



# WINTER HAZARDS

## Location

Northern Wisconsin receives about 100 inches of snowfall per year. Winter storms travel to the city using several paths producing a varying degree of effects. Storm tracks that originate in the southern Rockies or Plains states move northeastward and produce the heaviest precipitation (typically 6 to 12 inches). Meanwhile, low-pressure systems originating in the northwest (Alberta Clippers) tend to produce only light snowfalls (generally two to four inches). Snowfall associated with Alberta Clippers occurs more frequently with colder weather.

Although massive blizzards are rare in Wisconsin, blizzard-like conditions often exist during heavy snowstorms when gusting winds off of Lake Superior cause blowing and drifting snow. A storm is not considered a blizzard unless accompanied by wind speeds in excess of 35 miles per hour.

## Hazard Profile

Winter in the City is typically cold and snowy with occasional severe storms involving snow, high wind, freezing rain and/or extremely cold temperatures. March and December are usually the most precipitous months, while January is usually the coldest. The lowest temperature recorded in the City was  $-38^{\circ}$  F on March 1, 1962 and also on February 12, 1967. The average high in January is  $23.8^{\circ}$  F and the average low is  $-6^{\circ}$  F.

Winter storm hazards can come in many forms and can affect the entire City. Snow may come alone as light flurries, intense showers, or in concert with high wind, causing blowing, drifting snow and blizzard conditions. Winter storms occurring in spring, fall, or during winter warm-ups, when air temperatures are higher, may produce precipitation as sleet or freezing rain. Freezing rain is liquid precipitation that falls onto a surface whose temperature is below freezing, thus forming a coating or glaze of ice. Even small accumulations of ice can cause a significant hazard. Extreme cold temperatures can also pose a threat to the City. For example, when extreme cold temperatures accompany lack of snow, complications with underground utilities can arise. If high wind, is also involved, public safety can be at risk. In the spring, snowmelt can become a flooding hazard to buildings, roads, and wastewater treatment utilities and can aggravate erosion in streams, rivers, and coastal areas.

Typically, between the first annual frost, usually in October, and the last frost, usually in April or May, precipitation falls as snow. All months between October and May have received snow. Superior typically sees 27 days of trace snow, 19 days of snow accumulating more than one inch, 11 days of snow accumulating more than 2 inches and about 2 days of snow accumulating more than 5 inches. The winter of 1968-69 showed a

total accumulation of 121 inches of snow between October and May. March 1917 holds the record for the greatest month-long snow accumulation at 48.2 inches. Both ice and sleet storms can occur at any time throughout the winter season from November to April.

All types of winter storms can disrupt various services in the City, including public transportation, postal service, flight service out of Bong Airport, rail service and garbage collection, among others.

Table 9.1 Common Terms & Explanations Related to Winter Hazards

<b>Winter weather advisory</b>	This alert may be issued for a variety of severe conditions. Weather advisories may be announced for snow, blowing or drifting snow, freezing drizzle, freezing rain, or a combination of weather events.
<b>Winter storm watch</b>	Severe winter weather conditions may affect your area (freezing rain, sleet, or heavy snow may occur separately or in combination).
<b>Winter storm warning</b>	Severe winter weather conditions are imminent.
<b>Freezing rain or freezing drizzle</b>	Rain or drizzle is likely to freeze upon impact, resulting in a coating of ice glaze on roads and all other exposed objects.
<b>Sleet</b>	Small particles of ice, usually mixed with rain. If enough sleet accumulates on the ground, it makes travel hazardous.
<b>Blizzard warning</b>	Sustained wind speeds of at least 35 mph are accompanied by considerable falling or blowing snow. This alert is for the most perilous winter storm with visibility dangerously restricted.
<b>Frost/freeze warning</b>	Below freezing temperatures are expected and may cause significant damage to plants, crops and fruit trees.
<b>Wind chill</b>	A strong wind combined with temperatures slightly below freezing can have the same chilling effect as temperatures nearly 50 degrees lower in a calm atmosphere. The combined cooling power of the wind and temperature on exposed flesh is called the wind-chill.

## Snow from Winter Hazards

Snow is a predictable annual occurrence in the City. Typically, snow blankets the ground from November to March. Hazardous conditions can come in the form of heavy snowfall alone or in combination with high winds that result in blizzard conditions.

The City is a prime target for the natural phenomenon of “lake effect” snowstorms. Even during winter, water contained in large masses, such as Lake Superior, stay warmer than the air temperature. When cold air from northern storm fronts hit the warm lake air, the

air destabilizes, clouds form and snow falls. This often occurs on the tail of a conventional snow event, so areas prone to lake effect events receive higher snowfall over longer periods of time than areas further away from the lake. Lake effect snowfall is dependent on the position of the storm tracks, the degree and variations in lake water temperatures, the extent of ice coverage and prevailing wind direction and speed. Lake effect snowfall contributes between 30% and 50% of the annual winter snowfall on the eastern and southern shores of the Great Lakes.

Snow events resulting in significant accumulation pose hazards for travel on City, county, and state roads. Snow accumulation of more than 12” in any single event results in travel advisories and may result in cancelled garbage pickup. These actions aid City maintenance crews in snow removal operations.

Snow coupled with warm daytime temperatures pose the threat of slippery road conditions during night and morning travel. The snow can melt and cover the roads during the day, then freeze overnight when temperatures drop to or below freezing. Increased sanding and salting operations by City maintenance crews help to control this hazard.

