



SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.11 Winter Weather

The following section provides the hazard profile and vulnerability assessment for the winter weather hazard in Fort Bend County.

Hazard Profile

Hazard Description

Severe winter weather brings the threat of snow, freezing rain, and ice storms to Fort Bend County. Winter weather involves weather events in which the main types of precipitation are snow, sleet, or freezing rain. They can be a combination of heavy snow, blowing snow, and dangerous wind chills. According to the National Severe Storms Laboratory, the three basic components needed to make a winter weather include the following:

- Below-freezing temperatures (cold air) in the clouds and near the ground to make snow and ice
- Lift to raise the moist air to form clouds and cause precipitation, such as warm air colliding with cold air and being forced to rise over the cold dome or air flowing up a mountainside (orographic lifting)
- Moisture to form clouds and precipitation, such as air blowing across a large lake or the ocean (NSSL n.d.)

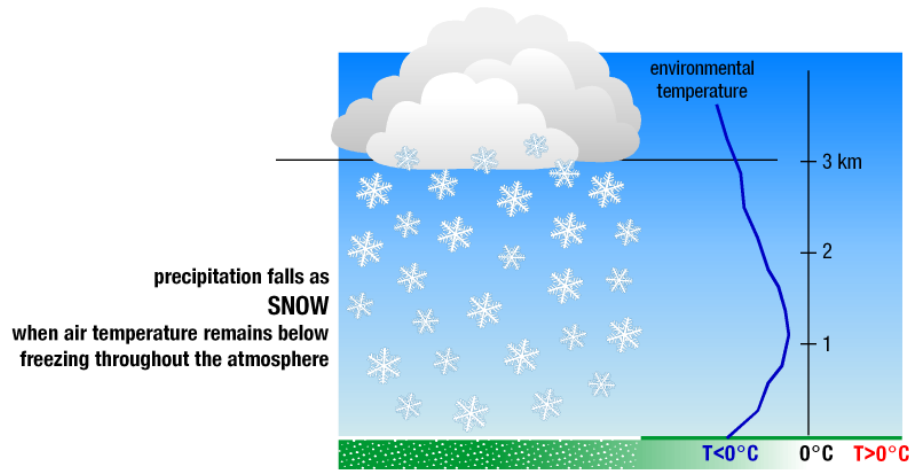
Winter weather might immobilize an entire region or only affect a single community. Winter weather typically is accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of winter weather can have an impact on a community or region for days, weeks, or even months, potentially causing cold temperatures, flooding, storm surge, closed and blocked roadways, downed utility lines, and power outages. In Fort Bend County, winter weather includes snowstorms, blizzards, and ice storms. Extreme cold temperatures and wind chills are associated with winter weather; however, they are discussed in Section 4.3.3 (Extreme Temperature).

Heavy Snow

According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals. It originates in clouds when temperatures are below the freezing point (32°F) and water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or snow pellet, which then falls to the earth. Snow falls in different forms: snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Figure 4.3.11-1 depicts snow creation.



