Joined the NFIP in: March 2, 1981 Current **effective Map:** March 4, 2008

NFIP Number: 190030

Previous Hazard Mitigation Plans

The City previously completed a Hazard Mitigation Plan, which was adopted by the Waverly City Council on December 15, 2003.

Flood Insurance Information

A Flood Insurance Study was completed by the Federal Emergency Management Agency in September of 1980. The study reflects 100 and 500-year flood levels for three streams in the community; the Cedar River, Dry Run Creek, and Unnamed Creek. The corresponding Flood Insurance Rate Map (FIRM), originally prepared circa 1976, was updated in 1989 as part of the Bremer County Flood Insurance Study.

At the time of this initial Flood Insurance study the city had not taken any action on flood protection projects. They had been proactive in securing studies for the various channels located within the city. Since the completion of that study, Waverly has continued a proactive approach, including joining the National Flood Insurance Program, initiating a flood control ordinance, and continuing to seek ways to reduce the effects of the flood problems they have so often experienced.

HAZARD ANALYSIS AND RISK ASSESSMENT

HAZARD ANALYSIS

In order to properly identify mitigation strategies and projects, the hazards that may affect the city must be identified. The following section lists the potential hazards to the city that were identified by the planning committee. This section also discusses previous occurrences of the hazards, the areas of the city most at risk from each hazard, and the populations most at risk. By identifying the hazards and quantifying the risks, the city can better assess current mitigation strategies, develop future mitigation strategies and identify needed mitigation projects.

The hazard analysis identifies potential hazards that could affect the City of Waverly for the purposes of mitigation planning. It is important to note that the focus of mitigation is on reducing long-term risks of damage or threats to public health and safety caused by hazards and their effects. Thus, in some cases the hazards identified for mitigation will not include all of or the same hazards identified for preparedness, response or recovery.

The potential hazards identified for the City of Waverly and discussed in detail below include:

Winter Storm
Thunderstorm/Lightning/Hail
Watershed Pollution
Transportation Hazards
Tornado/High Wind Events
Flood
Communications Failure
Fire
Hazardous Materials
Dam Failure
Drought
Terrorism
Earthquake
Bridge Failure
Explosion
Excessive Heat
Disease
Riot/ Violent Demonstration
Sinkholes
Nuclear
Landslides/Mud Flows
Grass or Wild land Fires
Levee Failure
Expansive Soils

These hazards will be defined and discussed at length on the following pages. The discussion will include known historical occurrence, probability of future occurrence, vulnerability, maximum threat, severity, and the speed of onset. For each of these elements, not only discussion will take place, but the results of the Planning Committee's scoring efforts will also be included. Furthermore, a composite score is included in the tables below. The composite score accounts for events resulting from and caused by other hazards. The composite score is achieved by combining the Planning Committee's score with other criteria outlined in a matrix established by FEMA. The composite scoring table can be reference on page 59 of the plan.

Hazard	Winter Storm	
Definition	**Winter Storm:** A storm including any one or more of the following that has a damaging effect on daily activities: heavy snow, freezing rain, blowing snow, sleet, or extremely low temperatures.	
Description	A winter storm can cause many problems for a city. Winter storms often result in hazardous travel conditions. This alone can result in reduction of access both to and from service organizations. Increased government expenditure of time and money on such things as road clearing and maintenance can also cause financial stress on communities. Winter storms are most likely to occur between late October and late March.	**Rating**
Historical Occurrence	Waverly has experienced winter storms of some type every winter on record. According to the National Climatic Data Center there have been 45 Snow and Ice events reported in Bremer County between January 11, 1993 and April 28, 2008. Over an eight year period that would average to 3.75 events per year. These snow and ice events have been responsible for six deaths in the county over that period of time. Over that same time there has been nine (9) reported "extreme" low temperature and wind-chill events reported in the county. December of 2000 brought with it record snows. Approximately 34 inches of snow fell during the month. This is believed to have dwarfed the previous record for snow in a month set in January of 1962.	9
Probability	The probability of a winter storm affecting the City of Waverly is almost certain on an annual basis. Some winters have been historically worse than others, but Waverly can expect at least several events per winter season.	9
Vulnerability	Those most vulnerable to the effects of a winter storm are those who cannot fend for themselves in times of severe weather. Example populations would be the elderly or disabled who rely on outside entities for delivery of food or medicine for their livelihood. At the time of the 2000 Census, there were 2,208 persons in Waverly who were over the age of 64 and/or disabled. People who work outdoors are also at greater risk of being affected by wind chill, extreme low temperature, and wet winter conditions.	7
Maximum Threat	Although the developments in technology have been very beneficial in reducing the long-term negative effects of winter storms, certain dangers still exist. The maximum threat of winter conditions would be realized if it was accompanied by power outages and elimination of travel due to hampered road conditions. This could result in the inability for some of the population to maintain temperatures necessary for the body. In addition long winter events that eliminate communication could result in the reduction of adequate medical response time.	8
Severity of Impact	Depending on the type, duration, and the size of the event the entire population could feel the effect of a winter storm. Generally, due to existing snow removal services and other community services the affects of winter storms on Waverly are short term. Although more of an inconvenience, and somewhat more dangerous, travel and communication is usually an option in less than 24 hours of any given event.	5
Speed of Onset	The National Weather Service has developed effective weather advisories, which are promptly and widely distributed. Radio, TV, and Weather Alert Radios provide the most immediate means to do this. Accurate information is made available to public officials and the public up to days in advance. Again, weather prediction capabilities have made significant improvements in the past few years. There are several notifications made by the National Weather Service. These include winter storm watch, winter storm warning, blizzard warning, winter weather advisory, and a frost/freeze advisory.	5
	Hazard Worksheet Score	**43**
	Composite Score	**53**