Drifting snow may occur during or after snowfall events when high winds push snow up on roads and in open areas. The quantity of snow in an exposed drifting area can add up to a depth many times more than what actually fell from precipitation. Drifting snow can cause travel delays and lane or road closures on major thoroughfares hampering or impeding motorists from getting to and from work, school, or other destinations. Snowdrifts are formed in areas without protection from wind such as in fields or other open areas.

Snowdrift areas at highest risk are Tower Avenue, especially near the Fairgrounds and East 2<sup>nd</sup> Street (Highway 53/2). Tower Avenue was constructed lower than the surrounding land in order to manage stormwater in South Superior. Unfortunately, this hampers snow maintenance operations, since snow blows over the roadsides and fills in the roadway. East 2<sup>nd</sup> Street was constructed similarly, but also employs a central median. The median traps snow blowing across the road, causing drifting and potential road obstructions.

Table 9.2 City of Superior Significant Drifting Events

Date	Wind Velocity (mph)	New Snow Depth (inches)	Drift Heights (inches)
February 1922	40-60	32	264
March 1943	45	1.5	14
December 1950	35	29	96
December 1985	20-40	18.5	44

### ***Historical Events***

- In March 1917, 36 inches of snow fell in Superior over 24 hours. High winds caused snow to form drifts 10-12 feet high. Drifts impeded train and motorist passage.
- In February 1922, 32 inches of snow fell in 55 hours, accompanied with 40-60 mph winds causing 22-foot drifts. Impassable roads prevented fire rescue operations and businesses were closed 3-4 days until roads were reopened.
- In March 1943, 45 mph winds persisted during a light (1.5 inch) snowfall causing 14 foot drifts closing roads, businesses and schools.
- In December 1950, 29 inches of snow fell, accompanied by 35 mph winds resulting in 5-8 foot snowdrifts that buried parked cars.
- In March 1956, 12 inches of snow accompanied by 30-68 mph winds caused massive snowdrifts resulting in closure of most City offices and most businesses. Reduced travel resulted in more efficient snow removal operations.
- In January 1967, 15 inches of snow fell, accompanied by 50 mph winds creating massive snowdrifts closing most secondary highways and City streets. Snowdrifts trapped people in their homes and vehicles.
- In November 1975, 15 inches of snow accompanied by freezing rain and ice caused extremely hazardous road conditions. Roads, schools and airports were closed, all Greyhound busses were cancelled and trains derailed. Iced power lines broke in high winds causing some power outages.
- In December 1982, 12-24 inches of snow fell over 48 hours, causing the Bong Airport to close, Greyhound busses, garbage and the United States Postal Service to cancel all services, businesses to close and travel advisories to be issued.
- In November 1983, a total of 31.5 inches of snow fell during two back-to-back storms over the Thanksgiving holiday.
- In December 1985, drifting snow resulted from 18.5 inches of snow falling in 36 hours accompanied by 20-40 mph winds. Drifts reached 44 inches, burying parked cars.
- On Halloween 1991, 37 inches of snow fell in 48 hours, with effects lasting several days after snow stopped falling. A Declaration of Snow Emergency was made by Mayor Bergson. Citizens were trapped in their homes by drifting snow that built against doors and windows. A few homes suffered collapsed walls and ceilings due to the weight of snow accumulation. A strict travel advisory was issued to prevent motorists from traveling on dangerous roads and to limit obstacles to snow removal operations. Both the Bong and Blatnik Bridges were closed. St. Mary Hospital called in any available vehicles with 4-wheel drive to bring nurses and doctors to the hospital. Garbage service, schools and all Parks and Recreation activities were cancelled for one to several days.
- On New Years Day 1997, 22 inches of snow fell in 24 hours. A Declaration of Snow Emergency was made by Mayor Margaret Ciccone.
- On March 1-3, 2007, a severe winter storm hit the City. The storm brought over 20 inches of snow and sustained winds of 40 mph with frequent gust up to 52 mph. Blizzard conditions affected the City with whiteout conditions and zero visibility. The City pulled snowplows off the roads and travel became virtually impossible. The storm resulted in snowdrifts and freezing precipitation that covered trees, homes and power lines.

- On March 9, 2007, Firefighters were called to a house fire where there was considerable snow accumulation on the boulevards. Due to the snow conditions, a hydrant could not be located, hindering firefighting activities and increasing the extent of the damage.
- In April 2008, a snow storm that blew through Superior, devastating the local cemetery. The storm felled 10 large trees and several tombstones. An estimated \$7,000 in damage was caused to remove the trees and reset the tombstones.
- In February 2009, snow and freezing ice conditions closed area schools, including UW-Superior, despite its policy to never close.
- In December 20-21, 2010, close to 10-12 inches of snow fell causing business closures throughout the Twin Ports.
- In December 31-January 1, 2012, a mix of 3-6 inches of snow with 40mph winds came across Duluth/Superior.
- The top 4 years for snow with the highest snow accumulation are: 1949-1950: 132 inches; 1988-1989: 121 inches; 1995-1996: 135 inches; 1996-1997: 127 inches.

### ***Probability & Predictability***

The probability of a snowstorm causing damage in the City is high (>5% annually). Significant snowstorms (5-12 inches in 24 hours) can be expected to occur once annually, most of which will result in travel advisories and potentially, school and/or road closures. Severe, hazardous snow conditions appear to occur at least once every 10-15 years. A 100-year snowstorm would likely be of the same magnitude as the storm that occurred on Halloween 1991.

## **Ice from Winter Hazards**

Ice becomes threatening as liquid water falls below 32°F and freezes. When snow melts during warm-ups then freezes over roadways as temperatures drop, especially at night, slippery road conditions can impair travel. Ice is also hazardous in the form of precipitation (freezing rain) when liquid rain falls onto objects, such as roads, trees and power lines with surface temperatures below freezing.

