4.4 Hazard Profiles

4.4.1 Tornadoes

Tornadoes are defined as violently-rotating columns of air extending from thunderstorms to the ground, with wind speeds between 40-300 mph. They develop under 3 scenarios: (1) along a squall line; (2) in connection with thunderstorm squall lines during hot, humid weather; and (3) in the outer portion of a tropical cyclone. Funnel clouds are rotating columns of air not in contact with the ground; however, the column of air can reach the ground very quickly and become a tornado.

Since 2007, tornado strength in the United States is ranked based on the Enhanced Fujita scale (EF scale), replacing the Fujita scale introduced in 1971. The EF scale uses similar principles to the Fujita scale, with 6 categories from 0-5, based on wind estimates and damage caused by the tornado. The EF Scale is used extensively by the NWS in investigating tornadoes (all tornadoes are now assigned an EF Scale number), and by engineers in correlating damage to buildings and techniques with different wind speeds caused by tornadoes. To see a comparative table of F and EF scales, see http://www.spc.noaa.gov/faq/tornado/ef-scale.html.

Figure 7. Tornado in southern MN, June 17, 2010 (Silver Lining Tours, 2010)

In Minnesota, the peak months of tornado occurrence are June and July. The typical time of day for tornadoes in Minnesota ranges between 4:00 p.m. and 7:00 p.m. Most of these are minor tornadoes, with wind speeds under 125 miles per hour. A typical Minnesota tornado lasts approximately 10 minutes, has a path length of 5 to 6 miles, is nearly as wide as a football field, has a forward speed of about 35 miles an hour, and affects less than 0.1% of the county warned.

Tornado History in Steele County

According to the NCEI, 22 tornadoes were reported in Steele County between 1950 and March of 2017, causing no deaths, one injury, and over $53,000,000 dollars in property damage. Tornado classification ranged from F0/EF0 to F3/EF3 on the Fujita Scale.

The most recent tornado occurred in March of 2017 in Ellendale. It was a continuation of the Freeborn County tornado that moved into Steele County for approximately 2.4 miles before lifting. In Freeborn County, it was rated EF-1, but in Steele County, it produced EF-0 damage to trees and farm outbuildings. Peak winds in Steele County were estimated at 80 mph.

Several major tornadoes occurred in the region in June of 2010 (Figure 7). Only 1 injury was recorded by the NCEI.

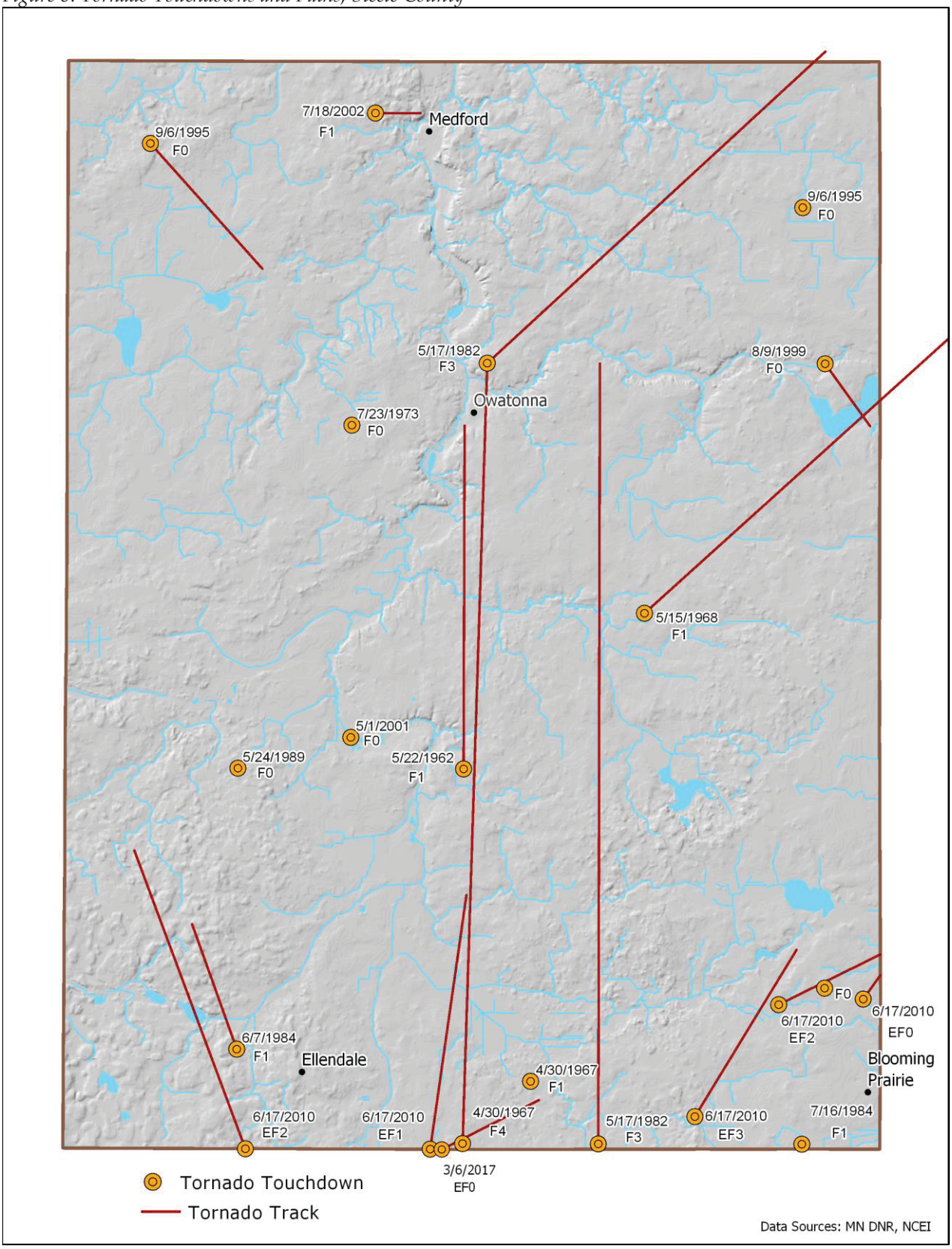
Figure 8 below shows tornado touchdown points and tracks in Steele County. Historic tornado events in the county are listed in Table 19.