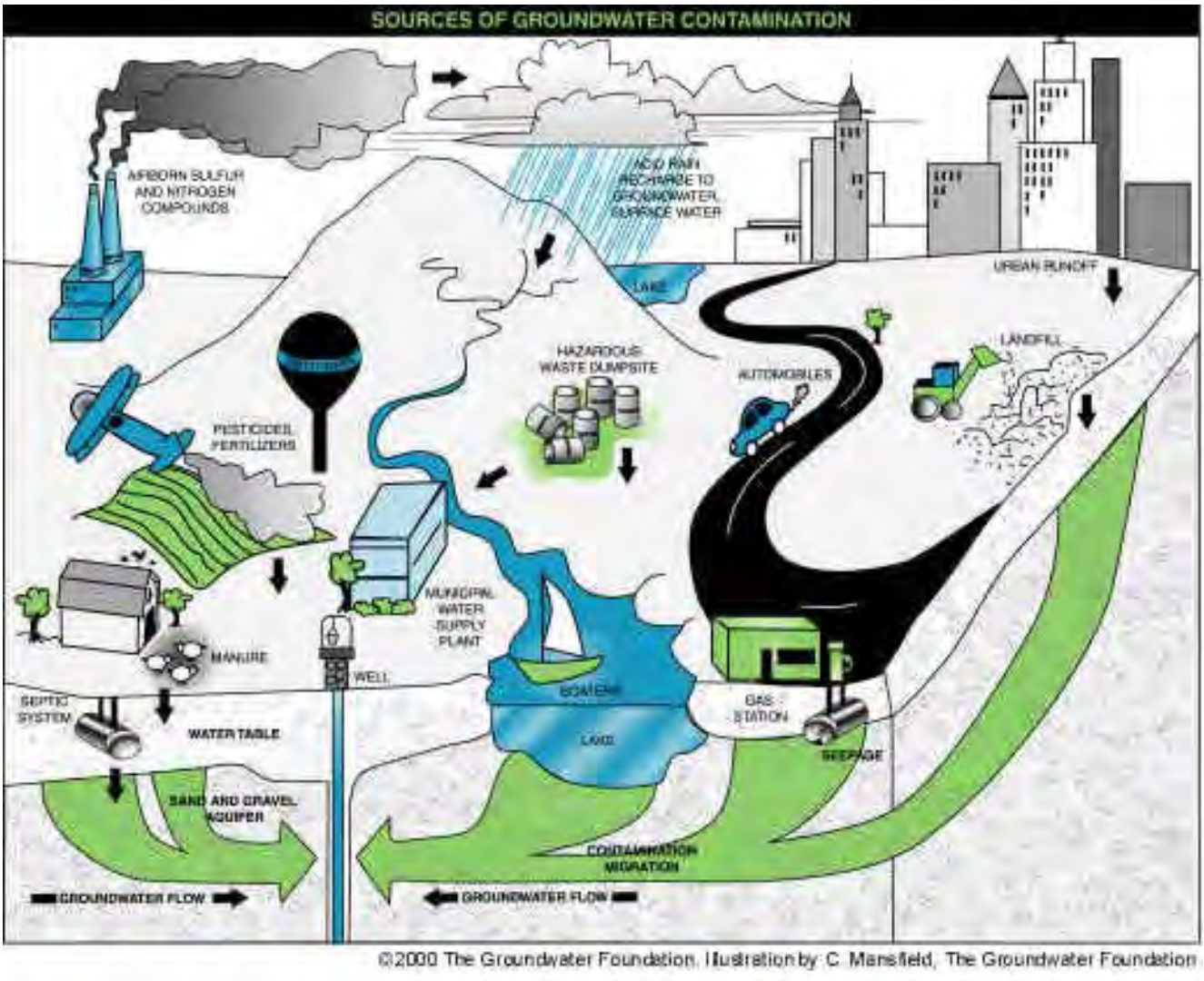
Hazard	Thunderstorms / Hail / Lightning Events	
Definition	**Thunderstorm:** A thunderstorm is formed from a combination of moisture, rapidly rising warm air and a force capable of lifting air such as a warm and cold front, a sea breeze or a mountain. All thunderstorms contain lightning. Thunderstorms may occur singly, in clusters or in lines. Thus, it is possible for several thunderstorms to affect one location in the course of a few hours. Some of the most severe weather occurs when a single thunderstorm affects one location for an extended time. **Lightning:** Lightning is an electrical discharge that results from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt." This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning reaches a temperature approaching 50,000 degrees Fahrenheit in a split second. The rapid heating and cooling of air near the lightning causes thunder.	
Description	Thunderstorms can bring heavy rains (which can cause flash flooding), strong winds, hail, lightning and tornadoes. Lightning associated with thunderstorms is itself a major hazard. In the United States, between 75 to 100 Americans are hit and killed each year by lightning. The power of lightning's electrical charge and intense heat can electrocute on contact, split trees, ignite fires and cause electrical failures. Since March 1993 there have been 94 Thunderstorm events recorded in Bremer County. Many of these storms affected the residents of Waverly. Since 1993, thunderstorms have caused approximately $1.862 million in property damage and $505,000 in crop damage. Hail is another hazard produced by many strong thunderstorms. Hail can be smaller than a pea or as large as a softball and can be very destructive to property, animals, plants, and crops. Since May 1993, there have been a total of 31 reported hail events in Bremer County, causing approximately $325,000 in property damage and $343,000 in crop damage. Another hazard related to thunderstorms is flash flood events. The heavy rains from thunderstorms can overwhelm a city's storm sewer system and result in localized street and basement flooding.	**Rating**
Historical Occurrence	Thunderstorms are a common occurrence in Waverly. Each spring and summer brings many thunderstorms, accompanied by lightning, high winds, and small hail. Residents in Waverly recall a hailstorm in 1998 that dropped golf ball sized hail on the city and caused extensive property damage. In addition, it is not uncommon for lightning to hit electrical substations, causing short-lived power outages.	9
Probability	Residents of Waverly experience thunderstorm events many times during a typical year. Based on county data, the City experiences an average of six thunderstorms each year. Each storm carries the potential for heavy rain, dangerous lightning, high winds, and hail.	9
Vulnerability	Due to the large size of most thunderstorms, all residents of the city would be equally vulnerable. Those especially at risk would be persons working outside, traveling in vehicles, living in mobile homes/manufactured housing, and/or living in the floodplain. In Waverly there are currently 400 houses located in the 100-year floodplain, and approximately 936 persons living in those houses.	7
Maximum Threat	Although the developments in technology have been very beneficial in reducing the long-term negative effects of thunderstorms, certain dangers still exist. The maximum threat of a thunderstorm would be realized if it was accompanied by power outages and limitation of travel due to debris in the roadways. In addition lightning damage to communication centers could result in the reduction of adequate medical response time.	6
Severity of Impact	Depending on the type, duration, and the size of the event the entire population could feel the effect of a severe thunderstorm event. Generally, due to the ability of the city's electricity supplier and the existing debris removal services the affects of thunderstorms on Waverly are short term.	4

