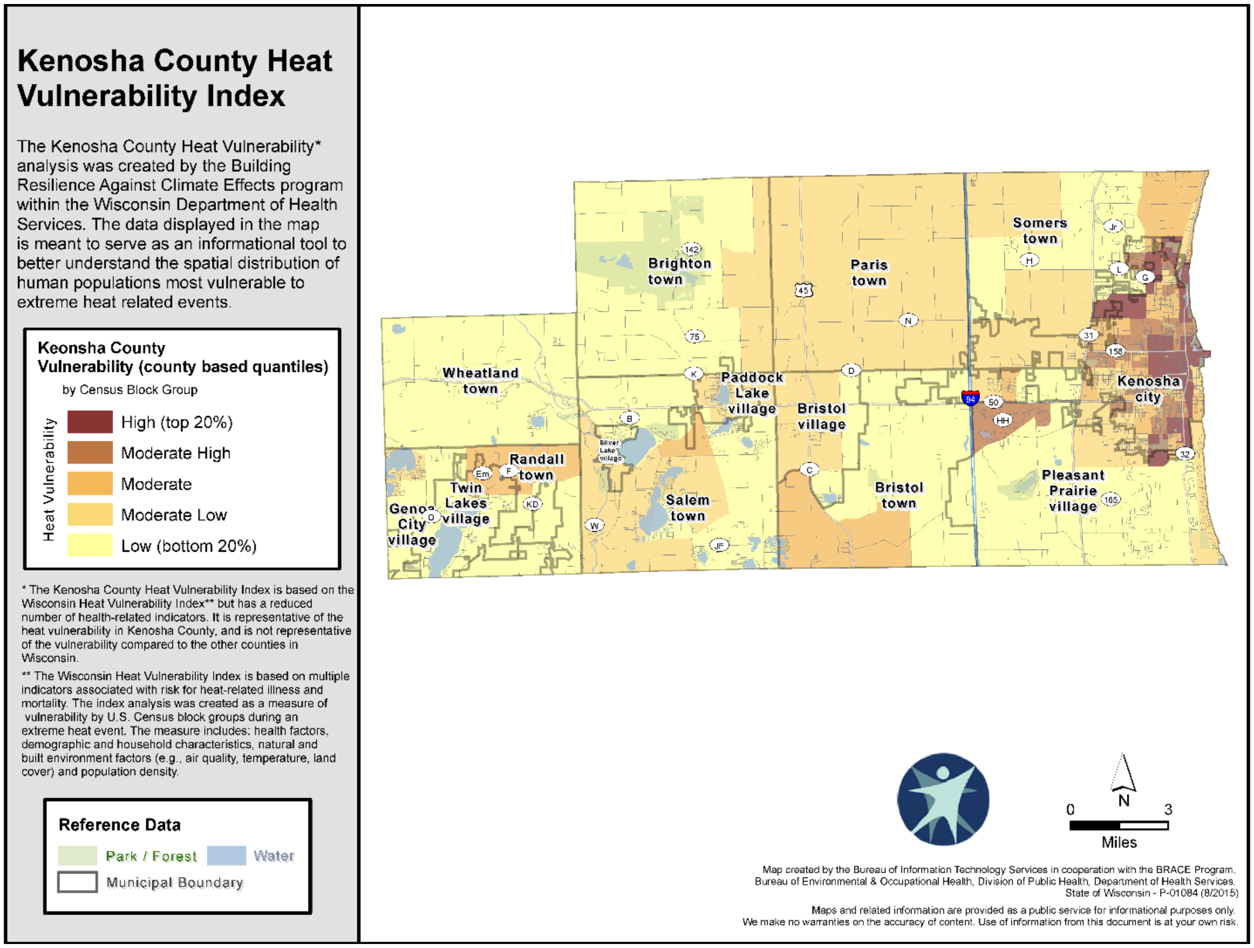
Likelihood of heat disorders with prolonged exposure or strenuous activity:

- Caution
- Extreme Caution
- Danger
- Extreme Danger

Source: National Weather Service and SEWRPC

#265916 – Kenosha Co HMP Figure 3.3
500-1148
CDP/mid
2/13/2023; 11/29/2022

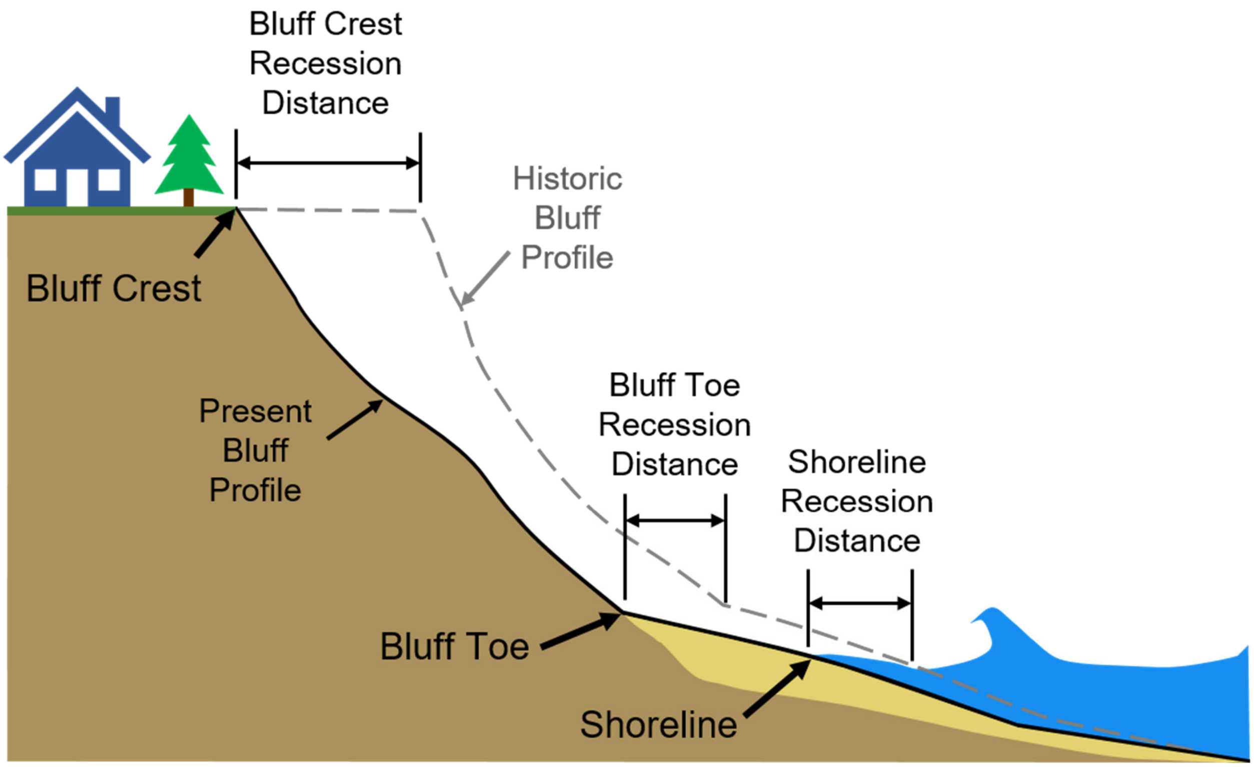
Figure 3.3
Kenosha County Heat Vulnerability Index: 2015



Source: Wisconsin Department of Health Services, Building Resilience Against Climate Effects Program