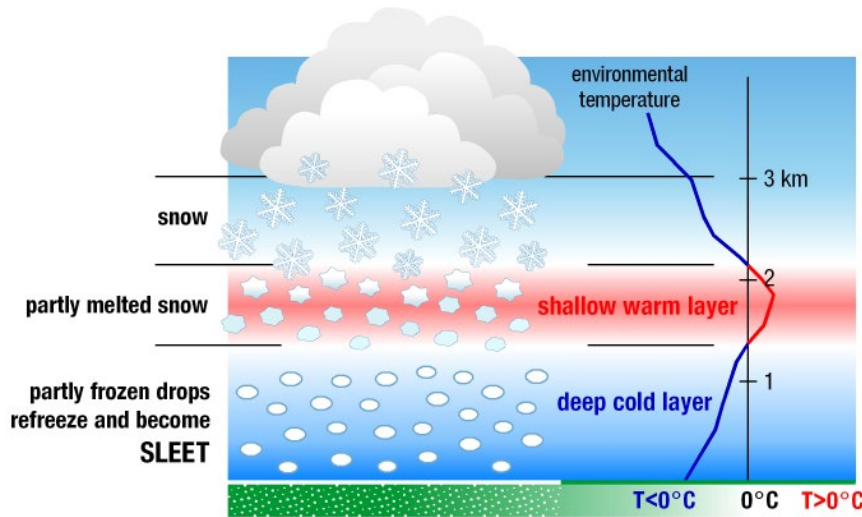
Figure 4.3.11-1. Snow Creation



Source: NOAA NSSL n.d.

Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets, which are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. Sleet is made up of drops of rain that freeze into ice as they fall through colder air layers. They are usually smaller than 0.30 inches in diameter (NSIDC 2020).

Figure 4.3.11-2. Sleet Creation



Source: NOAA NSSL n.d.

Blizzards

A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile, as the predominant conditions over a 3-hour period. Extremely cold temperatures often are associated with blizzard conditions but are not a formal part of the definition. The hazard, created by the combination of snow, wind, and low visibility, significantly increases when temperatures are below 20°F . A severe blizzard is categorized as having temperatures near or below 10°F , winds exceeding 45 mph, and visibility reduced by snow to near zero. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing

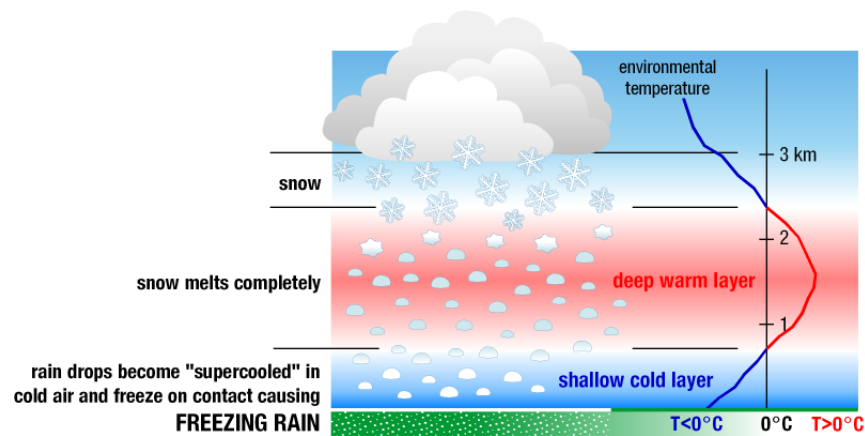


cold air from the north to clash with warm, moister air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (NWS n.d.).

Ice Storms

An ice storm describes those events when damaging accumulations of ice are expected during freezing rain situations. Significant ice accumulations typically are accumulations of 0.25 inches or greater. Heavy accumulations of ice can bring down trees, power lines, utility poles, and communication towers. Ice can disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians (NWS 2018).

Figure 4.3.11-3. Freezing Rain Creation



Source: NOAA NSSL n.d.

Location

Winter weather can happen anywhere in the state of Texas. The southern portions of the state are not as likely to incur severe winter weather, but when it does happen, the impacts are much stronger because the communities and governments are not as prepared. Because winter weather can impact the entire State, the entire County and its jurisdictions can be impacted by winter weather events.

Extent

The magnitude or severity of severe winter weather depends on several factors, including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day and week (e.g., weekday versus weekend), and time of season.

The extent of severe winter weather can be classified by meteorological measurements and by evaluating its societal impacts. The National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5 and is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA NCEI n.d.). Table 4.3.11-1 presents the five RSI ranking categories.



The maximum winter weather extent that can be expected in Fort Bend County is an RSI Category 5 snowfall event. Because the County is located in the National Centers for Environmental Information’s south climate region, the amount of snow that can fall for this category event is up to 15 inches; however, the area will most likely see lower amounts of snow based on history of occurrence. The last major winter weather event to affect the County were two RSI Category 3 winter storms in February 2021. Overall, the County has a 60-percent chance of a Category 1 event occurring in any given year.