Table 19. Historic Tornado Events in Steele County, 1950-March 2017

Location or County	Date	Magnitude	Deaths	Injuries	Property Damage
Ellendale	3/6/2017	EF0	0	0	0
Ellendale	6/17/2010	EF2	0	0	0
Ellendale	6/17/2010	EF1	0	0	0
Blooming Prairie	6/17/2010	EF3	0	0	0
Blooming Prairie	6/17/2010	EF2	0	1	0
Blooming Prairie	6/17/2010	EF0	0	0	0
Medford	7/18/2002	F1	0	0	0
Hope	5/1/2001	F0	0	0	0
Merton	8/9/1999	F0	0	0	0
Blooming Prairie	7/20/1997	F0	0	0	0
Morristown	9/6/1995	F0	0	0	0
Clinton Falls	9/6/1995	F0	0	0	0
Steele Co.	5/24/1989	F0	0	0	0
Steele Co.	7/16/1984	F1	0	0	$25,000
Steele Co.	6/7/1984	F1	0	0	$2,500,000
Steele Co.	5/17/1982	F3	0	0	$250,000
Steele Co.	5/17/1982	F3	0	0	$250,000
Steele Co.	7/23/1973	F0	0	0	$2,500
Steele Co.	5/15/1968	F1	0	0	$25,000
Steele Co.	4/30/1967	F1	0	0	$25,000,000
Steele Co.	4/30/1967	F4	2	0	$25,000,000
Steele Co.	5/22/1962	F1	0	0	$250,000

Source: National Centers for Environmental Information

Figure 8. Tornado Touchdowns and Paths, Steele County



Tornadoes and Climate Change

Tornadoes and other severe thunderstorm phenomena frequently cause as much annual property damage in the U.S. as do hurricanes, and often cause more deaths. Although recent research has yielded insights into the connections between global warming and the factors that cause tornados and severe thunderstorms, such as atmospheric instability and increases in wind speed with altitude (Del Genio, Yao, & Jonas, 2007), these relationships remain mostly unexplored, largely because of the challenges in observing thunderstorms and tornadoes and simulating them with computer models (National Climate Assessment Development Advisory Committee, 2013).

According to Harold Brooks of NOAA's National Severe Weather Laboratory, there is increasing variability in the "start" of tornado season. The number of days with more than 30 EF1 or greater tornadoes is increasing, while the number of days with at least 1 EF1 or greater tornadoes is decreasing. Thus, tornadoes are occurring on fewer days, but *more* are occurring on outbreak days.

Tornadoes have not been recorded in Minnesota in the winter months of December, January and February (MN DNR, 2014). However, the state of Wisconsin has recorded 3 tornadoes in January and 6 in December during the period of 1844-2013 (National Weather Service Weather Forecast Office, 2014) including a recent January tornado in 2008.

Vulnerability

The county has experienced at least one tornado in 13 of the 66 full years on record. According to these statistics, there is a 19.7% chance of a tornado affecting Steele County each year. The vulnerability of each jurisdiction to severe summer storms has not changed due to any development in the last 5 years.

Plans and Programs in Place

Emergency Notifications – Summer storm warnings are initiated by the National Weather Service or local trained SKYWARN spotters. The emergency warning system is activated by the dispatch center as directed. Residents receive warnings by NOAA weather radio, the Everbridge Emergency Notification System, IPAWS and the outdoor warning siren system.

SKYWARN Program – Steele County offers SKYWARN training on an annual basis to local fire departments and local residents that wish to be trained as volunteers. SKYWARN Spotters help keep their local communities safe by providing timely and accurate reports of severe weather to their local National Weather Service office.

Severe Weather Awareness Week – Steele County helps promote and participates in the National Weather Service's "Severe Weather Awareness Week" held in April each year. The event seeks to educate residents on the dangers of severe summer storms and highlights the importance of preparing for severe weather before it strikes.

Outdoor Warning Sirens – There are outdoor warning sirens located throughout Steele County. Sirens are activated when the National Weather Service or trained weather spotters notify Dispatch that there are high winds or tornado conditions that pose a risk to public safety.

School Closings – All school districts within Steele County have a school closing policy and communications plan in place if inclement weather or temperatures create a hazardous situation for students or staff.

Program Gaps or Deficiencies

Doppler Radar – Because of the distance from the Doppler radar in Chanhassen, smaller tornadoes are difficult to identify on radar. SKYWARN spotters are not activated and are not used in the dark. Steele County residents are vulnerable to tornados at night that cannot be spotted or identified on radar.

4.4.2 Windstorms

FEMA defines winds in excess of 58 miles per hour, excluding tornadoes, as windstorms. Straight-line winds and windstorms are used interchangeably in the plan. This hazard is treated as a different category than tornadoes (which may also include high winds). Windstorms are among the nation's most severe natural hazards in terms of both lives lost and property damaged.