Speed of Onset	The National Weather Service has developed effective weather advisories, which are promptly and widely distributed. Radio, TV, and Weather Alert Radios provide the most immediate means to do this. Accurate information is made available to public officials and the public in advance of the storm. Again, weather prediction capabilities have made significant improvements in the past few years. There are several notifications made by the National Weather Service. These include severe thunderstorm watch, severe thunderstorm warning, tornado watch, tornado warning, flash flood watch, and flash flood warning.	5
	Hazard Worksheet Score	**40**
	Composite Score	**59**

Hazard	**Watershed Pollution**	
Definition	**Watershed:** that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community." (EPA). **Pollutant:** Any substance that when added to water (or another substance) makes it impure and unfit for consumption or use.	
Description	Fifty percent of the United States population depends daily on groundwater for their drinking water. Groundwater is also one of our most important sources of irrigation water. Unfortunately, groundwater is susceptible to pollutants. Groundwater is generally a safe source of drinking water; however, there are concerns that contamination may increase as toxins dumped on the ground in the past make their way into groundwater supplies (*The Groundwater Foundation*). According to *The Groundwater Foundation*, groundwater contamination occurs when man-made products such as gasoline, oil, road salts and chemicals get into the groundwater and cause it to become unsafe and unfit for human use. Some of the major sources of these products, called contaminants, are storage tanks, septic systems, hazardous waste sites, landfills, and the widespread use of road salts and chemicals. Finally, according to *The Groundwater Foundation*, drinking contaminated groundwater can have serious health effects. Diseases such as hepatitis and dysentery may be caused by contamination from septic tank waste. Poisoning may be caused by toxins that have leached into well water supplies.	**Rating**
Historical Occurrence	Watershed Pollution is a concern for residents of Waverly. There is concern that pollutants from residential and farm chemicals and/or pollutants from the city sewer system may eventually contaminate the groundwater. Even so, to date there have been no noted instances of groundwater pollution	5
Probability	Due to the large amount of water that runs through the city's storm sewer system, sanitary sewer system and the number of uncapped wells in the city, there is a probability that there may be some groundwater contamination issues for the city in the future.	6
Vulnerability	As noted above, drinking contaminated water can cause serious injury or death. In the event that the groundwater was contaminated, this would affect each resident in the city who drank the water from local wells, including the city wells.	6
Maximum Threat	Again, if the city's groundwater were contaminated, this would have an affect on the entire city.	6

Severity of Impact	The severity of impact would largely depend on how quickly the contamination was discovered and the level of pollutant in the water. The worst-case scenario would occur if contamination was not discovered in a timely manner and the population has been using unsafe water for a period of time. A hazard of this magnitude could cause many injuries and could also result in a number of deaths.	5
Speed of Onset	Watershed pollution resulting from a chemical or fertilizer spill would likely result from an accident and there would be no notice or advance warning.	6
	Hazard Worksheet Score	**34**
	Composite Score	**34**

Figure 5: Sources of Groundwater Contamination



Source: *www.groundwater.org*

Hazard	Transportation Hazards	
Definition	**Transportation Hazard:** A hazard to the community resulting from an incident related to or caused by any vehicle used to transport persons or items, such as cars, trucks, airplanes, trains, boats, etc.	
Description	Transportation hazards can occur in any community at any time and may result in injury, loss of life, property damage, and hazardous chemical spills. The possibility of such a hazard is increase by the number of major transportation routes near the community. Three major transportation routes exist in or near the City of Waverly. Car and truck traffic is highest on Interstate 218/27, which runs around the western and southern borders of the city. According to the Iowa Department of Transportation, an average of 6,600 cars and trucks travel on that stretch of highway each day. An additional 9,500 cars and trucks travel within the city on Old Highway 218 and 3,620 vehicles travel on Highway 3, which passes through the city on an east-west route. Finally, an average of 15,400 vehicles travel on city streets each day. The second major transportation route located near the city is the Illinois Central Railroad, which enters the city from the south and exits to the west. This railroad operates 850 miles of track in Iowa. Most of the trains running through Waverly carry farm products, however, occasionally the trains do carry chemicals that could cause a hazard if spilled or leaked into the environment. The third major transportation route is the airspace above the city. The Waverly Municipal Airport is located just one mile north of Waverly and the Waterloo Municipal Airport is located just 20 miles south of Waverly. These airports average a total of 224 aircraft operations per day and many of these airplanes fly over the city.	**Rating**
Historical Occurrence	Traffic accidents are a common occurrence in the city. According to the Iowa Department of Transportation a total of 609 vehicle crashes had occurred in the City from 2001 to 2005. These accidents resulted in 2 fatalities, 15 major injuries, and 84 minor injuries. Crashes, injuries and fatalities are declining compared to the recent decade, 1990-1999 which reflected a five year average of 696 crashes, 30 major injuries, 156 minor injuries and 3 fatalities. There have been no rail accidents or aircraft accidents that have occurred within the city limits or near to the city that have affected it residents.	8
Probability	Based on past history, there is a high probability of traffic accidents occurring within Waverly; in addition, there is a good probability of hazardous material spills occurring in conjunction with some traffic accidents. However, the probability of rail or air traffic accidents remains relatively low.	8
Vulnerability	There exist a large number of streets and intersections in the city, any street or intersection could be the site of a traffic accident. Persons driving on Interstate 218/27 or Highway 3 may be more vulnerable to traffic accidents due to the larger number of drivers on this road and the increased road speed. Residents in the extreme southwestern portion of the city limits may be vulnerable to a rail disaster, especially one that included the spillage or leakage of hazardous materials. All residents have the potential to be vulnerable to an air traffic event. Not all residents would be directly affected if an airplane were to land or crash within the city limits; however most would be at least indirectly affected, especially if the plane were to hit the water tower or sewer treatment facility.	3