Fighting ice on roadways involves applying chemicals and/or sand initially to priority routes. Sanding and/or salting activities may be done as a preventative measure and/or treatment for existing conditions. With favorable temperatures, rock salt can be used to melt up to two inches of snow and prevent the bonding of compacted snow to pavements. This ensures a cleaner plowing job, should plowing become necessary. Less than optimum results of chemical and sand application occur when temperatures are below 15° F and when traffic volumes are too light to activate the chemicals. When temperatures are extremely low and salt cannot melt the snow and ice, sand must be used to act as an abrasive material to provide traction to vehicle tires.

Snow removal operations involve plowing priority routes and residential streets. Plowing begins when snow accumulation exceeds 2” and more snowfall is expected. First, priority snow routes are cleared and if snow accumulation exceeds 3”, streets in residential districts are cleared.

Ice storms cause significant direct and indirect damage to structures, natural resources, and utilities in the City. As rain falls on an object whose ambient temperature is below freezing, the water freezes over the surface of the structure. When high winds accompany precipitation of this sort, damages can be high. Northeasterly winds striking power lines perpendicularly, especially in the Central Park, East End, and Allouez neighborhoods, can cause conductors (power lines) to snap, resulting in power outages. This phenomenon can also occur on cable ties supporting elevated structures such as aerial conveyor belts and hoppers used for loading products such as taconite onto railroad cars. When these supports break, the structures are at a higher risk for wind related damages.

Ice floes are floating chunks of ice that have been problematic in the harbor and at the mouth of the Nemadji River. They can block spring snowmelt runoff and cause flooding over roads and bridges. Cold temperatures perpetuate this hazard by causing floodwater to freeze on roads and bridges creating hazards for motorists.

### ***Historical Events***

- Freezing rain resulted in ice storms in April 1947 and 1968. Ice-coated power lines and tree branches snapped when high winds made contact. Damage to electrical lines and transformers caused widespread power outages. As the ice melted after the 1947 storm, sewers were plugged with slush, causing flooding and freezing across roads. In 1968, 95 power poles and 300 cross arms were damaged by high winds.
- During a warm spell in December 1956, sleet and rain caused ice to form on roads, causing extremely hazardous conditions. All bus service was cancelled and 3 people were hospitalized from falls on the ice.
- In April 2002, a mixture of sleet and freezing rain fell, causing accumulations of up to ½” of ice on roads, trees, and power lines. Strong winds of 35-50 mph were recorded in the Duluth-Superior Harbor, causing the iced power lines and tree branches to snap, causing power outages throughout the City. During the same storm, strong winds pushed a ship into the ice for several hours at the Superior Entry.

### ***Probability & Predictability***

The probability of an ice storm is moderate (2-5% annually). Minor ice storms are expected annually in late winter and early spring. Severe ice storms may be expected to occur once every 25 years, according to historical data. Winds are expected during ice storms in this area as they usually carry the cold air and precipitation that cause the storm.

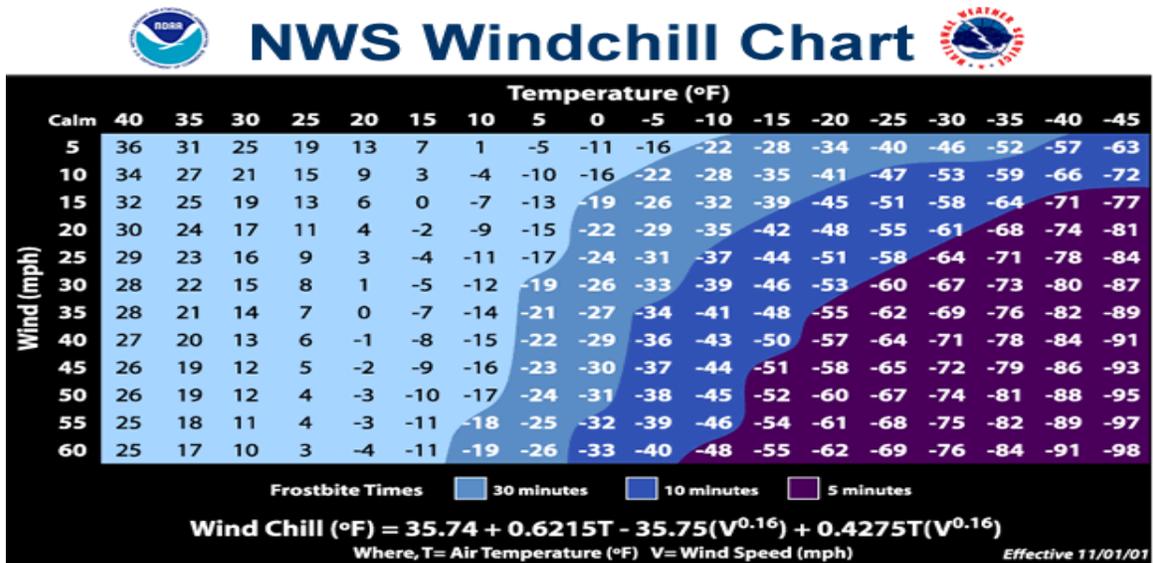
## **Extreme Cold Temperatures from Winter Hazards**

When lack of snow combines with low temperatures, Superior homes and businesses are at risk of water line freezing and interruption of drinking water service. Low snow cover or exposed ground along with temperatures at or below -20° F or no snow cover and persistent freezing temperatures (around 0° F), typically lead to isolated or localized water main breaks. Occurrences of water main breaks are higher in areas where snow removal is persistent, and insulating snow cover is limited, such as along City streets,

alleys and sidewalks. Water lines supplying buildings in the City are managed by Superior Water Light & Power (SWL&P); however, the property owner is responsible for maintenance and repair of service laterals.