#266288 – Kenosha Co HMP Figure 3.4
500-1148
CDP/mid
2/13/2023; 1/4/23

Figure 3.4
Bluff Recession Schematic



Source: Wisconsin Coastal Management Program and SEWRPC

#266289 – Kenosha Co HMP Figure 3.5
500-1148
CDP/mid
2/13/2023; 1/4/23

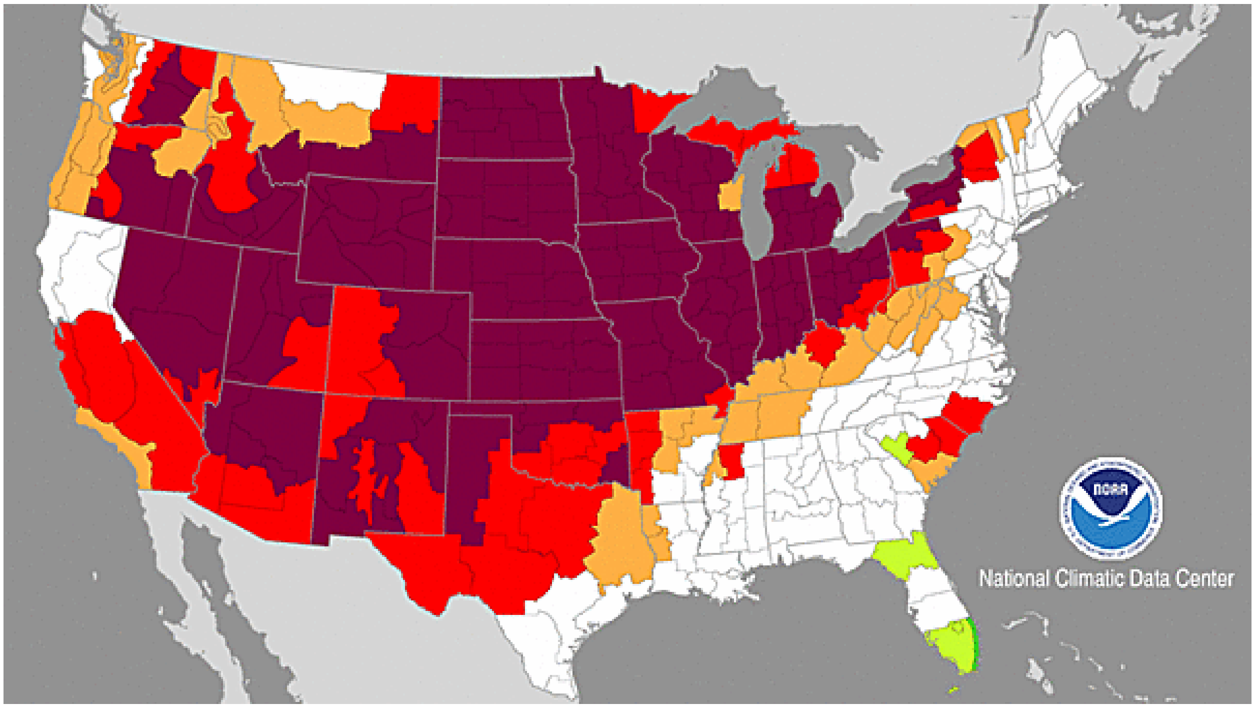
Figure 3.5
U.S. Drought Monitor Classifications

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

Source: U.S. Drought Monitor Drought Classification (droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx)

#266291 – Kenosha Co HMP Figure 3.6
500-1148
CDP/mid
2/13/2023; 1/4/23

Figure 3.6
Palmer Drought Severity Index for July 1934

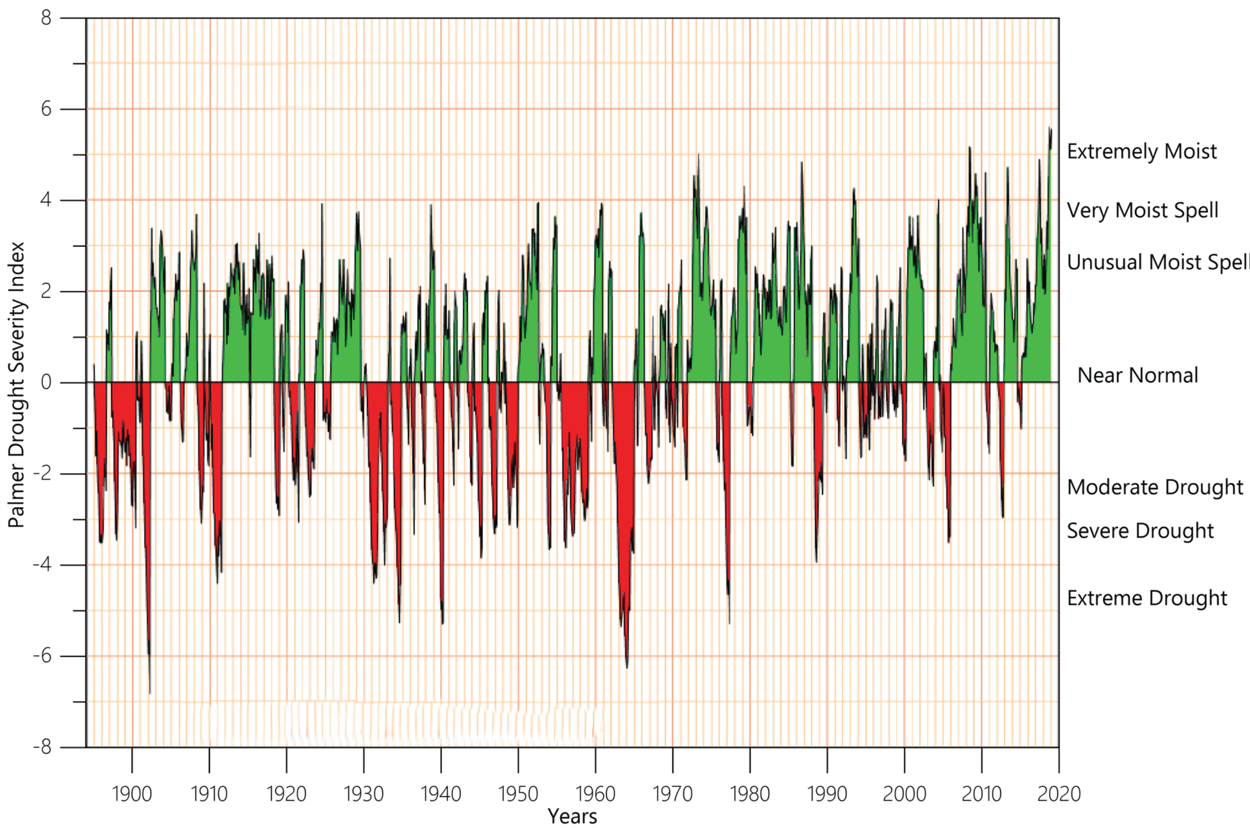


Extreme Drought	Severe Drought	Moderate Drought	Midrange	Moderately Moist	Very Moist	Extremely Moist
-4.00 and Below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and Above

Source: National Climatic Data Center

#266292 – Kenosha Co HMP Figure 3.7
500-1148
CDP/mid
2/13/2023; 1/4/23

Figure 3.7
Palmer Drought Severity Index for Southeastern Wisconsin: 1895-2022



Source: University of Wisconsin Atmospheric and Oceanic Sciences, Wisconsin State Climatology Office

SEWRPC Community Assistance Planning Report No. 378 (4th Edition)

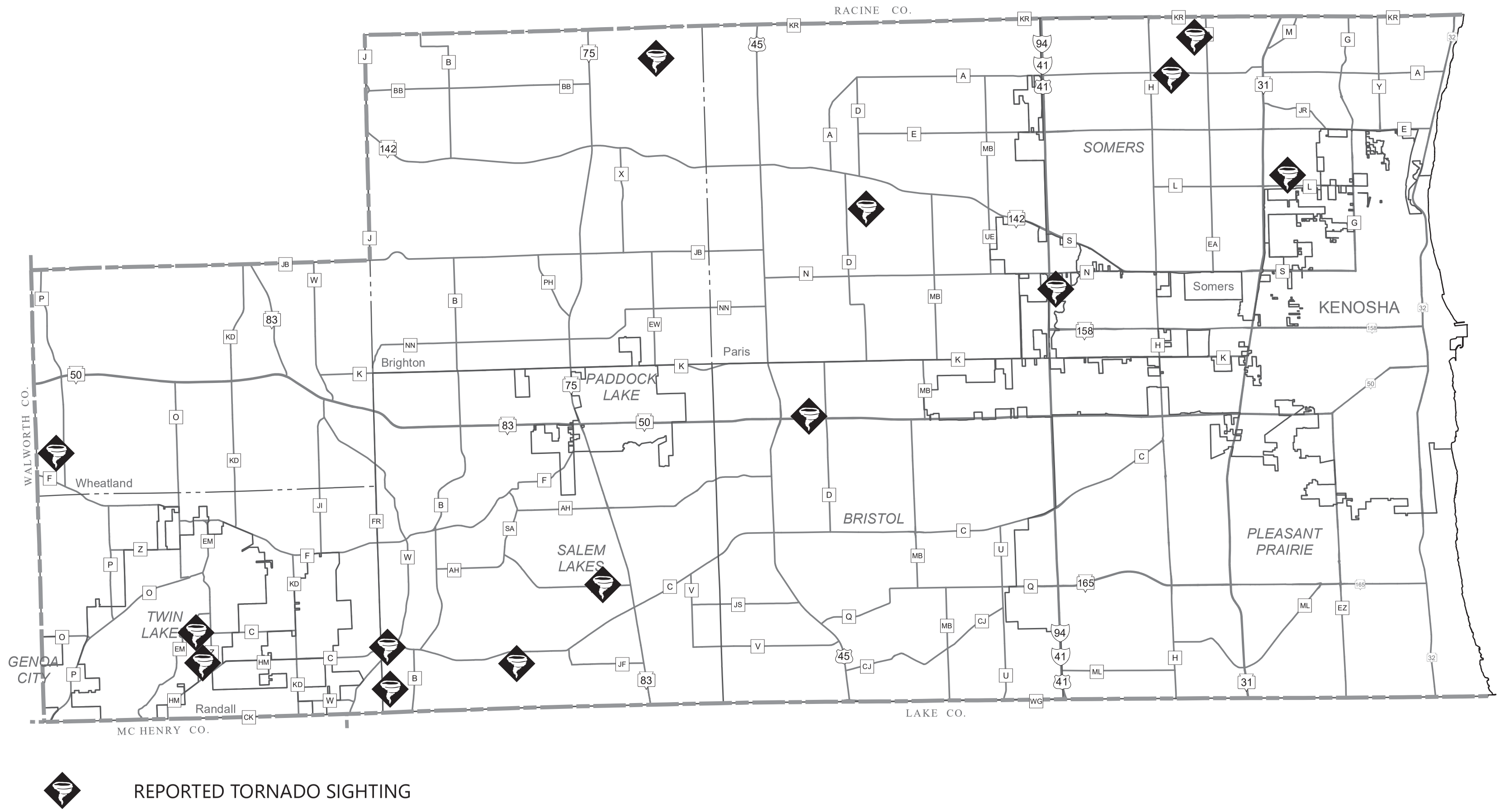
KENOSHA COUNTY HAZARD MITIGATION PLAN UPDATE: 2023-2028