Table 4.3.11-1. RSI Ranking Categories for the South Climate Region

Category	Description	RSI Value	Snowfall Thresholds
1	Notable	1–3	<2
2	Significant	3–6	>2
3	Major	6–10	>5
4	Crippling	10–18	>10
5	Extreme	18.0+	>15

Source: NOAA NCEI n.d.

Note: RSI = Regional Snowfall Index

The NWS operates a widespread network of observing systems, such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists, who then write and disseminate forecasts (NOAA 2017).

According to the National Weather Service (part of NOAA), the magnitude of winter weather can be qualified into five main categories by event type:

- Heavy Snowstorm – Snowfall accumulating to 4 inches or more in 12 hours or less or snowfall accumulating to 6 inches or more in 24 hours or less.
- Sleet Storm – Significant accumulations of solid pellets that form from the freezing of raindrops or partially melted snowflakes, causing slippery surfaces and posing a hazard to pedestrians and motorists.
- Ice Storm – Significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations; significant ice accumulations are usually ¼” or greater.
- Blizzard – Sustained winds or frequent gusts of 35 mph or more; considerable blowing snow with visibility frequently below one-quarter mile prevailing over an extended period.
- Severe Blizzard – Wind velocity of 45 mph, temperatures of 10°F or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period (NWS n.d.).

The NWS uses winter weather watches, warnings, and advisories to ensure that people know what to expect in the coming hours and days.

- Watches
 - Blizzard – Conditions are favorable for blizzard conditions to be met in the next 12 to 48 hours.
 - Winter Weather - Issued when winter storm conditions, defined above, are possible within 24 to 48 hours.
- Warnings



- Blizzard – Issued when sustained winds or frequent gusts ≥ 35 mph combined with blowing and or falling snow, reducing visibility below 1/4 mile for 3 hours or more, when imminent or expected within the next 36 hours. Temperatures are assumed below 32°F, and snow should accumulate at least one inch in 12 hours.
- Winter Weather - Issued when the following conditions, capable of producing high impact and potentially life-threatening conditions, are occurring or expected to occur within the 36 hours: snow - ≥ 1 inch in 12 hours; sleet - $\geq 1/2$ inch in 12 hours; and or a combination of snow, sleet, ice with snow or sleet meeting warning criteria.
- Ice Storm – Issued when $\geq 1/8$ inch of ice is expected to accrete on trees, power lines, and bridges/overpasses for the entirety of the event. These conditions are capable of producing high-impact and potentially life-threatening conditions and are either occurring or expected to occur within the next 36 hours.
- Advisories
 - Winter Weather – Issued when the following conditions, capable of producing significant, but not necessarily life-threatening, inconveniences, are occurring or expected to occur within the next 36 hours:
 - Snow: 1/2 to 1 inch in 12 hours
 - Sleet: $< 1/2$ inch in 12 hours
 - Ice: $< 1/8$ inch in 12 hours
 - Combination: Snow, sleet, and ice with snow or sleet meeting advisory criteria (NWS n.d.).

Worst-Case Scenario

Overall, the maximum winter weather extent that can be expected in Fort Bend County is an RSI Category 3 snowfall event. Because the County is located in the National Centers for Environmental Information’s south climate region, the amount of snow that can fall for this category event is up to 10 inches; however, the area will most likely see lower amounts of snow based on history of occurrence. A winter weather of that magnitude has the potential to cause between \$16–\$166 billion in property damage countywide.

A worst-case winter weather scenario would be a storm similar to the February 2021 ice storm that brought extreme temperature lows, deaths and injuries, and significant ice buildup on structures and infrastructure, including highway overpasses. A storm like this could lead to downed trees and power lines, power outages, closed roadways, and overall impact to the Planning Area. This would lead to disruption in emergency services and limited access to essentials (e.g., water, heat).