Wind chill is defined as the temperature of the air in terms of how cold it feels to humans and animals. This differs from the air temperature because wind increases evaporation of moisture from the skin, making it feel colder. As wind increases, heat is carried away from the body at a faster rate, driving down both skin temperature (which can cause frostbite) and eventually the internal body temperature (which can kill). Frostbite and hypothermia threaten the well being of humans and animals. Frostbite is damage to body tissue caused by that tissue being frozen. Hypothermia is body temperature less than 95° F. Wind Chill has been measured and converted into an index by the National Weather Service. When wind accompanies cold air temperatures, as they often do in this area, wind chill advisories may be issued. These advisories are issued by the National Weather Service and are usually reported to the public via radio and television broadcasts. Wind chill Advisories are issued when the wind chill temperature is expected to fall between -15°F and -24°F.

Figure 9.1 National Weather Service Windchill Chart



Source: NOAA's National Weather Service  
Office of Climate, Water, and Weather Service

**Historical Events**

- On January 29, 1951, temperatures dropped to -37° F causing school closures.
- On February 10, 1995, brisk winds gusting 30-40 mph combined with temperatures as low as -25° F to create wind chills between -50° F and -70° F. Schools were closed and most outdoor activities in Douglas County were cancelled.
- On January 17, 1997, sub-zero temperatures and 30 mph winds resulted in wind chills of -60° F and -70° F for Douglas County, including Superior.
- On December 21, 1998, a Wind Chill Advisory was issued for the City. The low temperature was -11° F and winds 15-30 mph caused a wind chill of -30° F.

- On January 30, 2004, a water main break at 1925 Hammond Avenue spilled 500,000 gallons of water onto roadways and into yards, flooding at least one basement and endangering cars parked along the roadside. Vehicles not moved could have been stuck in up to 1 foot of ice. Temperatures during this time were 20° F below zero.

### ***Probability & Predictability***

The probability of damage incurred by extreme cold temperatures is high (>5% annually). Cold temperatures are predicted to occur annually. The 100-year extreme cold temperature is approximately -37° F. Persistent cold temperatures, combined with low precipitation leading to deep ground frost, occurs at least once every 5 years. During years when winter precipitation is light and low temperatures are normal, water main breaks can occur in late winter and early spring. These breaks occur as the depth of ground frost reaches beyond 6 feet, where water mains are laid. This tends to occur once every 5-10 years.

## **Snowmelt from Winter Hazards**

The last spring freeze, when temperatures remain above 32° F, typically occurs between the end of April and the middle of May. Spring snowmelt begins in March when daily high temperatures reach above freezing. When warm springs follow winters with particularly high precipitation, spring flooding hazards can occur.

Superior's rivers and streams are particularly vulnerable to the erosive qualities of runoff from snowmelt. Many buildings suffer flooded basements, yards and streets become flooded with standing water and the stormwater and combined sewer systems become overwhelmed.

Snow that has been collected from streets, parking lots and sidewalks can be contaminated with salt, nutrients, oil, sand, silt, litter, biological contaminants from pet waste, pesticides, heavy metals or toxic chemicals. Disposal of snow and ultimately snowmelt, in places that can contaminate surface waters or groundwater is managed by the Wisconsin Department of Natural Resources (WDNR).

Springtime flooding from snowmelt is particularly problematic in the City, since there is little topographic relief, and low ground permeability, due to the clay nature of the soil. The City must rely on its wetlands and stormwater and combined sewer systems to manage stormwater. The City must be in compliance with discharge regulatory standards defined by the United States Environmental Protection Agency (US EPA) and the WDNR.

Snowmelt from upstream sources, including those outside the City limits, can move through any of the numerous streams and rivers that flow through the City toward Lake Superior. During years of above normal snow accumulation, the snowmelt runoff can aggravate the unstable banks of these streams and rivers. The clay-dominated soils are easily eroded. Eroded sediments are carried with the runoff and deposited in Lake Superior, contributing to sedimentation of the lake. High flow also undercuts and

weakens the stream and river banks, decreasing property values along the banks and endangering homes and other structures, including private and public boat docks and fishing piers.

### ***Historical Events***

Flooding events are found in the Thunderstorms Section of the Plan Update.

### ***Probability & Predictability***

The probability of snow in Superior during any given year is 100%. The probability of annual snowfall exceeding 80" is 1%. The probability of flooding due to snowmelt is determined by the total accumulation of snow and intensity of weather factors contributing to snowmelt. The probability of damage being incurred from floodwaters caused by snowmelt is low (1-5% annually).

## **Thundersnow from Winter Hazards**

Thundersnow events are rare occurrences of lightning and thunder during a snowstorm. These storms are more common in the Great Lakes and around mountains than elsewhere in the US, but remain rare nonetheless. Since heavy snow can obscure the sound and light from thunder and lightning, these events are infrequently observed. Thundersnows form when storm clouds collect warmer air (such as air over a lake or ocean surface) that mixes with the turbulence in a cloud. This turbulence mixes snow crystals with super-cooled water droplets in the cloud. The turbulence causes positive and negative charges in the cloud to separate, which can result in thunder and lightning associated with the storm.