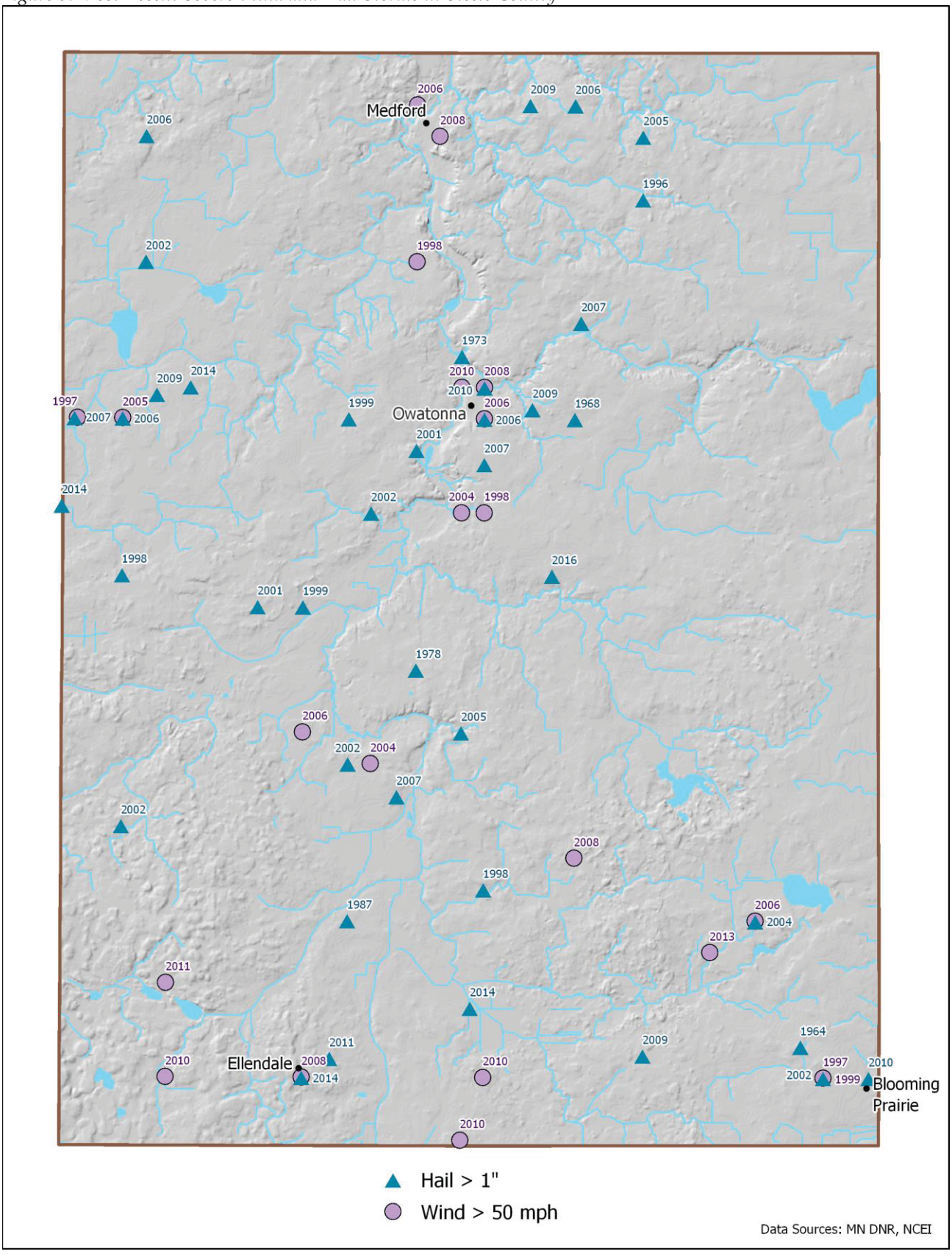
Severe winds can damage and destroy roofs, toss manufactured homes off their pier foundations, and tear light-framed homes apart. There are several different types of windstorms. A "downburst" is defined as a strong downdraft with an outrush of damaging winds on or near the earth's surface. Downbursts may have wind gusts up to 130 mph and are capable of the same damage as a medium-sized tornado. A "gust front" is the leading edge of the thunderstorm downdraft air. It is most prominent near the rain-free cloud base and on the leading edge of an approaching thunderstorm and is usually marked by gusty, cool winds and sometimes by blowing dust. The gust front often precedes the thunderstorm precipitation by several minutes. Straight-line winds, when associated with a thunderstorm, are most frequently found with the gust front. These winds originate as downdraft air reaches the ground and rapidly spreads out, becoming strong horizontal flow.

Windstorm History in Steele County

Steele County experiences less frequent high winds blowing at over 50 knots than other Minnesota counties. According to NCEI records there have been 80 thunderstorm wind and high wind events reported between 1950 and March 2017 with wind speeds at or above 50 knots. The highest recorded wind speed from a windstorm event in Steele County was measured at 70 knots on 6/26/1979 and again on 5/19/1996. These winds can inflict damage to buildings and in some cases overturn high-profile vehicles.

The most recent severe wind and hail storms in Steele County are shown in Figure 9.

Figure 9. Most Recent Severe Wind and Hail Storms in Steele County



Windstorms and Climate Change

Lack of high-quality long-term data sets make assessment of changes in wind speeds very difficult (Kunkel, et al., 2013). One analysis generally found no evidence of significant changes in wind speed distribution. Other trends in severe storms, including the numbers of hurricanes and the intensity and frequency of tornadoes, hail, and damaging thunderstorm winds are uncertain. Since the impact of more frequent or intense storms can be larger than the impact of average temperature, climate scientists are actively researching the connections between climate change and severe storms (National Climate Assessment Development Advisory Committee, 2013).

Vulnerability

The magnitude of summer storms each year is unpredictable and within Steele County and the vulnerability of jurisdictions to windstorms does not vary geographically. The vulnerability of each jurisdiction to severe summer storms has not changed due to any development in the last 5 years.

Plans and Programs in Place

Emergency Notifications – Summer storm warnings are initiated by the National Weather Service or local trained SKYWARN spotters. The emergency warning system is activated by the dispatch center as directed. Residents receive warnings by NOAA weather radio, the Everbridge Emergency Notification System, IPAWS and the outdoor warning siren system.

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Program Gaps or Deficiencies

Doppler Radar – Because of the distance from the Doppler radar in Chanhassen, smaller tornadoes are difficult to identify on radar. SKYWARN spotters are not activated and are not used in the dark. Steele County residents are vulnerable to tornados at night that cannot be spotted or identified on radar.

4.4.3 Lightning

Lightning typically occurs as a by-product of a thunderstorm. In only a few millionths of a second, the air near a lightning strike is heated to 50,000° F, a temperature hotter than the surface of the sun.

The hazard posed by lightning is significant. High winds, rainfall, and a darkening cloud cover are the warning signs for possible cloud-to-ground lightning strikes. While many lightning casualties happen at the beginning of an approaching storm, more than half of lightning deaths occur after a thunderstorm has passed. Lightning has been known to strike more than 10 miles from the storm in an area with clear sky above.

Lightning strikes the ground approximately 25 million times each year in the U.S. According to the NWS, the chance of an individual in the U.S. being killed or injured by lightning during a given year is 1 in 240,000 (NOAA National Severe Storms Laboratory, n.d.).

Lightning is the most dangerous and frequently encountered weather hazard that most people in the United States experience annually. Lightning is the second most frequent killer in the U.S., behind floods and flash floods, with nearly 100 deaths and 500 injuries annually. The lightning current can branch off to strike a person from a tree, fence, pole, or other tall object. In addition, an electrical current may be conducted through the ground to a person after lightning strikes a nearby tree, antenna, or other tall object. The current may also travel through power lines, telephone lines, or plumbing pipes to damage property or cause fires.