Chapter 3

ANALYSIS OF HAZARD CONDITIONS

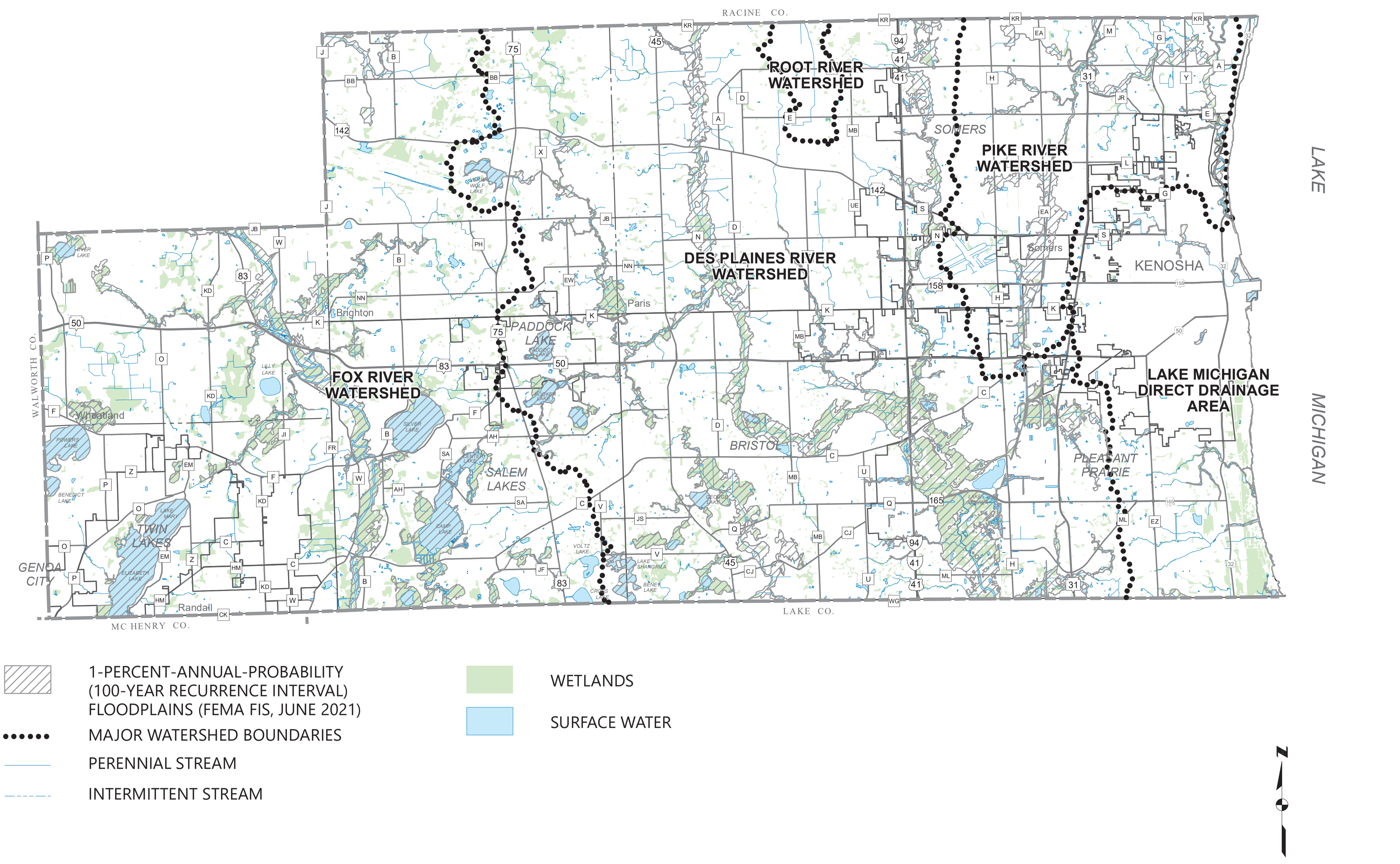
MAPS

Map 3.1
Historic Tornado Events Reported in Kenosha County: 1963-2021



Source: National Climatic Data Center and SEWRPC

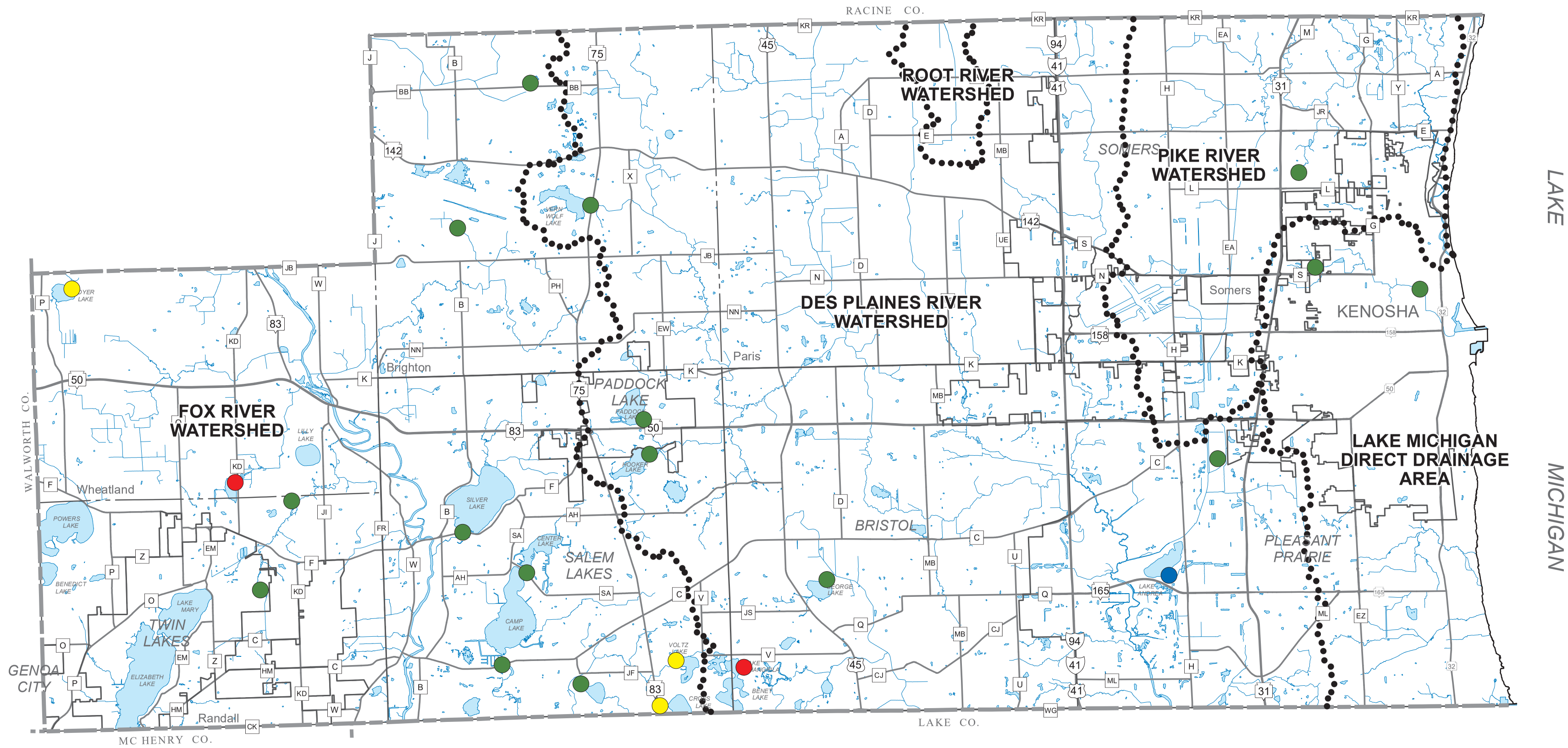
Map 3.2
Surface Waters, Wetlands, and Floodplains in Kenosha County: 2020