The hazards associated with thundersnow are not unlike the hazards associated with any lightning event. Humans can be struck by lightning and fires may be ignited when lightning contacts trees or building structures. Due to the lack of exposed organic material and snow cover during winter months, damage from residential structures is more likely.

### ***Historical Events***

- During a severe winter storm in early March of 2007, thundersnow was reported for a period of six hours in the Duluth/Superior metro area.

### ***Probability & Predictability***

It is estimated that only 0.07% of recorded snowstorms are associated with thunder. Wisconsin and Minnesota are among the few states where these rare thundersnows are most common. Thundersnow events tend to occur mostly in March, since there are higher incidences of air mass collisions of warm and cold temperatures. There are no specific thundersnow events on record for the City; therefore, the probability of thundersnow events causing damage in the City is low (<1%).

## Vulnerability Assessment

Receiving and analyzing weather information is perhaps the most critical link for a successful snow and ice control program. Making a decision at the right time, before the storm has effectively blocked most courses of action, is vital to the success or failure of the total operation. At the present time, the Public Works Department and the UW-Superior depends upon the U.S. Weather Bureau forecasts and television/radio forecasts.

Winter storms are considered deceptive killers because most deaths are indirectly related to the storm; people die in traffic accidents on icy roads, of heart attacks while shoveling snow and of hypothermia from prolonged exposure to cold. Of winter deaths related to ice and snow, 70% occur in automobiles and 25% are people caught out in the storm (the majority are males over 40 years old). Half of winter deaths related to cold are people over the age of 60, 75% are males and 20% occur in the home.

Stranded persons at home or on the road without emergency provisions are vulnerable to freezing, starvation, or other problems, especially if there is no power for heat or communications. The frequency of structural fires increases during storms, as residents turn to alternative methods of heat, especially during power outages.

### *Critical Facilities*

Snow emergency procedures have been developed for City Fire, Police, Public Works, and Medical Services. These procedures provide a coordinated response of essential services in a centralized location at the Municipal Service Building on Hill Avenue. During a declared snow emergency, a snow emergency room is set up for emergency services to operate. Emergency vehicles for fire, police, medical and street maintenance can be stored at this location for dispatch.

The City has established at least six emergency snow removal routes that are the first routes cleared and are the highest priority for maintenance during snow events. These routes are strategically selected to place most residences no more than a total of six City blocks away from the snow emergency route. Routes to critical facilities, including hospitals, are assigned special equipment and are ensured to be clear at all times.

Police and fire emergency operations may utilize the City's front-end loader to break trails to emergency call locations in the event that severe snowstorms make routes impassable.

Substantial snowfalls can hamper emergency response. Unmanaged snow banks can hide fire hydrants, hamper access to homes for medical and fire rescue and also inhibit delivery of mail.

Winterstorms do not pose a particular threat to the fueling facilities or the refinery, although road conditions may impede or delay access to fueling stations by emergency vehicles and road maintenance equipment. In order to avoid shortages during

emergencies in the winter, emergency vehicles try to maintain full fuel tanks. A fuel truck is also available for refueling emergency fire vehicles.

### ***Schools***

There are eight schools in the School District of Superior. This includes six elementary: Bryant, Cooper, Four Corners, Great Lakes, Lake Superior, and Northern Lights; one middle school: Superior Middle School; and one high school: Superior High School. Four Corners Elementary School is located in the Town of Superior, outside the corporate City limits.

A Crisis Communications Building Plan has been templated for all facilities in the School District of Superior that can be tailored to each facility. All facilities are required to have a completed Plan and must practice drills annually. Weather related drills are generally conducted during Wisconsin's Severe Weather Awareness week in April.

School closures are expected at least once annually. There are three snow days budgeted per academic calendar. While these days may be used for any type of school closure, closures due to inclement winter weather are most common. If more closures are required than scheduled, facilities must remain open to make up those days at the end of the school year. During scheduled snow days, teachers are paid their standard salary, while support staff must use a benefited sick day. In the event that schools make up days at the end of the year, there are additional per day costs for salaries, benefits and other costs in addition to standard costs for the academic year. School closings usually occur as a result of hazardous driving conditions, especially on rural routes. Even when conditions are safe in the City, rural conditions can dictate school closures and vice-versa.

If schools close during the school day, parents are notified and children may be picked up as prearranged on an emergency notification card, required to be filled out when the child is enrolled in school. Children on bus routes are bussed home, or in some instances, to an alternative care facility prearranged between the parent, the facility and the school district. For children not on a bus route, parents are responsible for their child's transportation. This applies to families that live less than two miles from the school. Children living inside the 2-mile radius must be picked up (grades K-5) or walk home (grades 6-12).

Athletic events are usually cancelled when schools are cancelled. However, athletic events may also be closed in consideration of the team traveling to Superior, or home after an event.

### ***Day Care Facilities***

Many day care facilities close due to inclement weather, though they are less likely to close than schools. Day care employees may not be able to get to work safely due to road conditions or road closures. Facilities that are run out of a home with a single care provider would not necessarily be affected by road conditions or closures.

### ***Medical Facilities***

Essentia Hospital of Superior is the only hospital in the City. There is one outpatient Surgery Center/Urgent Care center at the Mariner Medical Clinic, a subsidiary of St. Luke's Hospital. The Veterans Administration Twin Ports Clinic is located in the City, just south of Essentia Hospital of Superior. There are several private clinics and specialty offices throughout the City, including the Lake Superior Community Health Center on Hill Avenue.

Essentia Hospital of Superior has a Severe Weather Policy that dictates roles and procedures in the event of severe weather. The Gold Cross Ambulance service is responsible for transporting patients to the facility in any type of weather.