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1953 and 2022, FEMA included the State of Texas in six winter weather-related disaster declarations. Generally, these disasters cover a wide region of the state; therefore, they may have impacted many counties. Fort Bend County was included in two winter weather-related declarations for the same event in February 2021 (FEMA 2022). For events prior to 2017, refer to the 2018 Fort Bend County Hazard Mitigation Plan (HMP).



Table 4.3.11-2. FEMA Disaster Declarations for Winter Weather in Fort Bend County (1954–2022)

Date(s) of Event	Declaration Date	FEMA Declaration Number	Description
February 11-21, 2021	February 19, 2021	4586-DR-TX	Texas Severe Winter Storms
February 11-21, 2021	February 19, 2021	3554-EM-TX	Texas Severe Winter Storm

Source: FEMA 2022

USDA Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, there were no USDA disaster declarations related to winter weather events (USDA FSA 2022).

Previous Events

For this 2023 HMP update, known winter weather events that impacted the County between 2017 and 2022 are discussed below.

Table 4.3.11-3. Winter Weather Events in Fort Bend County (2017–2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County included in Declaration?	Description
December 7-8, 2017	Heavy Snow	N/A	N/A	The forcing of an approaching upper trough and jet streak allowed precipitation falling through a deep enough sub-freezing lower layer to turn to snow. The heaviest snow fell across the northwestern CWA on the evening of the 7th, with measurable snow across the central and southern forecast area occurring during the early morning hours of the 8th. 1 to 2 inches of snow was measured across the eastern side of Fort Bend County.
February 11-21, 2021	Ice Storm	4586-DR-TX, 3554-EM-TX	Yes	Very cold air and gusty winds overspread SE Texas behind an Arctic front with wind chill indices from near zero to single digits for much of the period from Sunday night to Tuesday morning. Increased power demand, wind, and ice led to widespread power outages. Bursting pipes caused many to be without water as well. Numerous fatalities resulted from hypothermia, carbon monoxide poisoning, and other effects.
February 3-4, 2022	Winter Weather	N/A	N/A	A period of freezing rain fell over areas mainly north and west of Houston, producing an icy glaze and numerous car accidents. Portions of US90, I69 SH99 and I10 closed due to ice. A 10-car accident was reported near Westpark Tollway and FM1464. A 12-car accident was reported along SH59.
January 20, 2017	Flash Flood	N/A	N/A	Slow-moving showers and thunderstorms produced hail and flash flooding in the afternoon through early evening hours. There were several road closures in and around the Rosenberg area. No damages to property or crops were recorded.

Sources: FEMA 2022; NOAA-NCEI 2022

* Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table

Probability of Future Occurrences

For the 2022 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of winter weather events of all types for Fort Bend County. Figure 4.3.11-4 summarizes data regarding the probability of occurrences of winter weather events in the County based on the historic record.





The information used to calculate the probability of occurrences is based on NOAA-NCEI storm events and FEMA database results.

Table 4.3.11-4. Probability of Future Occurrence of Severe Winter Weather Events in Fort Bend County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurrence in Any Given Year
Blizzard	0	0%
Heavy Snow	2	2.74%
Ice Storm	3	4.17%
Sleet	0	0%
Winter weather	3	4.17%
Winter Weather	1	1.39%
Total	9	12.33%

Source: NOAA-NCEI 2022, FEMA 2022

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act and selected winter weather events since 1968. Due to limitations in data, not all severe winter weather events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

Based on the number of winter weather events, the County averages less than one winter weather event each year. A winter weather event has a 12.33-percent chance of occurring in any given year. Based on the history of events and input from the Planning Partnership, the probability of winter weather events occurring in Fort Bend County is considered “rare”. Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Climate Change Projections

Changes in climate can affect how much snow falls and influence the timing of the winter snow season. Changes in the amount of snow covering the ground and changes in how the snow melts in the spring, will affect the water supplies that people use for things like farming and making electricity (NSIDC 2010). With these projections, the County might not experience an increase in winter weather events, but the lack of snow could impact the water supply.