- 1-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAINS (FEMA FIS, JUNE 2021)
- MAJOR WATERSHED BOUNDARIES
- PERENNIAL STREAM
- INTERMITTENT STREAM
- WETLANDS
- SURFACE WATER

Source: Federal Emergency Management Agency and SEWRPC

Map 3.3
Dams Located in Kenosha County: 2021



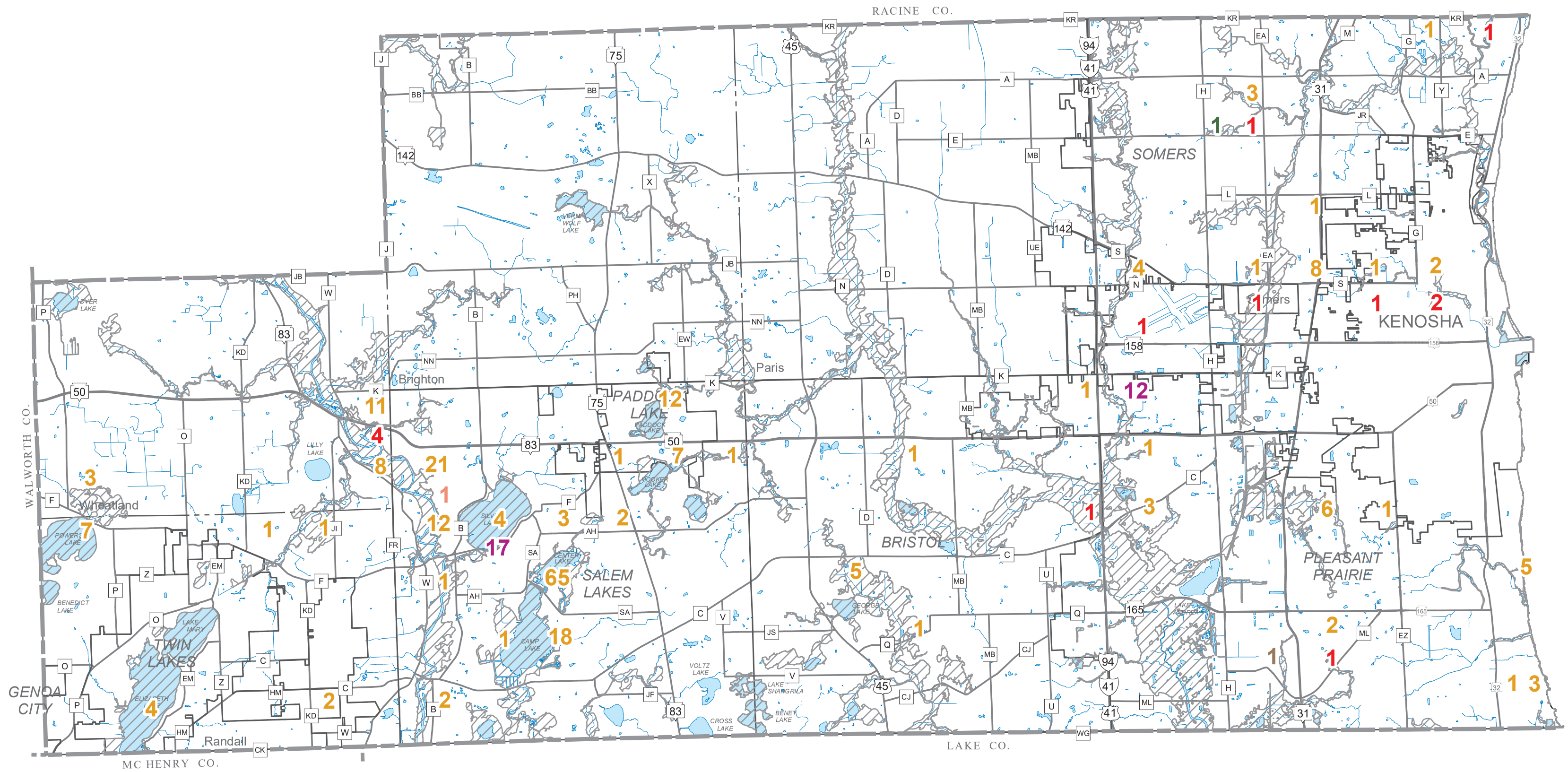
HAZARD RATING

- HIGH
- SIGNIFICANT
- LOW
- NONE ASSIGNED

0 1 2 3 Miles

Source: Wisconsin Department of Natural Resources and SEWRPC

Map 3.4
Structures Located Within the 100-Year Floodplain: 2022



241	RESIDENTIAL STRUCTURES WITHIN U.S. PUBLIC LAND SURVEY SECTION
13	COMMERCIAL STRUCTURES WITHIN SECTION
1	AGRICULTURAL STRUCTURES WITHIN SECTION
29	MOBILE HOMES WITHIN SECTION
1	COMMUNITY UTILITY STRUCTURES WITHIN SECTION
1	OTHER STRUCTURES WITHIN SECTION

1-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAINS (FEMA FIS, JUNE 2021)

PERENNIAL STREAM

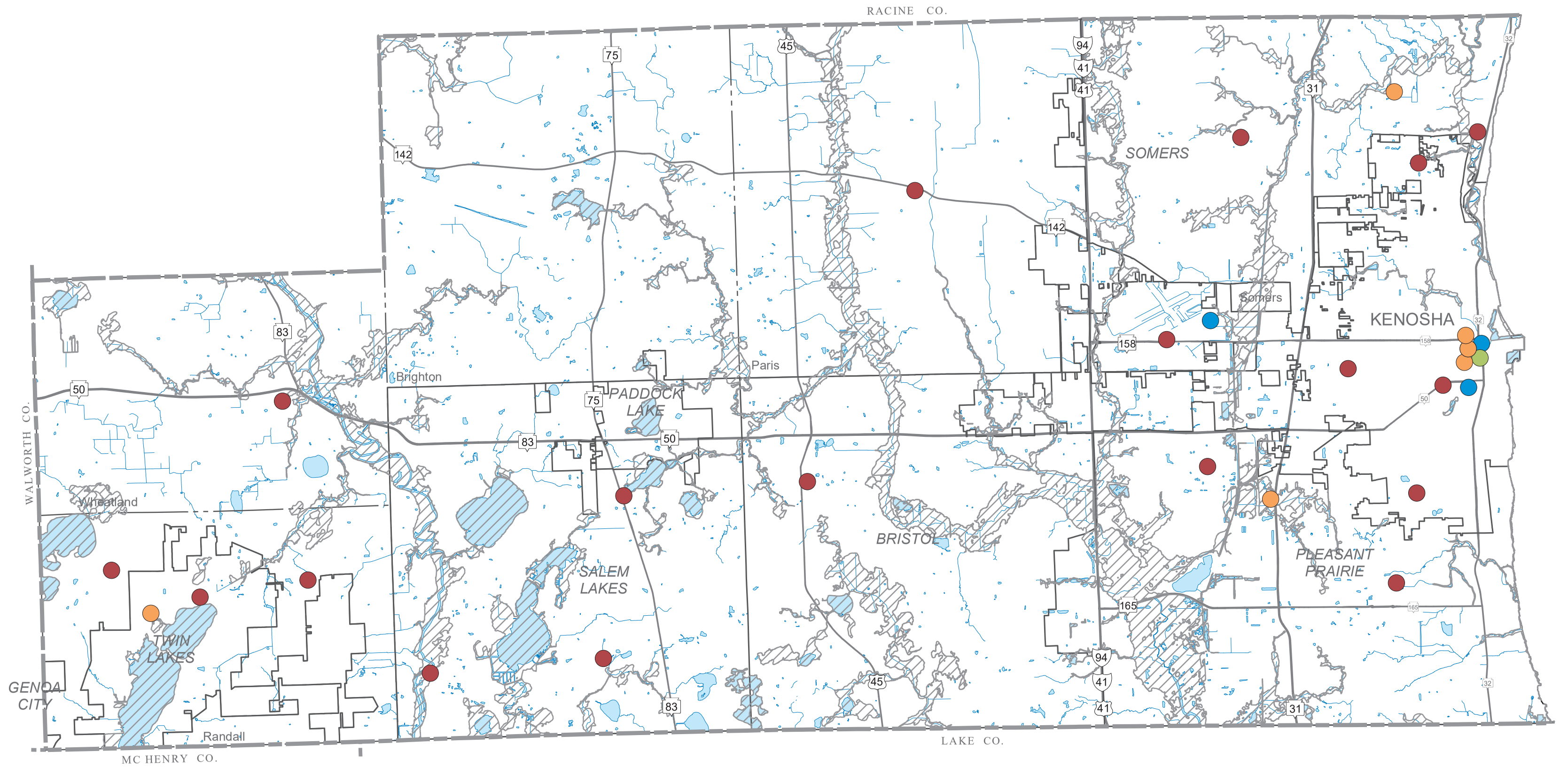
INTERMITTENT STREAM

SURFACE WATER

0 1 2 3 Miles

Source: Federal Emergency Management Agency, Kenosha County, and SEWRPC

Map 3.5
Emergency Service Structures in Relation to 100-Year Floodplains: 2022



FIRE/EMS STATION

POLICE STATION

COUNTY COURT HOUSE

CORRECTIONAL FACILITY

1-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAINS (FEMA FIS, JUNE 2021)