Gold Cross Ambulance is the primary mode of emergency transportation servicing Essentia Hospital of Superior and also Duluth hospitals. Their dispatch center in Rochester, Minnesota is directly linked to the Douglas County Communications Center and both monitor local weather advisories, watches and warnings. In the event of a severe weather watch, all on-duty crews are notified of the conditions. In the event of a severe weather warning, all on-duty and off-duty crews are notified and put on standby. Gold Cross Ambulance can cooperate with other emergency vehicle resources for vehicles and manpower in the event that a natural hazard results in increased casualties. During a hazardous weather event, non-emergency transport activities are cancelled and all calls are triaged. In the event of a snowstorm, the Superior Station has access to a four-wheel drive ambulance. Gold Cross dispatch works closely with the City of Superior Public Works Department and can request assistance from the City Streets Department. In the event of a power outage, operations can relocate to Essentia Hospital of Superior, as the Gold Cross Station does not have a back-up generator.

### ***University of Wisconsin-Superior***

While classes may be cancelled due to inclement weather, the University rarely suffers a complete shutdown. Even when classes are cancelled, employees are still expected to report for work.

### ***City Streets***

The City has implemented a Winter Road Maintenance Policy and an associated snow and ice control program. Substantial snow accumulation is of particular concern in the central business district, where the accumulated snow may need to be hauled away. The time at which a storm occurs can impact its effects. A storm during a weekday rush hour is more difficult to combat than the same storm during a weekend. High wind conditions can require additional effort on the part of snow fighting forces, as drifted snow can block roadways. During major storms, City snow maintenance crews assign trucks to major thoroughfares. Additional resources focused on major routes increase the overall costs of maintenance during storms and also hamper maintenance in other areas where these additional trucks could be used.

The temperature at the time of the storm will also affect conditions. Snow falling on warm pavement may disappear with little effort. However, a moderate storm, coupled

with a prolonged sub-freezing period, will greatly increase the required removal effort. The type of snow will also have an effect on the snow fighting effort. Light, dry snows handle more easily than heavy, wet snows. Pre-storm mitigation efforts include monitoring weather forecasts, traffic density, pavement surface temperature and time of day. Much of this information can be gained from Remote Weather Information Sensors.

The City has established at least six emergency snow removal routes that are the first routes cleared and are the highest priority for maintenance during snow events. These routes are strategically selected to place most residences no more than a total of six City blocks away from the snow emergency route. Routes to critical facilities, including hospitals, are assigned special equipment and are ensured to be clear at all times.

Wisconsin's snow plowing and ice control guidelines outline the priorities for winter road maintenance. The goal of winter maintenance is to achieve "passable roadways" during a winter storm. Passable roadways are defined as roadways free of drifts, as much ice and packed snow as is practical and can be driven on safely at a reasonable speed without losing traction. Wisconsin state highways are categorized by the state and are maintained according to this categorization, with category 1 being the highest priority and category 5 being the lowest. The City's state highways (Highways 2 and 53) are considered category 2 and 3, with higher priority areas existing on the bridges connecting Duluth, MN and Superior.

### ***Motorists***

Winter storms are considered one of the biggest threats to motorists in Superior. They can cause of low visibility, slippery road conditions and engine problems.

Drivers can increase their risk during storms. Many drivers do not heed warnings from television and radio alerts, variable message signs, or observed weather conditions. Drivers may swerve off the road and become stranded or collide with other traffic, including snow plows or other stranded vehicles. Stranded drivers may leave their vehicles for help, exposing themselves to more hazardous conditions, including hypothermia and frostbite.

During winter, bridges, especially the Bong and Blatnik, are vulnerable to ice and snow buildup and are very vulnerable to high winds. Hazards are usually short term, 1-2 hours. These hazards can be intensified by careless drivers who fail to observe posted speed limits, speed advisories, which take road conditions into consideration, and common sense observation of the surrounding conditions. These two bridges have been closed during storms in April 1950 and November 1991.

There is a variable message sign at the base of the Blatnik Bridge at Hammond Avenue, available to northbound motorists just as they approach the bridge. There is one variable message sign on the bridge on the Minnesota side for southbound motorists, and at least three more signs near the bridges in Duluth, including one just before to the ramp used to access the Blatnik Bridge. Motorists accessing Superior from both north- and southbound routes along Interstate 35 can get information from these signs.

The Minnesota State Patrol dispatch station is in control of most of these signs and can update them, as information is available. The Douglas County Communications Center in Superior is in control of the Hammond Avenue sign, however the Minnesota State Patrol can override control and post information on this sign as well.

The Wisconsin Department of Transportation is developing an Intelligent Transportation System (ITS) for District 8 that will include actions to mitigate hazards on roads in Superior. This plan includes installation of variable message signs near both highway bridges and also near junctures where motorists may alternate their routes between one bridge or the other, depending on advisories, closures, delays, or other hazards. The ITS will also deploy several road weather information sensors that measure wind speed, pavement surface conditions, temperature, etc. These sensors can post real-time information electronically for access by road management officials and the public. The ITS includes extensive information technology strategies for emergency management and transportation maintenance to be controlled by Douglas County dispatch and coordinated with Minnesota State Patrol. The plan will also include a public education effort on resources available for travel planning prior to departure and also en route.

Drifting snow is another considerable hazard to motorists in Superior. Particularly hazardous areas include near the Fairgrounds on Tower Avenue and near Barker's Island on East 2<sup>nd</sup> Street (US Highway 2). In these areas, the road was constructed lower than the curbs in an effort to funnel stormwater away from private properties where basement flooding was a problem. However, by lowering the roadbed, blowing snow tends to fill in the channel and cause problems in the winter.