Maximum Threat	There remains a moderate threat of a traffic accident occurring within the city limits as well as a moderate threat of a hazardous materials event occurring as a result of the accident. However, there is only a minimal threat of a rail disaster or air disaster occurring near or within the city limits.	3
Severity of Impact	The exact area that will be affected by a traffic event will likely be small and have a minimal impact on the residents as a whole, unless a large or extremely dangerous hazardous material spill should result from the event. The same can be said for a rail disaster. An air disaster may impact a larger portion of the city, depending on where the impact occurred.	4
Speed of Onset	Due to their nature, there is little or no way to predict when or where a traffic accident will occur. The same can be said for rail disasters and air disasters.	8
	Hazard Worksheet Score	**34**
	Composite Score	**47**

Table 8: Traffic Accident Reports, 1990 – 2005

Year	Fatal Crashes	Injury Crashes	Property Damage Only	Total Crashes	Estimated Property Damage
1990	0	55	167	222	$522,778
1991	1	57	146	204	$492,578
1992	0	60	131	191	$618,161
1993	3	63	139	205	$433,643
1994	0	55	131	186	$457,541
1995	0	67	128	195	$528,304
1996	0	69	153	222	$621,176
1997	1	71	122	194	$508,457
1998	0	55	119	174	$411,522
1999	1	54	83	138	$140,500
2000	0	58	78	117	$699,082
2001	1	60	66	110	$1,618,505
2002	0	50	82	110	$1,672,383
2003	0	43	90	117	$1,726,075
2004	1	36	102	132	$1,807,615
2005	0	36	103	133	$1,511,285
Totals	**8**	**889**	**1,912**	**2,650**	**$12,045,256**

Source: Iowa Department of Transportation

Hazard	Tornado/High Wind Event	
Definition	**Thunderstorm/High Wind Event:** A violent destructive whirling wind accompanied by a funnel-shaped cloud that progresses in a narrow path over the land or a violent windstorm *(Webster)*	
Description	A tornado is an extremely violent wind that is generally identified by its funnel shape. A funnel cloud becomes a tornado when it makes contact with the ground. Tornados are most commonly associated with cumulonimbus cloud formations and can occur in conjunction with heavy rainfall, lighting, and hail. Tornados can vary in size from a few yards at their base to as much as a mile wide. The high winds that accompany tornadoes can result in the loss of life, generally due to the projection of surface debris or the destruction of occupied structures. Tornadoes are generally measured in intensity by a rating scale known as the Fujita Scale. The details of the Fujita Scale can be found in the table below.	**Rating**
Historical Occurrence	In the U.S., Iowa is ranked third in the number of strong-violent (F2-F5) tornadoes per 10,000 square miles. From 1950-2007, Iowa averaged 38 twisters per year. In Iowa most tornadoes occur in the spring and summer months, but twisters can and have occurred in every month of the year. Late afternoon to evening hour tornadoes are the most common, but they can occur at any time of the day. Bremer County has had 20 recorded tornadoes between 1950 and 2007. They are listed in the table below and are shown on the attached *Attachment 4: Historic Tornado Map of the County*. There have been no recorded deaths in that time period and no reports of injury due to tornados. High winds have been responsible for at least two events that caused extensive damage in the city. The first occurred in the mid 1980's when a roof was lifted off of a downtown business. Strong winds have caused damage to houses in the Murphy Addition. In 1998, straight line winds of approximately 78 miles per hour resulted in damage to doors on an airplane hanger at the Waverly Municipal Airport.	5
Probability	There have been 20 recorded tornadoes in Bremer County in the past 45 years. That amounts to 4.5 events per decade. Because tornadoes are sporadic there cannot be a reliable long-term prediction made as to when they may occur.	5
Vulnerability	Everyone is vulnerable to the powerful forces that accompany a tornado. There are those who are more vulnerable than others. For example: People in automobiles, People in mobile homes, People who may not understand warnings due to language barriers, The elderly and very young, and People with physical or mental impairments. At the time of the 2000 Census in Waverly there were approximately 198 persons living in mobile homes/manufactured housing and approximately 1,102 persons living in multi-family units, each of which may not have adequate storm shelters available. In addition, there were 2,208persons over the age of 64 and/or disabled. In addition, there were 450 children under the age of five. All populations that could be at additional risk in the event of a tornado/ high wind event. In the event of a tornado the City of Waverly operates outdoor early warning sirens that, given enough time, allow people to search for suitable shelter. The sirens are operable on a 24-hour basis.	7

Maximum Threat	The maximum threat of a tornado usually occurs from a few hundred feet to a mile away from the tornado. Much of the damage incurred during a tornado event is often due to the accompanying hail, lighting, and wind shear.	7
Severity of Impact	Impacts can vary from broken tree limbs to the total destruction of buildings and other structures.	8
Speed of Onset	Tornado watches can warn of likely conditions hours in advance of an upcoming storm. Although significant advances in meteorological technology has allowed for much more effective forecasting, specific tornadoes cannot be predicted with any precision any more than minutes before they develop. The rapid change in direction a tornado can achieve makes it difficult to say with certainty the path the tornado will continue on even after it has been identified. Therefore warning time can sometimes be very short or occasionally non-existent.	8
	Hazard Worksheet Score	**40**
	Composite Score	**54**