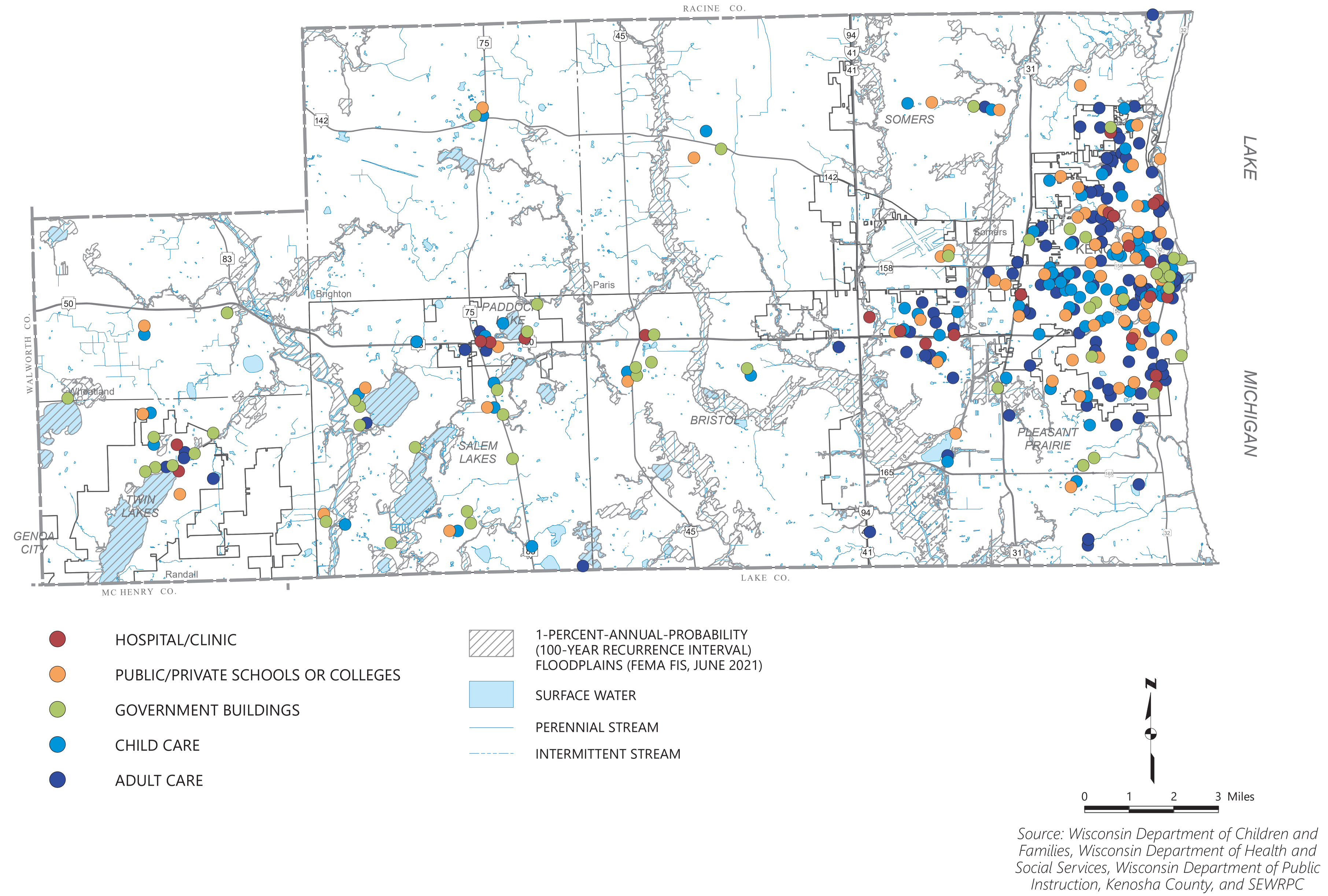
SURFACE WATER

PERENNIAL STREAM

INTERMITTENT STREAM

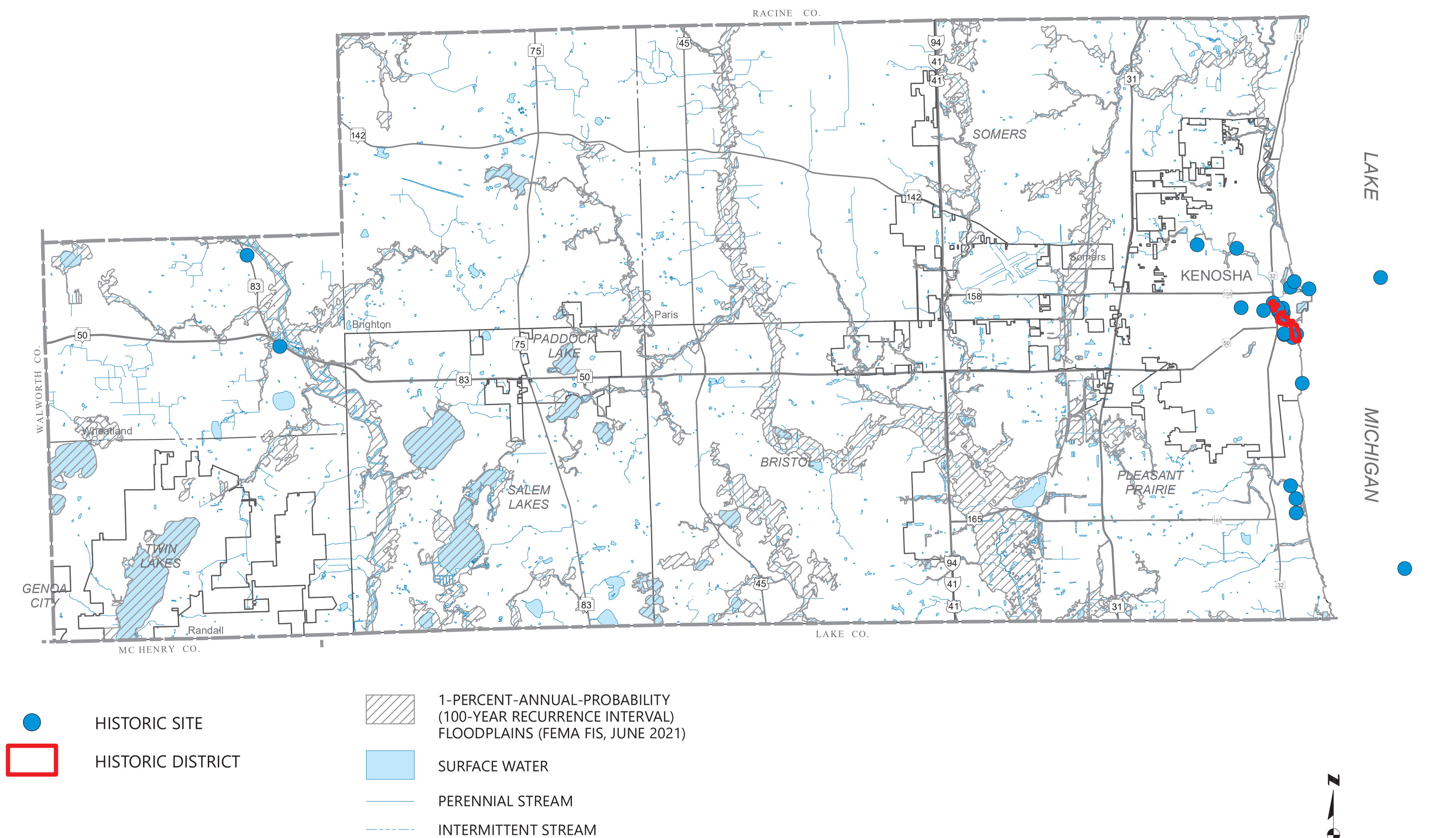
Source: Wisconsin Department of Justice (WILENET), Racine County Office of Emergency Management Department, Kenosha County, and SEWRPC