Stormwater may come in the form of snowmelt in late winter and early spring, especially after seasons with exceptionally high snow accumulation. This snowmelt can pool up or overflow onto roads during the day, then freeze when temperatures drop overnight, making the morning commute particularly hazardous.

### ***Economy***

Hazardous winter conditions that affect travel indirectly affect the economic security of residents and businesses. When winter driving conditions are hampered by heavy snow, ice and/or wind, consumers tend to stay home and not patronize businesses. Some businesses, including grocery stores, gas stations and discount stores, can receive a surge of patronage prior to an expected storm. The intensity and duration of the storm determines how unstable the economy will be.

### ***Residents and Private Property***

Residents of the City are responsible for snow removal on their own property and on sidewalks surrounding their property. The fine for noncompliance is up to \$100 per incident plus costs and assessments. Property owners can get information about this responsibility from the Street Division of Public Works. This responsibility may be difficult for many citizens to comply with due to physical limitations. Hospital emergency room incidences related to exertion or other minor to critical injuries increase

during snowstorms. Those unable to comply with the sidewalk maintenance ordinance for various reasons may contact their local church, Interfaith Caregivers, or the Salvation Army for assistance in snow removal.

Citizens that are homebound are particularly vulnerable to winter hazards, including heavy snow and extreme cold. Homebound citizens include those who are ill and/or elderly. Many participate in the Home Care program through the Douglas County Department of Health and Human Services. During hazardous snow and cold events, these citizens are checked on more frequently by program managers and employees to ensure their safety. Programs that supply food to homebound citizens, including Meals-on-Wheels, often are shut down due to inclement weather, when they may be needed the most.

### ***Barker's Island***

Barker's Island Marina is a private, pleasure craft facility with secure, all weather, floating slips available for vessels. Since the harbor freezes over annually, all vessels must be stored on shore in cradles and prepared for winter.

In an isolated incident, one vessel in dry storage was knocked off its cradle during severe straight-line winds. In order to avoid damage from winds, boats in dry storage are usually aligned with northeasterly winds that are common during winter storms. The marina has endured storms involving winds in excess of 70 mph with little to no damage to its facilities or moored vessels.

In another isolated incident in 1997, severe winter gales pushed ice against the dock facility, causing damage to the dock. Docks are pulled away from the shore during the winter in order to prevent damage from ice push.

Barker's Island also includes a large hotel and convention center and several upper-end homes on the southeastern end of the Island. All of these facilities are accessed by a single road at the northwestern end of the island, which can be accessed from East 2<sup>nd</sup> Street (Highway 2/53). Due to the openness of the area, heavy snow drifting occurs, making roads impassable. Although the City is responsible for clearing these roads, they are considered residential routes and are cleared after primary routes. Therefore, boats and residences could become vulnerable to fire damages during winter storms, if emergency vehicles cannot access them.

### ***Utilities***

Utilities are vulnerable to extreme cold temperatures. Damage to utilities can result in economic, structural and social impacts.

Power outages disrupt many utility services including telephone, electricity, natural gas, water and sewage. The surges associated with power outages can fatally disrupt electronic equipment for critical facilities, businesses, homes and other facilities.

When snow cover is minimal, buried water lines can freeze, causing rupture of water pipes or disruption of water service to a home or business. SWL&P is responsible for the water mains; however, customers are responsible for their own lateral service lines.

Home heating in Superior is done primarily through gas supplied by SWL&P. Other major sources for heating fuel are electricity (supplied by SWL&P) or fuel oil (from various vendors). Gas and electricity are supplied continuously to the customer through utility lines. Oil and occasionally, gas are supplied in containers that must be refilled on site by the supplying company. During a winter storm, many heat sources may be cut off due to electrical failure, no matter what source of fuel is used, since most furnaces require electrical power to run some components. Many structural fires are ignited due to use of alternative heating methods when primary sources are impaired.

Sanitary and stormwater sewers run throughout most of the City. With a customer population of approximately 27,000 people and 12,000 user connections, the City of Superior Environmental Services Division of Public Works (ESDPW) services both wastewater treatment and the collection system. The main treatment plant, located at the 51 East 1<sup>st</sup> Street along Superior Bay, houses two independent treatment plants. The main wastewater treatment plant is an activated sludge facility designed to handle all dry weather flow up to 5 million gallons per day (MGD), with a peak daily flow of 8 MGD and a peak pumping capacity of 15 MGD. The other treatment plant at the main plant is called the Combined Sewer Treatment Plant for sewer District #2 (CSTP #2). It is used to handle high rates of flow, which exceed the main plant's design capacity, such as in the spring during snowmelt or during major rain events.

Similar to potable water lines, the City is responsible for repair and maintenance of main sewers. However, property owners are responsible for their own lateral service lines. Damage can occur to sewer lines particularly during heavy snow thaw events in late winter and early spring. After a winter of significant snow accumulation, these events can put millions of additional gallons of snowmelt into the combined and storm sewer systems, potentially causing sewer backups that can damage basements, yards and municipal sewer systems.

### ***Parks & Recreation***

The City has vested numerous resources into its Urban Forest, which includes the trees planted throughout City streets and parks and the Superior Municipal Forest. In 1998, there were 4,348 trees from 62 species planted along the City's streets. The Superior Municipal Forest consists of 4,400 acres of relatively pristine boreal forest, willow/alder swale, upland conifer forest, and riverine wetlands. These resources can be threatened and can become a threat caused by the elements associated with winter storms. Wind, snow, ice and extreme cold can damage trees, hampering the health and quality of the forest, provide fuel for wildfires and impede access into and around the forest when branches and uprooted trees block roads and trails.