Figure 6: Iowa Tornado Risk

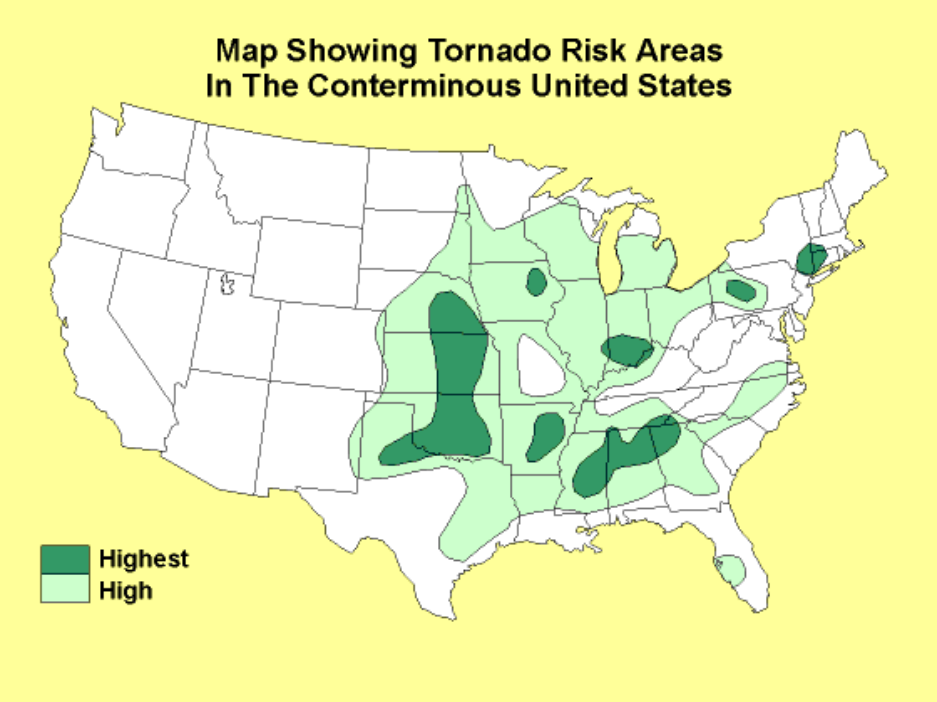


Figure 7: Wind Zones

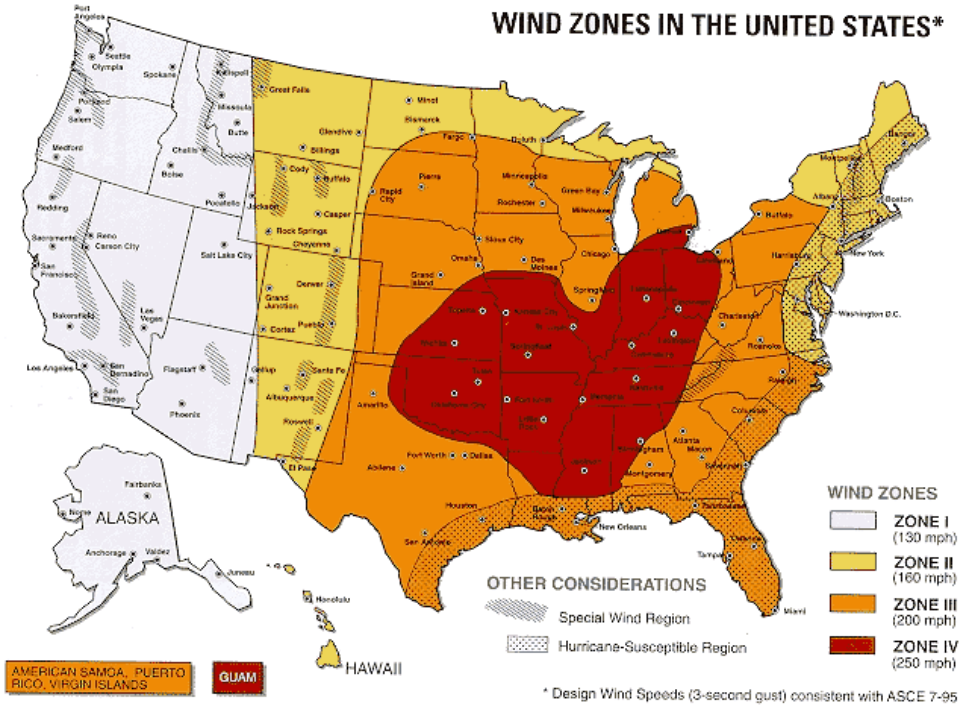


Figure I.2 Wind zones in the United States

Table 9: Fujita Scale & Enhanced Scale of Tornados

Original Fujita Scale

Category F0: **Gale tornado** (40-72 mph); light damage. Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage to sign boards.

Category F1: **Moderate tornado** (73-112 mph); moderate damage. The lower limit is the beginning of hurricane wind speed; peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads.

Category F2: **Significant tornado** (113-157 mph); considerable damage. roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.

Category F3: **Severe tornado** (158-206 mph); Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.

Category F4: **Devastating tornado** (207-260 mph); Devastating damage. Well-constructed houses leveled; structure with weak foundation blown off some distance; cars thrown and large missiles generated.

Category F5: **Incredible tornado** (261-318 mph); Incredible damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile sized missiles fly through the air in excess of 100 yards; trees debarked; incredible phenomena will occur.

Enhanced Fujita Scale

Category EF-0. Light damage (Wind 65 to 85 mph). Causes some damage to siding and shingles.

Category EF-1. Moderate damage (Wind 86 to 110 mph). Considerable roof damage. Winds can uproot trees and overturn single-wide mobile homes. Flagpoles bend.

Category EF-2. Considerable damage (Wind 111 to 135 mph). Most single-wide mobile homes destroyed. Permanent homes can shift off foundation. Flagpoles collapse. Softwood trees debarked.

Category EF-3. Severe damage (Wind 136 to 165 mph). Hardwood trees debarked. All but small portions of houses destroyed.

Category EF-4. Devastating damage (Wind 166 to 200 mph). Complete destruction of well-built residences, large sections of school buildings.

Category EF-5. Incredible damage (Wind above 200 mph). Significant structural deformation of mid- and high-rise buildings.