Map 3.6
Critical Community Facilities in Relation to 100-Year Floodplains: 2022



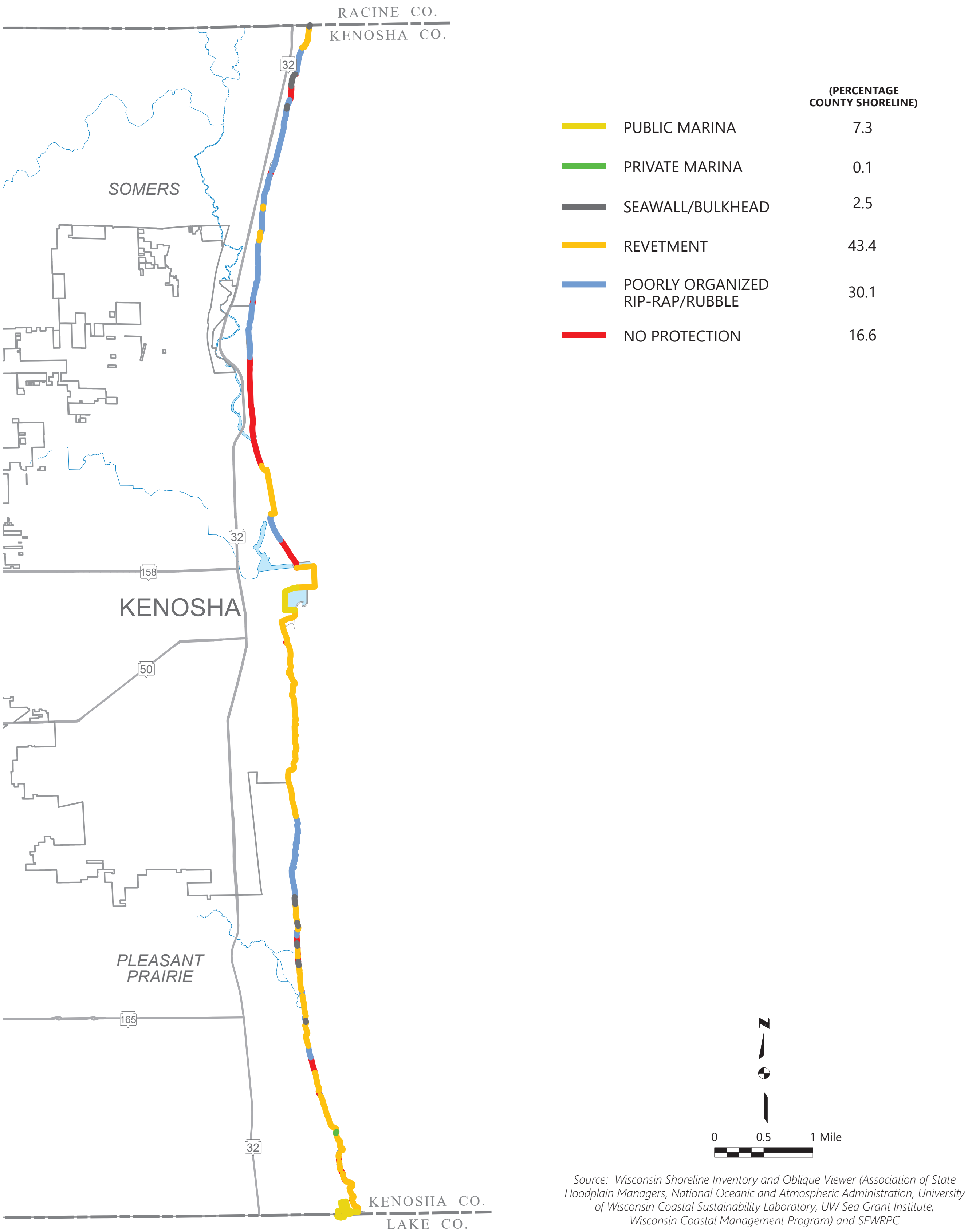
Source: Wisconsin Department of Children and Families, Wisconsin Department of Health and Social Services, Wisconsin Department of Public Instruction, Kenosha County, and SEWRPC

Map 3.7
National and State Registers of Historic Sites and Districts in Relation to 100-Year Floodplains: 2022



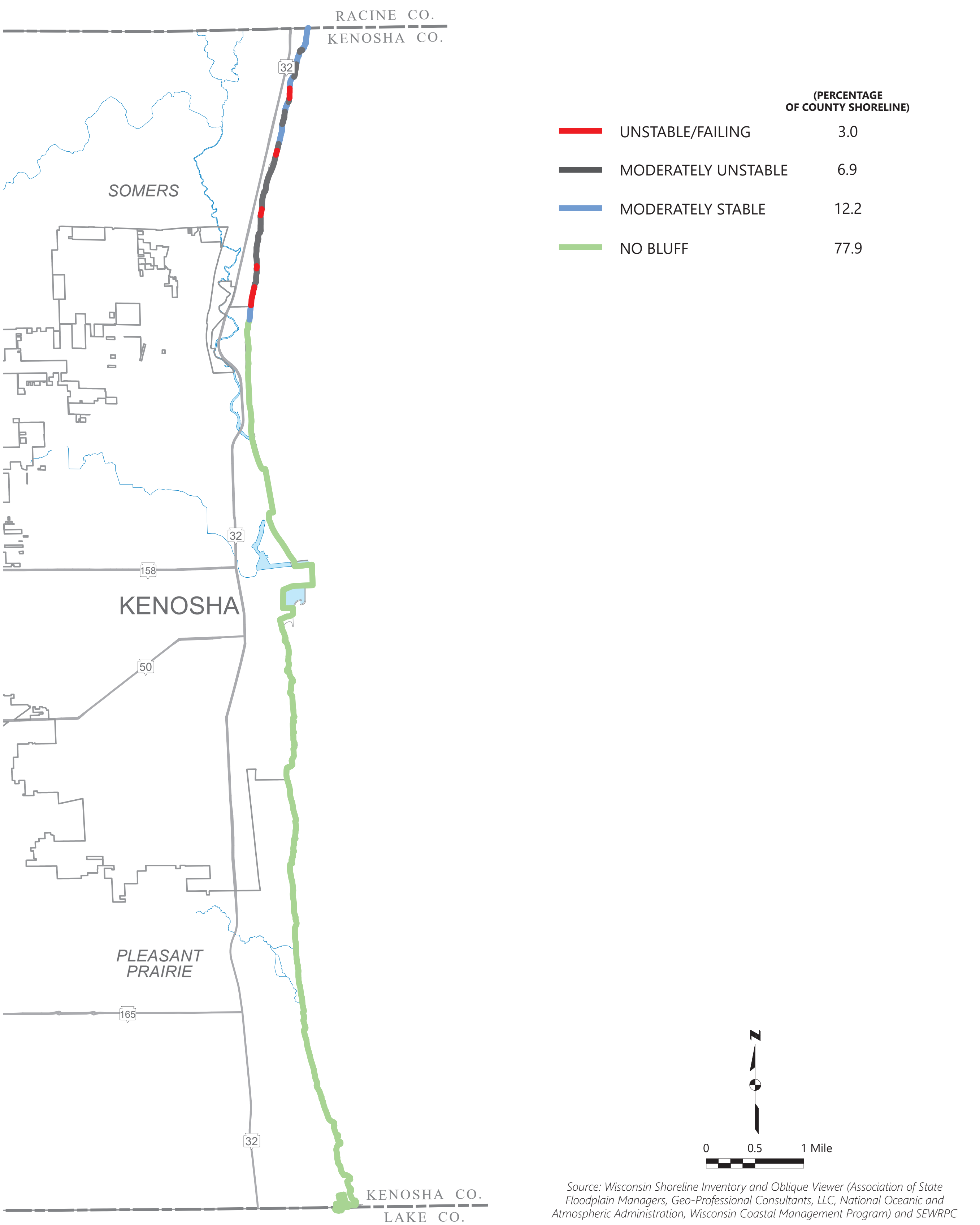
Source: Federal Emergency Management Agency and SEWRPC