Lightning History in Steele County

The NCEI has recorded just 1 lightning event in Steele County, which occurred on 6/26/2006, resulting in $1 million in property damages. A church in Havana Township burned to the ground after lighting hit. One fire fighter was injured while fighting the fire.

Lightning and Climate Change

The projected possible intensity and frequency of tornadoes, hail, and damaging thunderstorm winds, the conditions associated with lightning, are uncertain (National Climate Assessment Development Advisory Committee, 2013). Severe rain events are becoming more common and may include an additional risk of lightning.

Vulnerability

The magnitude of summer storms each year is unpredictable and within Steele County and the vulnerability of jurisdictions to windstorms does not vary geographically. The vulnerability of each jurisdiction to severe summer storms has not changed due to any development in the last 5 years.

Plans and Programs in Place

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4.4.4 Hail

Hailstorms are a product of severe thunderstorms. Hail is formed when strong updrafts within the storm carry water droplets above the freezing level, where they remain suspended and continue to grow larger, until their weight can no longer be supported by the winds. Hailstones can vary in size, depending on the strength of the updraft. The NWS uses the following descriptions when estimating hail sizes: pea size is ¼-inch, marble size is ½-inch, dime size is ¾-inch, quarter size is 1-inch, golf ball size is 1 ¾-inches, and baseball size is 2 ¾-inches. Individuals who serve as volunteer "storm spotters" for the NWS are located throughout the state, and are instructed to report hail dime size (¾-inch) or greater. Hailstorms can occur throughout the year; however, the months of maximum hailstorm frequency are typically between May and August. Although hailstorms rarely cause injury or loss of life, they can cause significant property damage.

Hail History in Steele County

Hail is a particular concern in Steele County due to the damage it can inflict on agriculture. Table 20 shows storms producing hail greater than 1 inch in diameter in Steele County.

Table 20. Storms producing hail greater than 1 inch diameter in Steele County, 1950-March 2017

Date	Hail Size (inches)	Injuries	Date	Hail Size (inches)	Injuries
8/4/2016	1.5	0	9/7/1999	1.75	0
7/24/2009	1.25	0	9/6/1995	1.75	0
6/17/2009	3.25	0	8/4/1989	1.75	0
6/17/2009	1.75	0	8/21/1987	1.75	0
6/17/2009	2.75	0	4/3/1981	1.75	0
6/17/2009	1.5	0	5/11/1973	1.75	0
3/21/2007	1.25	0	5/15/1968	1.75	0
7/19/2006	1.75	0	6/15/1967	1.75	0
9/7/1999	1.75	0	10/14/1966	1.75	0

Source: National Centers for Environmental Information

Hail and Climate Change

According to the Federal Advisory Committee Draft National Climate Assessment (NCA), trends in severe storms, including the numbers of hurricanes and the intensity and frequency of tornadoes, hail, and damaging thunderstorm winds are uncertain. Since the impact of more frequent or intense storms can be larger than the impact of average temperature, climate scientists are actively researching the connections between climate change and severe storms (National Climate Assessment Development Advisory Committee, 2013).

The occurrence of very heavy precipitation has increased in Minnesota in recent decades and future projections also indicate this will continue (International Climate Adaptation Team, 2013). While it is unknown if this precipitation will occur during severe storms that produce hail, the possibility has not been ruled out.

Vulnerability

Summer storms affect Steele County each year, so there is a 100% probability that the county and its jurisdictions will be affected. According to the 66 full year NCEI record, there is a 38% chance of a significant hailstorm any year in Steele County and a 20% chance in each year that there will be a hailstorm that produces hail greater than 1 inch in size.

The magnitude of summer storms each year is unpredictable and within Steele County the vulnerability of jurisdictions to summer storms does not vary geographically. The vulnerability of each jurisdiction to severe summer storms has not changed due to any development in the last 5 years.

Severe Summer Storms and Electrical Outages

According to NOAA data, the natural hazards that caused the greatest overall property loss in Minnesota between 1996 and 2014 were thunderstorms and lightning, at $86.3 million per year. The state also experienced 23 electric transmission outages from 1992 to 2009, 5 of which were due to heat waves and thunderstorms. On average, the number of people affected annually by all electric outages during 2008 to 2013 in Minnesota was 449,995, with a high of 1,460,810 in 2011 (U.S. Department of Energy, 2015). Figure 10 below shows the seasonality of electric outages by month for the years 2008-

2013, and Figure 11 shows the causes of outages in the state between 2008 and 2013, with the largest cause being weather/falling trees.

Figure 10. Electric Utility Reported Power Outages by Month (2008-2013)

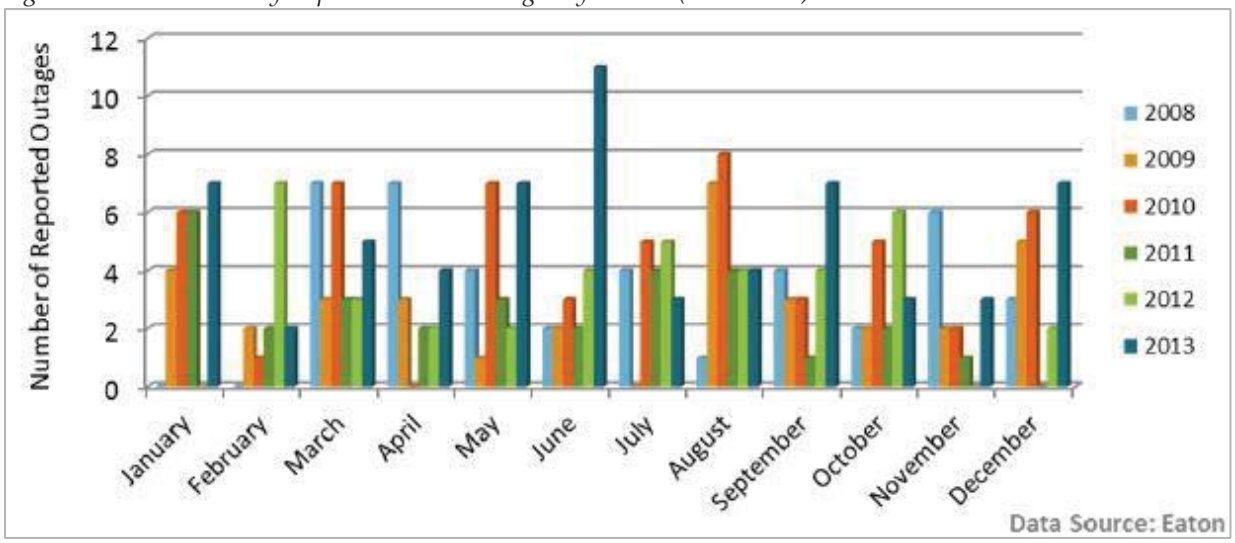
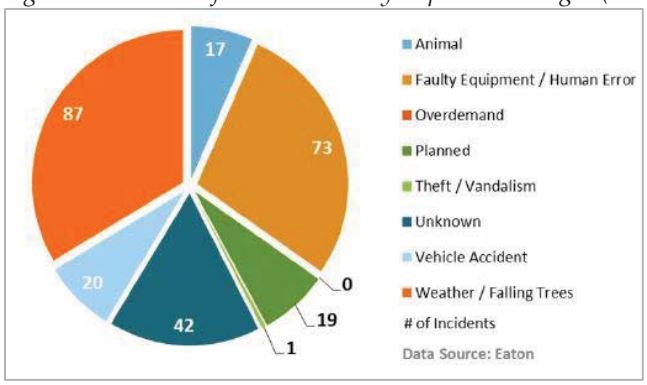