City trees are also threatened by extreme cold, heavy snow and wind. Damaged trees and limbs can break, tangle into power lines and/or fall onto buildings, streets, or other property, causing damage.

There are 26 kilometers of cross country ski trails, other hiking and snowshoe trails and several miles of motorized multi-use trails throughout the Superior Municipal Forest and the City. The City also manages 25 recreation areas, 8 of which have hockey and/or open skating rinks, 3 outdoor open space and special use areas, including the Superior Municipal Forest, Hog Island and Wisconsin Point, 13 waterfront recreation areas, all of which may be utilized during winter months. Social hazards exist in these areas as visitors are vulnerable to extreme cold, heavy snow and high winds associated with winterstorms. Many sites have appropriate shelter for protection against minor elements.

***Future Development***

Future development in the City of Superior is detailed in the 2010-2030 Superior Comprehensive Plan, on file with the City of Superior. Future development would not be impacted any differently than now exists from winter hazards. New development is governed by state standards, as well as local policy and legislation.

**Loss & Replacement Estimates**

Losses incurred from winter storms can affect social, economic and structural assets in the City. Table 9.3 shows the values of all improved parcels within the City limits. Based on historical incidences and frequency of occurrence, the estimated potential losses to structural property in the event of a severe snowstorm would be 5% of the improvement value of all properties in the City or \$70 million. Experience has shown that interruption of utility service, transportation infrastructure, businesses and schools occur more frequently and can be costlier than structural damage done.

Table 9.3 Values of all Improved Parcels

Parcel Land Classification	Total Parcels	Acreage	Land Value	Improvement Value	Total Value
Residential	10,213	2,836	\$161,215,600	\$841,248,600	\$1,002,464,200
Commercial	1,776	2,140	\$155,586,300	\$562,982,300	\$718,568,600
Manufacturing	408	853	\$250,900	\$1,324,300	n/a
Federal	8	23	n/a	n/a	n/a
State	89	397	n/a	n/a	n/a
County	1,420	3,908	n/a	n/a	n/a
City	1,327	7,465	n/a	n/a	n/a
Other	1,535	2,292	\$9,543,200	\$50,796,500	\$60,339,700

Source: City of Superior's GIS data of parcels.

### ***Commercial***

Severe winds can threaten operations and equipment in all port manufacturing and shipping facilities. In addition, severe winds can cause direct damage to trees and indirect damage to power lines, telephone lines, and buildings. The cost of this damage can range from thousands to millions of dollars, depending on the severity of the storm.

### ***Utilities***

Severe winds cause direct damage to trees and indirect damage to power lines, telephone lines and buildings. These costs can range from thousands to millions of dollars in damage, depending on the severity of the storm.

### ***Motorists***

Municipal road maintenance is strongly impacted when winter storms hit. Costs for snow removal increase due to the repetitive maintenance of drifting areas. High winter snow removal costs usually have direct impact on road maintenance and construction during summer months since maintenance and construction budgets are related. During years with high winter maintenance costs, fewer road construction and improvement project can be funded during the summer. For example, as a result of the 1991 Halloween snowstorm, City maintenance costs exceeded \$100,000, compared to \$20,000 the previous year. Since the last major storm in 1997, the Capital Improvement Fund has separated the materials used in maintenance and construction from the manpower and overtime costs. Therefore, sand and salt used in winter road maintenance now comes out of a different budget than the manpower, lessening the burden on these budgets.

### ***Residents***

Many employees suffer financial losses during winter storms. For example, an employee who was unable to get to work during or after a winter storm could lose wages and benefits for that time. Some employers allow employees with paid leave days to use this benefit in the event that weather hazards would prevent them from coming to work, thus mitigating this problem for many full time employees. Part-time, seasonal, and non-benefited employees may not have this option and must take the loss in the event that they cannot get to work for weather related reasons.

Frozen water mains can cost SWL&P an average of \$2,000 for each incident and involve extensive destructions and reconstruction of roads, alleys and/or sidewalks during winter or summer repair efforts. When lateral water lines that service homes and businesses break, it is the responsibility of the building owner to repair the water line. Similar efforts must be made to locate, expose and repair the water line. These costs can range from \$100 to \$1500 for each occurrence.

### ***Schools***

Many storm events may not be severe enough to prevent adults from getting to work, but may result in school closings. School closings are expected to occur at least once annually due to snow or other inclement weather. Parents must compensate for this by finding alternative care for their children, often at an additional cost or staying home with their children with or without compensation from their employers. Alternative care

options for parents with school-aged children include day care facilities, children staying home alone, children staying with another relative or friend, or taking the child to work with the parent. In an informal survey of eight of the City's licensed day care facilities, most will take children on a 'drop-in' basis should schools close due to weather. Most, however, require that the child be pre-registered with all necessary paperwork on file, prior to the event. A few facilities will only allow drop-in services for children who either previously attended the facility or have siblings currently attending the facility. Most facilities accept school aged children to the age of 11-13. All of these facilities do have capacity limits and may only take additional children in the event that cancellations occur.

Economic impacts at public schools, UW-Superior and Wisconsin Indianhead Technical College include snow removal costs not unlike those incurred for the City. Overtime compensation often must be made in order to keep all paths and accesses clear for safety reasons. When classes are cancelled, employees are still expected to report for work or they may lose pay.