Map 3.08
Types of Shore Protection in Kenosha County: 2018-2019



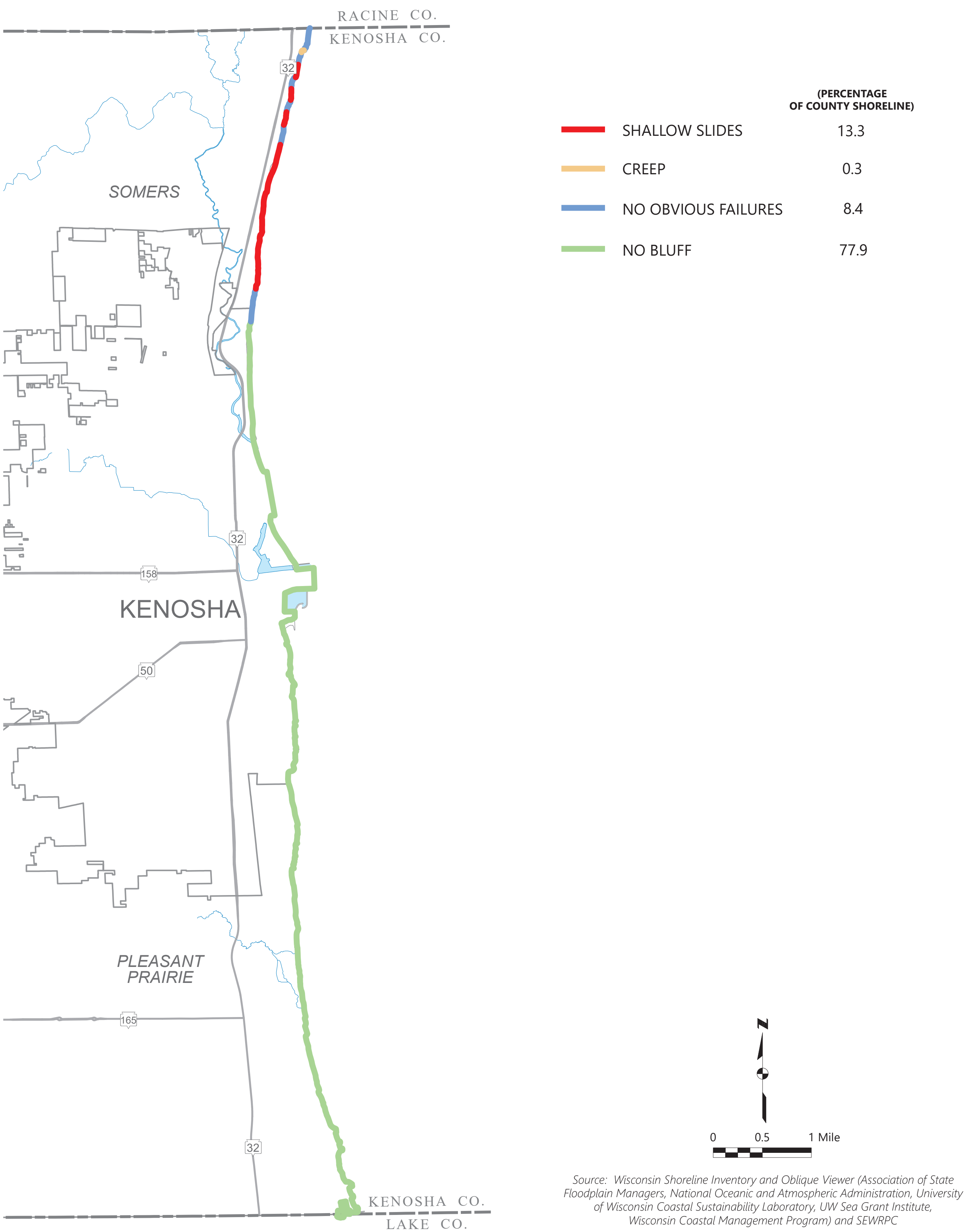
Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, National Oceanic and Atmospheric Administration, University of Wisconsin Coastal Sustainability Laboratory, UW Sea Grant Institute, Wisconsin Coastal Management Program) and SEWRPC

Map 3.9
General Bluff Conditions in Kenosha County: 2018



Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, Geo-Professional Consultants, LLC, National Oceanic and Atmospheric Administration, Wisconsin Coastal Management Program) and SEWRPC

Map 3.10
Types of Bluff Failure in Kenosha County: 2018-2019



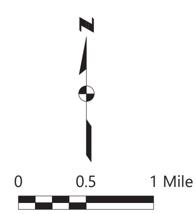
Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, National Oceanic and Atmospheric Administration, University of Wisconsin Coastal Sustainability Laboratory, UW Sea Grant Institute, Wisconsin Coastal Management Program) and SEWRPC

Map 3.11
Long Term Bluff Toe Recession in Kenosha County: 1956-2015

BLUFF RECESSION

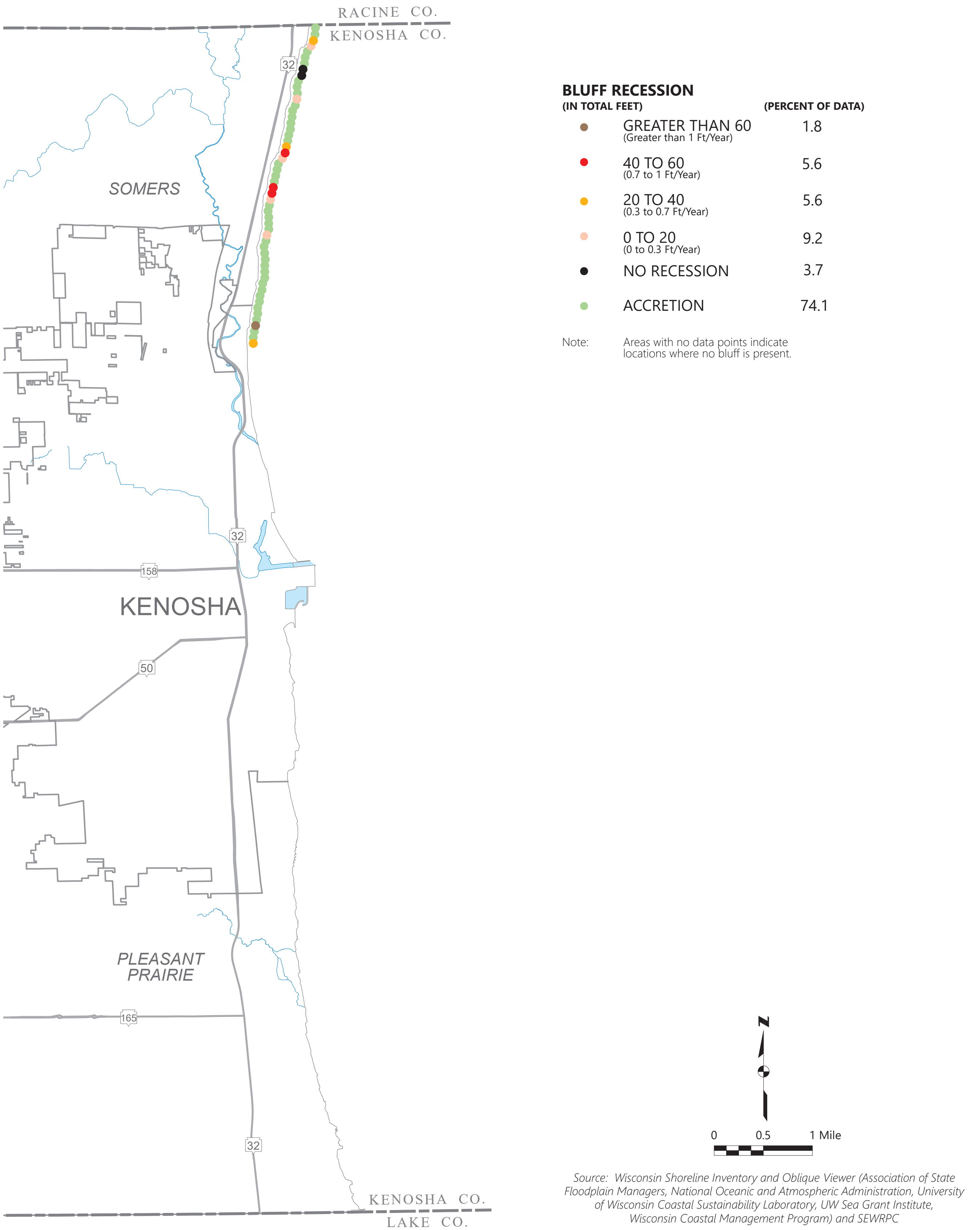
(IN TOTAL FEET)	(PERCENT OF DATA)
GREATER THAN 60 (Greater than 1 Ft/Year)	0.0
40 TO 60 (0.7 to 1 Ft/Year)	0.0
20 TO 40 (0.3 to 0.7 Ft/Year)	1.8
0 TO 20 (0 to 0.3 Ft/Year)	5.3
NO RECESSION	0.0
ACCRETION	92.9

Note: Areas with no data points indicate locations where no bluff is present.