Figure 11. Causes of Electric-Utility Reported Outages (2008-2013)



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4.4.5 Flash Flood and Riverine Flood

Flooding is a significant natural hazard throughout the United States. The type, magnitude, and severity of flooding are functions of the amount and distribution of precipitation over a given area, the rate at which precipitation infiltrates the ground, the geometry and hydrology of the catchment, and flow dynamics and conditions in and along the river channel. Upstream floods, also called flash floods, occur in the upper parts of drainage basins and are generally characterized by periods of intense rainfall over a short duration. These floods arise with very little warning and often result in locally intense damage, and sometimes loss of life, due to the high energy of the flowing water. Flood waters can snap trees, topple buildings, and easily move large boulders or other structures. Six inches of rushing water can upend a person; another 18 inches might carry off a car. Generally, upstream floods cause damage over relatively localized areas, but they can be quite severe. Urban flooding is a type of upstream flood, which involves the overflow of storm drain systems and can be the result of inadequate drainage combined with heavy rainfall or rapid snowmelt. Upstream or flash floods can occur at any time of the year in Minnesota, but they are most common in the spring and summer. 14 flash flood events have been recorded in Steele County since 1997.

Downstream floods, sometimes called riverine floods, refer to floods on large rivers at locations with large upstream catchments. Downstream floods are typically associated with precipitation events that are of relatively long duration and occur over large areas. Flooding on small tributary streams may be limited, but the contribution of increased runoff may result in a large flood downstream. The lag time between precipitation and the flood peak is much longer for downstream floods than for upstream floods, generally providing ample warning for people to move to safe locations and, to some extent, secure some property against damage.

Nationwide, floods caused 4,586 deaths from 1959 to 2005 while property and crop damage averaged nearly $8 billion per year (in 2011 dollars) from 1981-2011 (Georgakakos, et al., 2014).

During the past several decades, agencies have used the "100-year floodplain" as the design standard for projects funded by the federal government. However, today floods of that magnitude are occurring far more often than once per century (Natural Resources Defence Council, 2015). In recognition of increasing risks, in January of 2015 the President issued an executive order that updates flood protection standards that guide federally-funded projects in or near floodplains or along coastlines. These new standards require federally-funded projects to either build 2 feet above the 100-year flood elevation for

standard projects and three feet above for critical buildings like hospitals and evacuation centers; or build to the 500-year flood elevation (The White House, 2015).

Flood History in Steele County

The last major flood in Steele County occurred on September 22, 2016 (Figure 12). No injuries or deaths were reported by the National Centers for Environmental Information (NCEI). Between 3-6 inches of rain fell. Owatonna received the most profound impact from this event. A second rainfall increased the total by 2-4 inches. The most significant areas affected from this storm were focused around Waseca, where 10.16 inches of rain fell, causing flooding in at least 75% of neighboring homes and 15 county roads to close around Maple Grove and Brooklyn Park. Within Steele County, both the Straight River and Le Sueur River crested above flood stage. A presidential disaster declaration (DR-4290) was declared due to the flooding, and Steele County was included in the declaration.

Figure 12. Flooding in Albert Lea (ABC 6 News, 2016)

A flood in June of 2014 caused $2.4 million in damage in Steele County. Floodwaters from the Straight River impacted businesses in the city of Owatonna. The Minnesota State Emergency Operations Center was partially activated on June 16, and then was fully activated on June 18. On June 19, the Governor of Minnesota declared a State of Emergency for 35 counties. Steele County was included in presidential disaster declaration DR-4182.

Severe flooding also occurred in September of 2010. Numerous roads were closed in Steele County due to excessive rainfall that fell on September 22nd and 23th. The major areal flooding did not recede until late Saturday when most of the small streams and creeks had crested and only mainstream rivers remained flooded. Residents in Owatonna were fighting to save their homes along the flooded Maple Creek. 70 homes were evacuated in Owatonna due to the rising floodwaters. Friday morning was the first time that I-35 was closed due to floodwaters south of Owatonna. It re-opened during the afternoon as waters started to recede. The NCEI recorded $28 million in property damage in Steele County. A presidential disaster declaration was declared (DR-1941). FEMA Public Assistance (PA) for the State of Minnesota topped $33 million, while PA in Steele County alone was over $10 million.

Steele County was also part of DR-1921 due to flooding, tornadoes, and severe storms in June of 2010. Public Assistance for the state reached $17 million, and Steele County received over $125,000 in PA.

In August 2007, another presidential disaster declaration was signed for Steele County in the wake of major flooding and damage. Large areas of Owatonna were reported under 2-3 feet of water. Water completely covered a few roads, and was above car doors in some areas. Maple Creek at Dartt's Park three times as wide as normal, and spread out into the parking lot. Some basement walls collapsed, and two hotels in Owatonna were evacuated.