Table 10: Bremer County Tornado Events

DATE	EVENT #	TIME	DEATH	INJ.	FUJITA SCALE
MAY 14, 1961					
SEP 01, 1961	5	1710	0	0	F1
MAY 29, 1962	9	1540	0	0	F4
AUG 20, 1964	10	1810	0	0	F1
APR 19, 1966	41	1545	0	0	F0
SEP 09, 1970	4	1920	0	2	F2
JUL 12, 1971	19	1500	0	1	F2
JUN 04, 1973	31	1900	0	0	F2
NOV 09, 1975	13	1415	0	0	F1
JUN 07, 1977	32	1815	0	0	F1
JLY 16, 1977	20	1830	0	0	F1
APR 10, 1981	28	2035	0	0	F2
JLY 05, 1985	10	1912	0	0	F2
MAY 08, 1988	18	1540	0	0	F0
NOV 15, 1988	16	1315	0	0	F1
JUN 14, 1991	46	1850	0	0	F1
JUN 26, 1996	42	2315	0	0	F0
JUN 27, 1998	--	1450	0	0	F0
JUN 1, 2001	--	2157	0	0	F2
SEPT 6, 2001					

Source: www.tornadoproject.com

Hazard	Flood (Riverine & Flash)	
Definition	**Riverine Flood:** a rising and overflowing of a body of water especially onto normally dry land; *also* **:** a condition of overflowing <rivers in *flood*> *(Webster)* **Flash Flood:** a local flood of great volume and short duration generally resulting from heavy rainfall in the immediate vicinity *(Webster)*	
Description	Floods cause the most widespread and costly damage of any of the identified hazards in Waverly and in Iowa. In fact, Iowa is reported to Congress as experiencing the highest annual flood damage of any state in the nation, with annual damages exceeding $543 million. The primary flood hazard in the City of Waverly generally occurs as a result of overflow from one of two sources. The first source would include flooding from the Cedar River, which represents the largest single water-body in the city. The second source is Dry Run Creek, which is a tributary to the Cedar River. Another smaller stream referred to as "No Name Creek" can experience minor, rather insignificant flooding. An important note is the difference between a flash flood and other types of flooding. Flash flooding generally does not allow for the warning time that can be given in a regular flood. Therefore, the risks associated with flash flooding are substantially more severe.	Rating
Historical Occurrence	Unfortunately, the City of Waverly has had to deal with several flood events in its history. According to the Flood Insurance Study for the City of Waverly, the greatest floods occurring on the Cedar River before the 1990s took place in the years 1945, 1961, and 1965. The flood of March 1961 reached a peak discharge of 37,000 cfs. Therefore, this flood would be considered approximately a 25-year flood. Most damage from these floods effected residential properties, with less damage to commercial, industrial, and public property.	

<table>
<tr><td></td><td>Dry Run Creek extends west from the Cedar River and is the other stream in the community with a history of flooding. Again, according to the Waverly Flood Insurance Study, Dry Run Creek flooded in 1947, 1951, 1961, 1968, and 1979. The 1968 flood resulted in loss of life.

With the 1990's came the worst decade in terms of flooding that Waverly had ever experienced. The two greatest floods occurred in 1993 and 1999.

In 1999 there were actually two separate floods that inundated the city. The first occurred in May and the next in July. The July event was estimated to be a 100-year flood event. FEMA flood insurance payments for that summer were in excess of 2.7 million dollars.

Record flooding in 2008 devastated many areas in the Waverly Community. Both the residential and business districts absorbed significant damage. The river eventually crested at 19.1 ft, 2.5 ft above the previous record. During this event over 600 homes were flooded of which 36 had basements collapse and 16 were left condemned. This event was estimated to be a 500-year flood event.</td><td>7</td></tr>
<tr><td>Probability</td><td>Considering the historical occurrence of flood events and the number of streams and rivers located within the City of Waverly, the probability of future flooding remains high. Where the flooding may occur can vary substantially. Mitigation efforts made since the floods of 1999 have contributed very little throughout and surrounding Bremer County. Past mitigation efforts focusing on dikes and levees have contributed to rising waters. Flood waters of 2008 have proven the ineffectiveness of these flood control methods. Homes and businesses that remain in the floodway and 100-year flood plain will be flooded again in due time.</td><td>7</td></tr>
<tr><td>Vulnerability</td><td>Those who are directly vulnerable to future flooding in the city include all those residing in low-lying areas of the city. At greater risk are those with businesses or houses within the 100 and 500-year flood zones as indicated on the Flood Insurance Rate Maps (FIRM) created by the Federal Emergency Management Agency (FEMA).

According to City records, there are approximately 400 houses and 134 commercial/industrial/public structures in Waverly the 100-year floodplain, see Attachment 1, Figure 2: Floodplain Map of the City. Using the average persons per household, 2.36, approximately 936 persons are living in the floodplain.

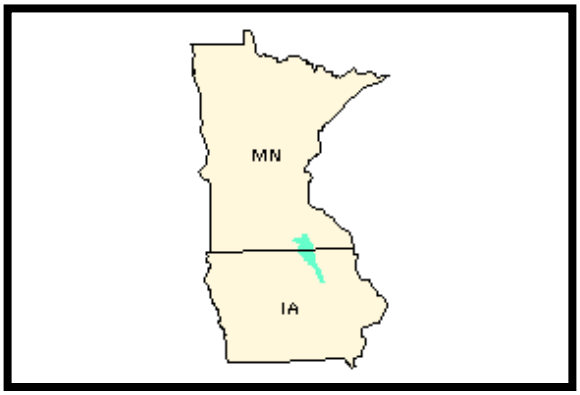
There are 51 streets that are either completely or partially in a flood hazard area as identified by the October 1998 FIRM map. Those streets are:

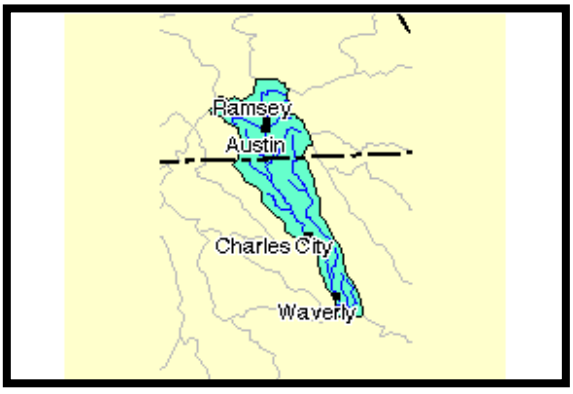
<table>
<tr><td>24th St. NW</td><td>4th Ave. NW</td></tr>
<tr><td>20th St. NW</td><td>5th Ave. NW</td></tr>
<tr><td>16th St. NW</td><td>6th Ave. NW</td></tr>
<tr><td>13th St. NW</td><td>7th Ave. NW</td></tr>
<tr><td>12th St. NW</td><td>1st Ave. NE</td></tr>
<tr><td>9th St. NW</td><td>2nd Ave. NE</td></tr>
<tr><td>8th St. NW</td><td>2nd Ave. SW</td></tr>
<tr><td>7th St. NW</td><td>3rd Ave. SW</td></tr>
<tr><td>6th St. NW</td><td>4th Ave. SW</td></tr>
<tr><td>5th St. NW</td><td>5th Ave. SW</td></tr>
<tr><td>4th St. NW</td><td>6th Ave. SW</td></tr>
<tr><td>3rd St. NW</td><td>7th Ave. SW</td></tr>
<tr><td>2nd St. NW</td><td>8th Ave. SW</td></tr>
<tr><td>1st St. NW</td><td>Crestwood Ave.</td></tr>
<tr><td>Adams Prkwy.</td><td>10th Ave. SW</td></tr>
<tr><td>Horton Rd.</td><td>2nd Ave. SE</td></tr>
<tr><td>1st St. NE</td><td>3rd Ave. SE</td></tr>
<tr><td>2nd St. NE</td><td>4th Ave. SE</td></tr>
<tr><td>W Bremer Ave.</td><td>6th Ave. SE</td></tr>
<tr><td>E Bremer Ave.</td><td>7th Ave. SE</td></tr>
<tr><td>1st Ave. SW</td><td>8th Prkwy. SE</td></tr>
<tr><td>1st Ave. SE</td><td>Jahnke Dr.</td></tr>
</table>
</td><td></td></tr>
</table>

	1st Ave. NW / Harl Pl. 2nd Ave. NW / 8th St. SE 3rd Ave. NW / 12th St. SE River Park Dr. / ----------	7
Maximum Threat	Flooding would likely affect the entire city in some regard. Whether it is closed roads resulting in limited access to business or residential areas or simply the cost incurred by the community as a result to increased man-hours, most of the city would be affected. The greatest threats of flooding are that of the loss of life, limb, and loss of property. As mentioned earlier, those who are at the greatest risk are those living in identified flood zones. The Federal Emergency Management Agency has delineated the probable extent of the 100-year flood hazard areas. These Flood Insurance Rate Maps (FIRMs) show properties affected by the floods that have at least a 1% chance of occurring in any particular year.	7
Severity of Impact	Flooding impacts include loss of life; property damage and destruction; damage and disruption of communications, transportation, electric service, and community services; crop and livestock damage and loss and interruption of business. Hazards of fire, health and transportation accidents, and contamination of water supplies are likely effects of flooding situations.	7
Speed of Onset	Flood warnings are disseminated from the National Weather Service, IAWAS, and Tornado Spotters to the Bremer County/City of Waverly Communications Center who, in turn, disseminates warnings to the affected areas of the city and county, using established procedures. People in the path of river floods may have time to take appropriate actions to limit harm to themselves and their property. Floods may occur in the form of flash flooding which can result in a matter of tens of minutes. Other floods can be forecasted to allow for several hours, perhaps even days notification.	4
	Hazard Worksheet Score	**39**
	Composite Score	**55**

Figure 8: Upper Cedar Watershed Area
The Cedar River that runs through Waverly is actually part of the larger Upper Cedar Watershed Area. This watershed area covers area in both southern Minnesota and Northeastern Iowa.

The figure below shows a more detailed map of the area that the Upper Cedar Watershed is responsible for draining. The Upper Cedar Watershed has a drainage area of 1,727.31 square miles and contains 14 rivers and streams for a total of 1,929.5 river miles. There are also 31 lakes covering 3,095.8 acres.





The table below shows the available gauge information for Bremer County & Waverly. Please note that the information given for the gauge is from the Janesville site. This was the only site that had historic stream flow data available for the Cedar River in Bremer County.

Table 11: Gauge Information

Cedar River at Janesville, Iowa
Station number: 05458500

Latitude (ddmmss)	42°38'54"
Longitude (ddmmss)	92°27'54" NAD27
State Code	19
County	Bremer
Hydrologic Unit Code	07080201
Basin Name	Upper Cedar
Drainage Area (square miles)	1,661
Contributing Drainage Area (square miles)	1,661
Gage Datum (feet above NGVD29)	868.26
Base Discharge (cubic ft/sec)	4,000

The City of Waverly now has a river gauge that provides real-time data. Unfortunately, this gauge site is new enough that historic river heights and discharges were unavailable. Therefore, information from the nearest gauge providing such information near Janesville, Iowa was substituted. Although the peaks from this site may vary from the peaks that the City of Waverly has experienced it should give a rather good picture of historic high water in the area. Please refer to the table below for Annual Recorded Peak flows from the Janesville site.