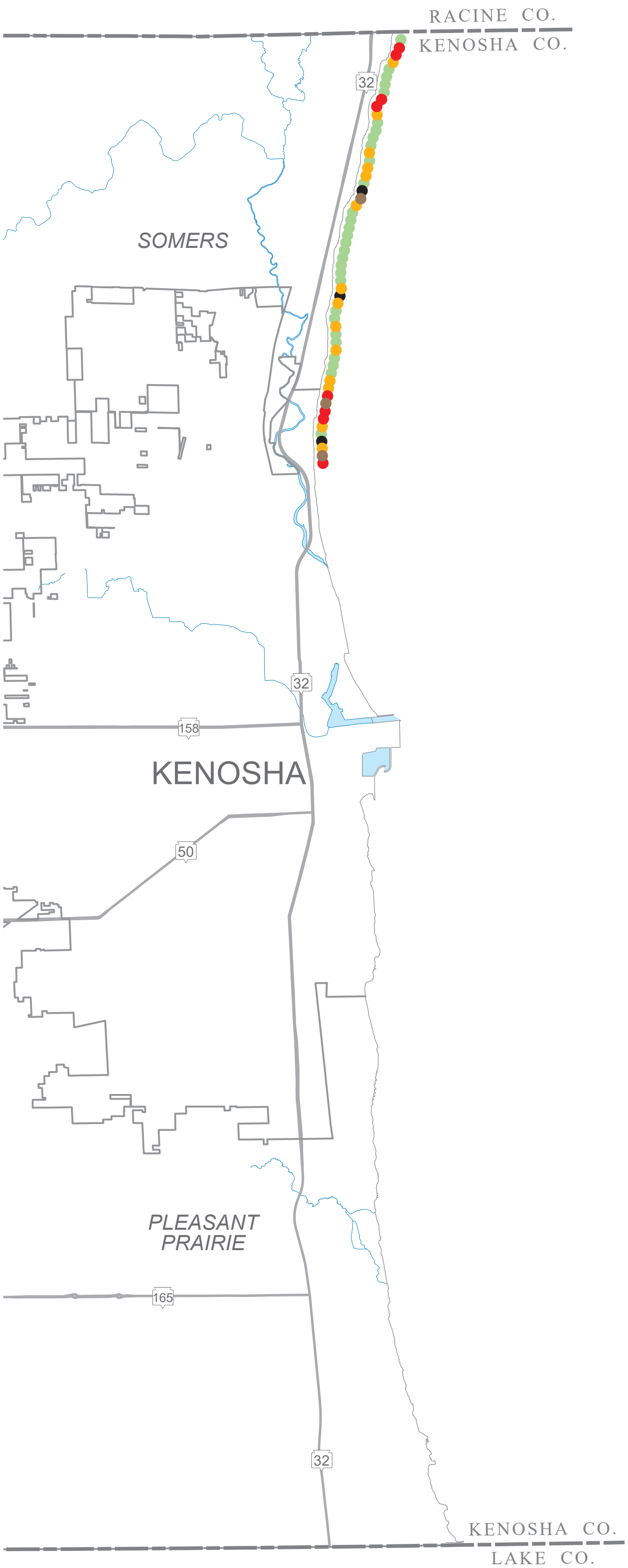
Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, National Oceanic and Atmospheric Administration, University of Wisconsin Coastal Sustainability Laboratory, UW Sea Grant Institute, Wisconsin Coastal Management Program) and SEWRPC

Map 3.12
Long Term Bluff Crest Recession in Kenosha County: 1956-2015



Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, National Oceanic and Atmospheric Administration, University of Wisconsin Coastal Sustainability Laboratory, UW Sea Grant Institute, Wisconsin Coastal Management Program) and SEWRPC

Map 3.13
Short Term Bluff Toe Recession in Kenosha County: 1995-2015



BLUFF RECESSION

(IN TOTAL FEET)	(PERCENT OF DATA)
GREATER THAN 20 (Greater than 1 Ft/Year)	5.3
10 TO 20 (0.5 to 1 Ft/Year)	14.0
0 TO 10 (0 to 0.5 Ft/Year)	24.6
NO RECESSION	5.3
ACCRETION	50.8

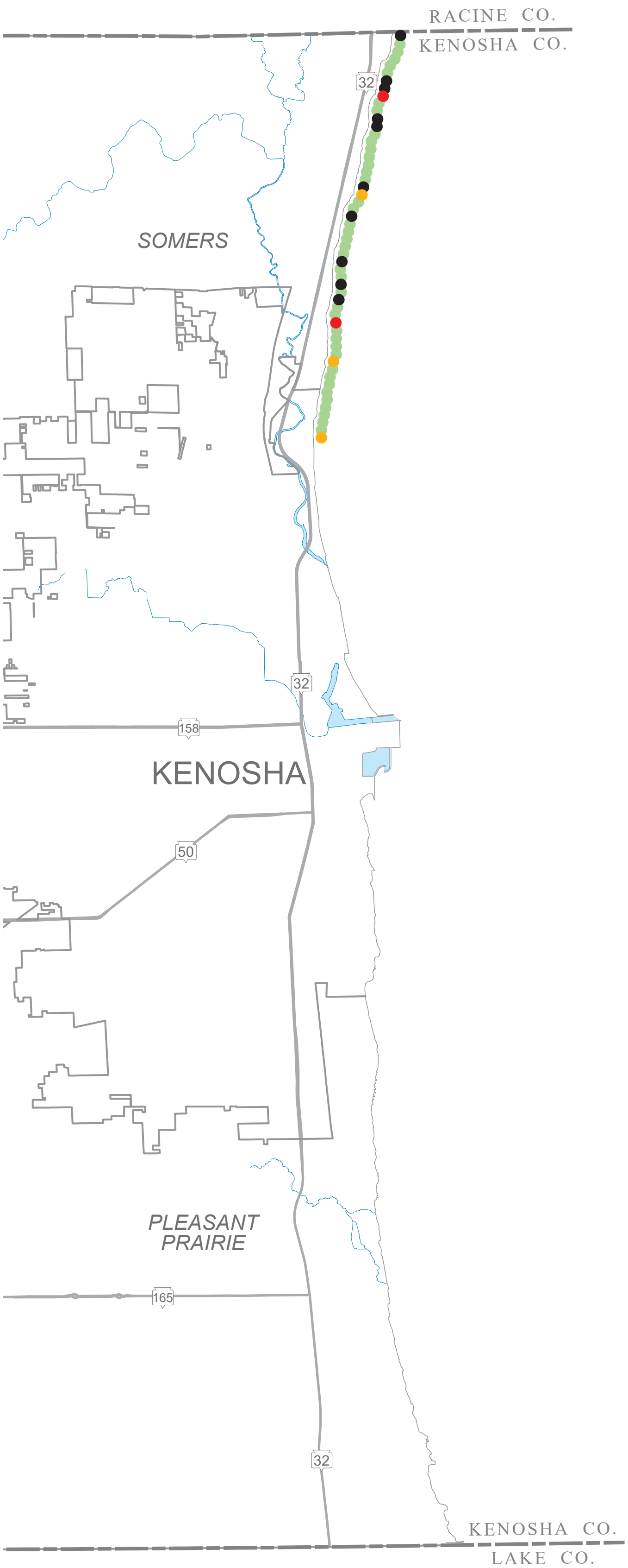
Note: Areas with no data points indicate locations where no bluff is present.

N

0 0.5 1 Mile

Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, National Oceanic and Atmospheric Administration, University of Wisconsin Coastal Sustainability Laboratory, UW Sea Grant Institute, Wisconsin Coastal Management Program) and SEWRPC

Map 3.14
Short Term Bluff Crest Recession in Kenosha County: 1995-2015



BLUFF RECESSION

(IN TOTAL FEET)	(PERCENT OF DATA)
GREATER THAN 20 (Greater than 1 Ft/Year)	0.0
10 TO 20 (0.5 to 1 Ft/Year)	3.7
0 TO 10 (0 to 0.5 Ft/Year)	5.6
NO RECESSION	18.5
ACCRETION	72.2

Note: Areas with no data points indicate locations where no bluff is present.

N

0 0.5 1 Mile

Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, National Oceanic and Atmospheric Administration, University of Wisconsin Coastal Sustainability Laboratory, UW Sea Grant Institute, Wisconsin Coastal Management Program) and SEWRPC

Map 3.15
Location of Structures Along the Lake Michigan Coastal that are Within the 1-Percent-Annual-Probability Flood Hazard Area: 2020

Source: Federal Emergency Management Administration, Wisconein Department of Natural Resources, and SEWRPC