The City of Medford experienced flooding on 9/22/10, 6/18/14, and 9/22/16. City records indicate claims were submitted to FEMA for all three of these floods. Approximately 6 homes' basements are flooded during most floods in Medford. Buyout of severely damaged homes or installation of berms to prevent flooding should be considered. The City's Straight River Park has also flooded several times. Picnic tables, electrical infrastructure, wood chips, baseball field, fencing, volleyball court sand & equipment, etc. has been damaged or washed away. The riverbank within the City is eroding. Streambank stabilization should be considered to prevent city stormwater infrastructure and private residential properties from falling into the river and washing away.

Nine of the 11 FEMA disaster declarations in Steele County have included flooding.

Table 21 below lists Steele County's historical floods since 1997 as recorded by the NCEI. Although no deaths or injuries were recorded with these floods, property damage from just one flood in Ellendale resulted in over $28 million in losses.

Table 21. Steele County Historical Floods, 1997-March 2017

Location or County	Date	Type	Deaths	Injuries	Property Damage
Meriden	9/22/2016	Flood	0	0	0
Owatonna Arpt	6/18/2014	Flood	0	0	$2,400,000
Pratt	6/16/2014	Flash Flood	0	0	0
Pratt	6/16/2014	Flash Flood	0	0	0
Blooming Prairie	7/15/2011	Flash Flood	0	0	0
Merton	9/23/2010	Flash Flood	0	0	0
Ellendale	9/23/2010	Flood	0	0	$28,400,000
Owatonna	6/26/2010	Flash Flood	0	0	0
Merton	6/17/2010	Flash Flood	0	0	0
Owatonna	10/1/2007	Flash Flood	0	0	$3,000,000
Owatonna	9/30/2007	Flash Flood	0	0	0
Owatonna	8/18/2007	Flash Flood	0	0	$2,500,000
Owatonna	6/9/2006	Flash Flood	0	0	$500,000
Owatonna	9/24/2005	Flash Flood	0	0	0
Countywide	9/14/2004	Flash Flood	0	0	0
Steele (zone)	6/14/2004	Flood	0	0	$2,800,000
Steele (zone)	6/10/2004	Flood	0	0	0
Blooming Prairie	7/21/2002	Flash Flood	0	0	0
Steele (zone)	4/1/2001	Flood	0	0	0
Blooming Prairie	7/8/2000	Flood	0	0	0
Blooming Prairie	8/18/1999	Flood	0	0	0
Medford	8/14/1997	Flash Flood	0	0	0

Source: National Centers for Environmental Information

The National Oceanic and Atmospheric Administration (NOAA) Advanced Hydrologic Prediction Service provides information from gauge locations at points along various rivers across the United

States. One NOAA gauging station is located in the county near Owatonna on the Straight River. Its flood crest data for the top 10 gauge heights is recorded in Table 22 below.

Table 22. Historical Flood Crests for USGS gauging station on the Straight River

Date	Gauge Height (feet)
09/24/2010	14.88
04/11/2001	12.88
03/25/1989	12.83
05/05/1974	12.74
03/08/1973	12.68
06/19/2014	12.20
02/18/1984	12.19
07/07/1990	11.31
05/01/1990	11.20
06/17/1993	11.16

Vulnerability and Hazus-MH Hazard Analysis

Hazus-MH was used to estimate the damages incurred for a 100-year flood in Steele County using a 10-meter DEM (digital elevation model) to create a flood depth grid from a DFIRM (digital flood insurance rate map).

This documentation does not provide full details on the processes and procedures completed in the flood risk analysis, it is only intended to highlight the major inputs that were used. The fields obtained from the Steele County tax assessor are noted in parentheses.

Steele County-specific building data was sourced from parcel tax databases and parcel polygon databases, including building valuations (SumOfAVBLD) and occupancy class (AVCLASDESC). Hazus-MH analysis of structures takes into account the depth of water in relation to the structure using finished square footage (TOTAL FIN AREA and Main_Style_Desc for number of stories). The tool also considers the actual dollar exposure to the structure for the costs of building reconstruction (SumOfAVBLD) and contents (calculated based on SumOfAVBLD and finished square footage). Damages are based upon the assumption that each structure will fall into a structural class (assumptions made based on Year Built and Effective Year), and structures in each class will respond in a similar fashion to a specific depth of flooding. Furthermore, the damage estimates assume an equal distribution of building classifications across the developed portion of a census block. These assumptions suggest that the loss estimates for aggregate structural losses need to be viewed as approximations of losses that are subject to considerable variability rather than as exact engineering estimates of losses to individual structures.

Building counts were aggregated from the individual parcel records to the relevant census administrative boundaries. There are an estimated 13,846 parcels with structures in the region with a total replacement value (excluding contents) of $2.2 billion. Approximately 85% of the buildings (and 68% of the building value) are associated with residential housing. Using the Steele County updated general building stock, the Hazus model reported an estimated 114 buildings will be at least moderately

damaged. This is over 81% of the total number of buildings in the scenario. There are an estimated 3 buildings that will be completely destroyed.