Table 12: Annual Recorded Peak Flows (Janesville, IA)

Water Year	Station	Date	Stream Flow (CFS)	Peak
1905	05458500	May 17, 1905	5,840	7.1
1906	05458500	Mar. 27, 1906	27,100	14.2
1915	05458500	May 31, 1915	7,220	8.9
1916	05458500	Jun. 2, 1916	12,100	11
1917	05458500	Mar. 24, 1917	21,900	13.8
1918	05458500	Mar. 20, 1918	7,400	9
1919	05458500	Apr. 10, 1919	6,870	8.7
1920	05458500	Mar. 28, 1920	6,190	7.3
1921	05458500	May 29, 1921	15,300	11.5
1923	05458500	Apr. 4, 1923	4,630	6.2
1924	05458500	Aug. 22, 1924	4,410	6
1925	05458500	Jun. 15, 1925	6,860	7.7
1926	05458500	Mar. 22, 1926	4,010	5.6
1927	05458500	May 28, 1927	4,630	6.2
1933	05458500	Apr. 1, 1933	33,300	16
1934	05458500	Apr. 6, 1934	11,200	9.9
1935	05458500	Mar. 5, 1935	9,580	9.1
1936	05458500	Mar. 24, 1936	11,200	9.8
1937	05458500	Mar. 8, 1937	12,000	11
1938	05458500	Sep. 17, 1938	8,910	8.8
1939	05458500	Mar. 17, 1939	7,500	9.4
1940	05458500	Apr. 1, 1940	4,410	6
1941	05458500	Apr. 20, 1941	8,890	8.7
1942	05458500	Jul. 16, 1942	10,100	9.3
1945	05458500	Mar. 17, 1945	34,300	16.2
1946	05458500	Sep. 9, 1946	14,700	11.3
1947	05458500	Jun. 13, 1947	12,200	10.14
1948	05458500	Mar. 1, 1948	25,100	14.1
1949	05458500	Mar. 7, 1949	14,000	11.4
1950	05458500	Mar. 28, 1950	20,200	12.7
1951	05458500	Apr. 9, 1951	25,000	14.05
1952	05458500	Apr. 2, 1952	14,700	10.74
1953	05458500	Aug. 6, 1953	15,000	10.8
1954	05458500	Jun. 22, 1954	18,400	12.08
1955	05458500	Mar. 14, 1955	4,430	5.16
1956	05458500	Apr. 5, 1956	3,530	4.46
1957	05458500	May 31, 1957	1,890	3.1
1958	05458500	Feb. 25, 1958	1,100	2.73
1959	05458500	Mar. 27, 1959	6,620	6.78
1960	05458500	Mar. 30, 1960	13,200	10.46
1961	05458500	Mar. 28, 1961	37,000	16.33
1962	05458500	Mar. 31, 1962	24,000	13.86
1963	05458500	Mar. 19, 1963	6,200	9.65
1964	05458500	Jun. 23, 1964	1,240	2.53
1965	05458500	Apr. 7, 1965	29,200	14.33
1966	05458500	Oct. 1, 1965	18,800	12.05
1967	05458500	Jun. 12, 1967	7,690	7.57
1968	05458500	Jul. 17, 1968	21,700	12.79
1969	05458500	Jul. 1, 1969	23,500	13.74
1970	05458500	Mar. 4, 1970	3,400	4.85
1971	05458500	Apr. 2, 1971	11,400	9.59
1972	05458500	Sep. 27, 1972	5,060	5.42
1973	05458500	Apr. 18, 1973	16,500	11.67
1974	05458500	Jun. 11, 1974	10,800	9.33

1975	05458500	Apr. 30, 1975	12,000	9.9
1976	05458500	Mar. 14, 1976	9,260	8.58
1977	05458500	Sep. 18, 1977	2,460	3.3
1978	05458500	Jul. 10, 1978	9,740	8.9
1979	05458500	Apr. 2, 1979	15,700	11.24
1980	05458500	Aug. 12, 1980	14,900	11.14
1981	05458500	Jul. 19, 1981	7,050	7.13
1982	05458500	Mar. 21, 1982	9,640	8.69
1983	05458500	Mar. 8, 1983	12,800	10.28
1984	05458500	Jun. 20, 1984	12,100	9.96
1985	05458500	Mar. 3, 1985	4,640	na
1986	05458500	Mar. 21, 1986	15,100	11.03
1987	05458500	Oct. 15, 1986	12,600	10.18
1988	05458500	Mar. 6, 1988	3,080	4.15
1989	05458500	Mar. 27, 1989	4,170	4.71
1990	05458500	Jul. 30, 1990	12,800	10.3
1991	05458500	May 20, 1991	14,500	10.98
1992	05458500	Mar. 11, 1992	8,830	8.31
1993	05458500	Aug. 18, 1993	35,000	15.74
1994	05458500	Jul. 23, 1994	5,690	6.29
1995	05458500	Apr. 15, 1995	4,450	5.16
1996	05458500	Jun. 21, 1996	4,250	4.88
1997	05458500	Mar. 25, 1997	11,000	9.52
1998	05458500	Jul. 1, 1998	10,700	8.83
1999	05458500	Jul. 22, 1999	42,200	17.15
2000	05458500	Jul. 13, 2000	17,000	11.91
2001	05458500	April 14, 2001	21,700	13.30
2002	05458500	June 7, 2002	2,590	3.48
2003	05458500	May 15, 2003	6,640	6.41
2004	05458500	Sept 18, 2004	25,000	13.40
2005	05458500	Feb. 17, 2005	7,370	8.37
2006	05458500	April 10, 2006	10,600	8.27
2007	05458500	March 24, 2007	10,500	8.75

*Peak flow data were retrieved from the National Water Data, Storage and retrieval System (WATSTORE). Gage heights are given in feet above gage datum elevation, discharge is listed in the table in cubic feet per second.

Table 13: Top 10 Peak Flow Recordings at Janesville

Year	Date	Gage at Peak	Discharge
1999	Jul. 22, 1999	17.15	42,200
1961	Mar. 28, 1961	16.33	37,000
1993	Aug. 18, 1993	15.74	35,000
1945	Mar. 17, 1945	16.2	34,300
1933	Apr. 1, 1933	16	33,300
1965	Apr. 7, 1965	14.33	29,200
1906	Mar. 27, 1906	14.2	27,100
1948	Mar. 1, 1948	14.1	25,100
1951	Apr. 9, 1951	14.05	25,000
2004	Sept. 18, 2004	13.40	25,000

Source: www.usgs.gov