According to the National Climate Assessment, rising air and water temperatures and changes in precipitation are intensifying droughts, increasing heavy downpours, reducing snowpack, and causing declines in surface water quality, with varying impacts across regions. Future warming will add to the stress on water supplies and adversely impact the availability of water in parts of the United States (USGCRP 2018).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entirety of Fort Bend County is exposed and vulnerable to the winter weather hazard; therefore, all assets within the County (population, structures, critical facilities, and lifelines), as described in Section 3 (County Profile), are potentially vulnerable to a winter weather event. The following text evaluates and estimates the potential impact of the winter weather hazard in the County.



Impact on Life, Health, and Safety

For the purposes of this HMP, the entire population of the County (806,497) is exposed to winter weather events (According to the 2021 U.S. Census Population Estimate). Winter weather can immobilize a region and paralyze a community. Additional impacts include stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NOAA NSSL n.d.).

Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

According to FEMA's National Risk Index, socially vulnerable populations in Fort Bend County have a relatively moderate susceptibility to the adverse impacts of winter weather, when compared to the rest of the United States (FEMA n.d.).

The homeless and elderly are considered most susceptible to this hazard; the homeless due to their lack of shelter and the elderly due to their increased risk of injuries and death from falls and overexertion or hypothermia from attempts to clear snow and ice. According to the 2021 U.S. Census Population Estimate, 11.3 percent of the population in Fort Bend County is 65 and over. Winter weather events can reduce the ability of these populations to access emergency services. Refer to Figure 4.3.11-4 for the social vulnerability index for wildfire.

Impact on General Building Stock

The entire general building stock inventory in Fort Bend County (281,285 buildings, replacement cost value of \$226.8 billion) is exposed and potentially vulnerable to the winter weather hazard; however, properties in poor condition or in particularly vulnerable locations may be at risk to the most damage. In general, structural impacts include damage to roofs and building frames rather than building content. Current modeling tools are not available to estimate specific losses for this hazard.