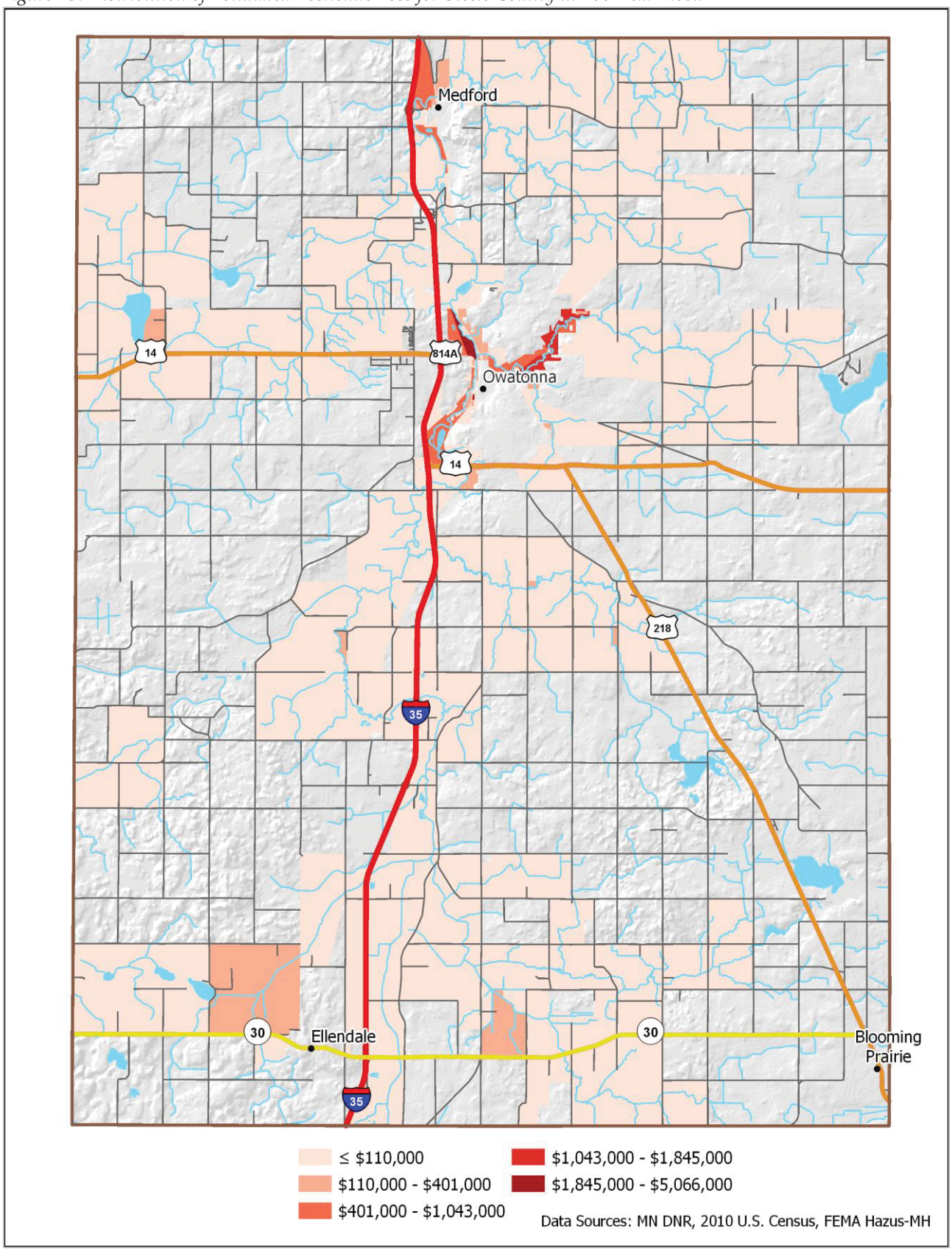
The total economic loss estimated for the flood is $33.7 million dollars, which represents 8% of the total replacement value of the parcels exposed. Building losses are broken into 2 categories: direct building losses and business interruption losses. Direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. Business interruption losses are associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood. The total building-related losses in the Hazus model was $31.9 million dollars. 5% of the estimated losses were related to business interruption in the region. Residential occupancies made up 44% of the total loss.

The reported building counts should be interpreted as degrees of loss rather than an exact number of buildings exposed to flooding. These numbers were derived from aggregate building inventories which are assumed to be dispersed evenly across census blocks. Hazus-MH requires that a predetermined amount of square footage of a typical building sustain damage in order to produce a damaged building count. If only a minimal amount of damage to buildings is predicted, it is possible to see zero damaged building counts while also seeing economic losses. The total estimated number of damaged buildings, total building losses, and estimated total economic losses are shown in Table 23. The distribution of economic losses for Steele County is depicted in Figure 13.

Table 23. Steele County Total Economic Loss from 100-Year Flood

General Occupancy	Estimated Total Buildings	Total Damaged Buildings	Total Building Exposure	Total Economic Loss	Building Loss
Agricultural	1082	0	$163,586,000	$2,712,000	$574,000
Commercial	619	3	$199,414,000	$3,556,000	$934,000
Education	33	0	$94,119,000	$0	$0
Government	127	3	$72,459,000	$10,823,000	$1,517,000
Industrial	186	0	$117,876,000	$1,687,000	$396,000
Religious/Non-Profit	89	0	$60,439,000	$39,000	$6,000
Residential	11,710	124	$1,490,735,000	$14,932,000	$10,504,000
Total	**13,846**	**130**	**$2,198,628,000**	**$33,740,000**	**$13,931,000**

Figure 13. Distribution of Estimated Economic Loss for Steele County in 100-Year Flood



Census blocks of concern should be reviewed in more detail to determine the actual percentage of facilities that fall within the flood hazard areas. The aggregate losses reported in this study may be overstated because values are distributed evenly in a census block. The 5 census blocks showing the highest estimated loss values are shown in Table 24, with their spatial extents shown in Figures 14-18.

Table 24. Steele County Census Blocks with the Greatest Estimated Losses in the 100-Year Floodplain

Census Block Number	Total Estimated Loss	City
271479604002000	$5,066,000	Owatonna
271479606002005	$3,746,000	Owatonna
271479602002002	$1,845,000	Owatonna
271479602002016	$1,561,000	Owatonna
271479602002018	$1,440,000	Owatonna