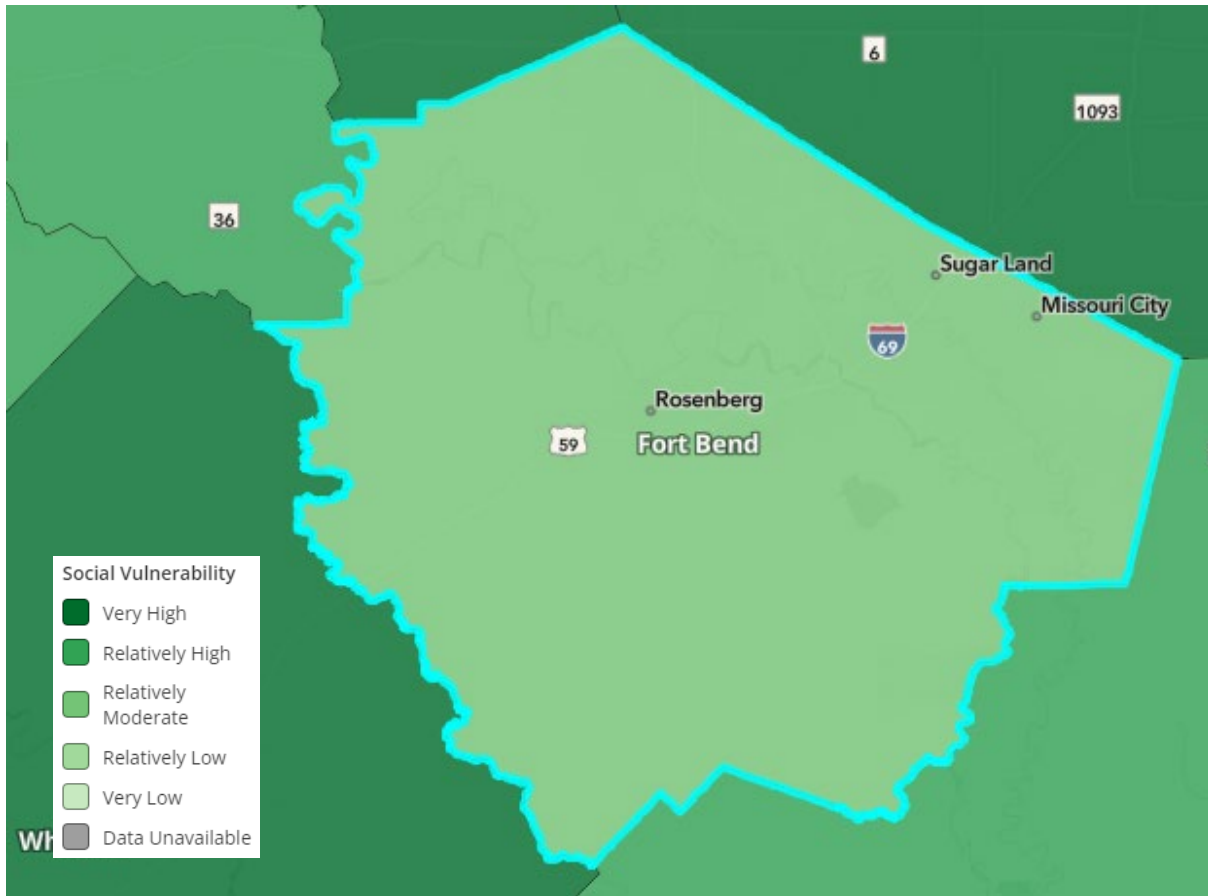
Impact on Critical Facilities

Full functionality of critical facilities, such as police, fire, and medical facilities, is essential for response during and after a winter weather event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from winter weather events. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles, utility lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice can cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL 2006). Winter weather events, such as ice storms, can lead to power outages. Therefore, it is recommended that critical facilities install backup power sources.

Infrastructure at risk for this hazard includes roadways that could be damaged due to salt application and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires the clearing roadways and alerting citizens to dangerous conditions; following the winter season, resources for road maintenance and repair might be required.



Figure 4.3.11-4. FEMA Social Vulnerability Index for Winter Weather



Source: FEMA NRI

Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Impacts on the economy also include commuter difficulties into or out of the area for work or school. The loss of power and closure of roads prevent commuters within the County.

Impact on Environment

As snow and ice accumulate, it becomes contaminated with salt, litter, dirt, and other pollutants. During the spring thaw, these pollutants wash away and can contaminate local waterways and ecological systems.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in the Planning Area can assist in planning for future development and ensure the establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change



Projected Development

Any areas of growth could be potentially impacted by the severe winter weather hazard because the entire County is exposed and vulnerable. The ability of new development to withstand winter weather impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction.

Projected Changes in Population

The County has experienced an increase in population between the 2010 Census (585,375) and the estimated 2016–2020 American Community Survey estimated population of 790,892. The population of the County is expected to increase over the next few years. With an increase in population, more people will be exposed to winter weather events. Additionally, the age of the population, changes in their geography, and how climate change could alter the winter weather received (rain versus snow) will be important to continue to assess future changes in vulnerability.

Climate Change

Climate is defined not only by average temperature and precipitation but also by type, frequency, and intensity of weather events. Both globally and at the local level, climate change can potentially alter the prevalence and severity of weather extremes, such as winter weather. While predicting changes in winter weather events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (U.S. EPA 2006). Based on the projections, the County can expect to experience more rain than snow during the winter months. In the immediate future, Fort Bend County can anticipate continuing to experience the impacts of winter weather events.

Change in Vulnerability Since 2018 HMP

Fort Bend County's population increased since the last HMP, increasing the number of people impacted during a winter weather event. Therefore, the entire County remains vulnerable to winter weather events.