Figure 14. Census Block #271479604002000 and 100-Year Floodplain in Owatonna

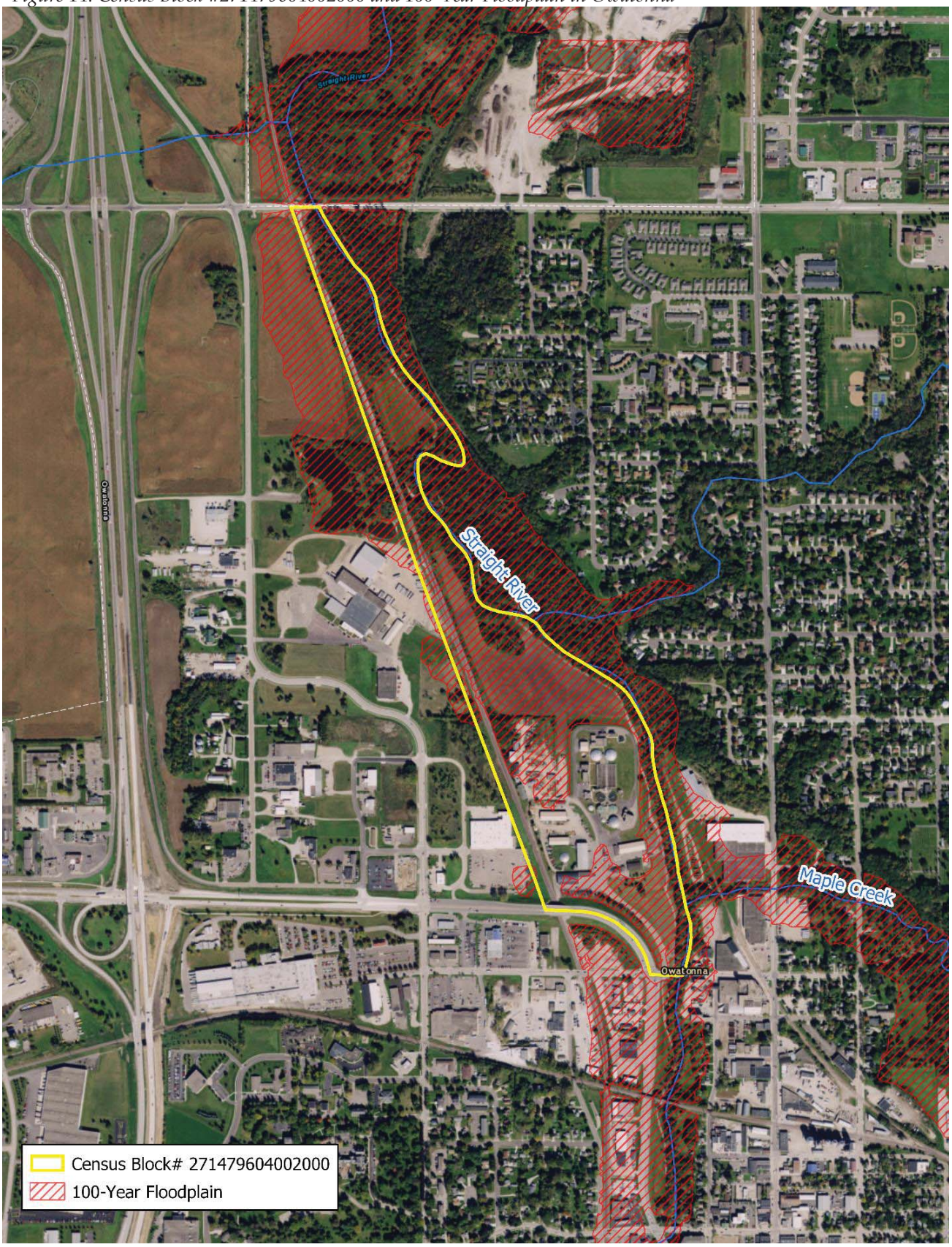


Figure 15. Census Block # 271479606002005 and 100-Year Floodplain by Owatonna

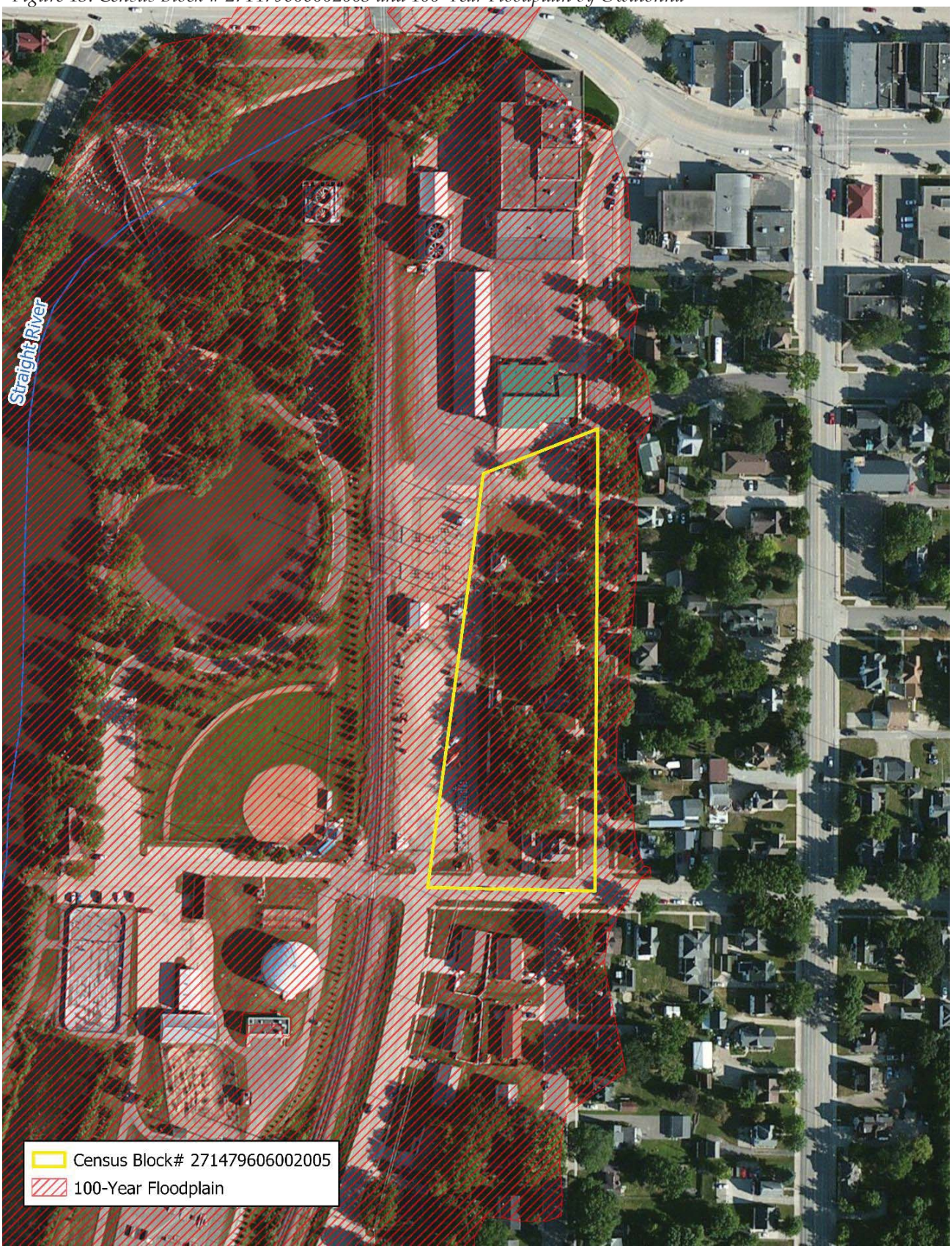


Figure 16. Census Block #271479602002002and 100-Year Floodplain by Owatonna

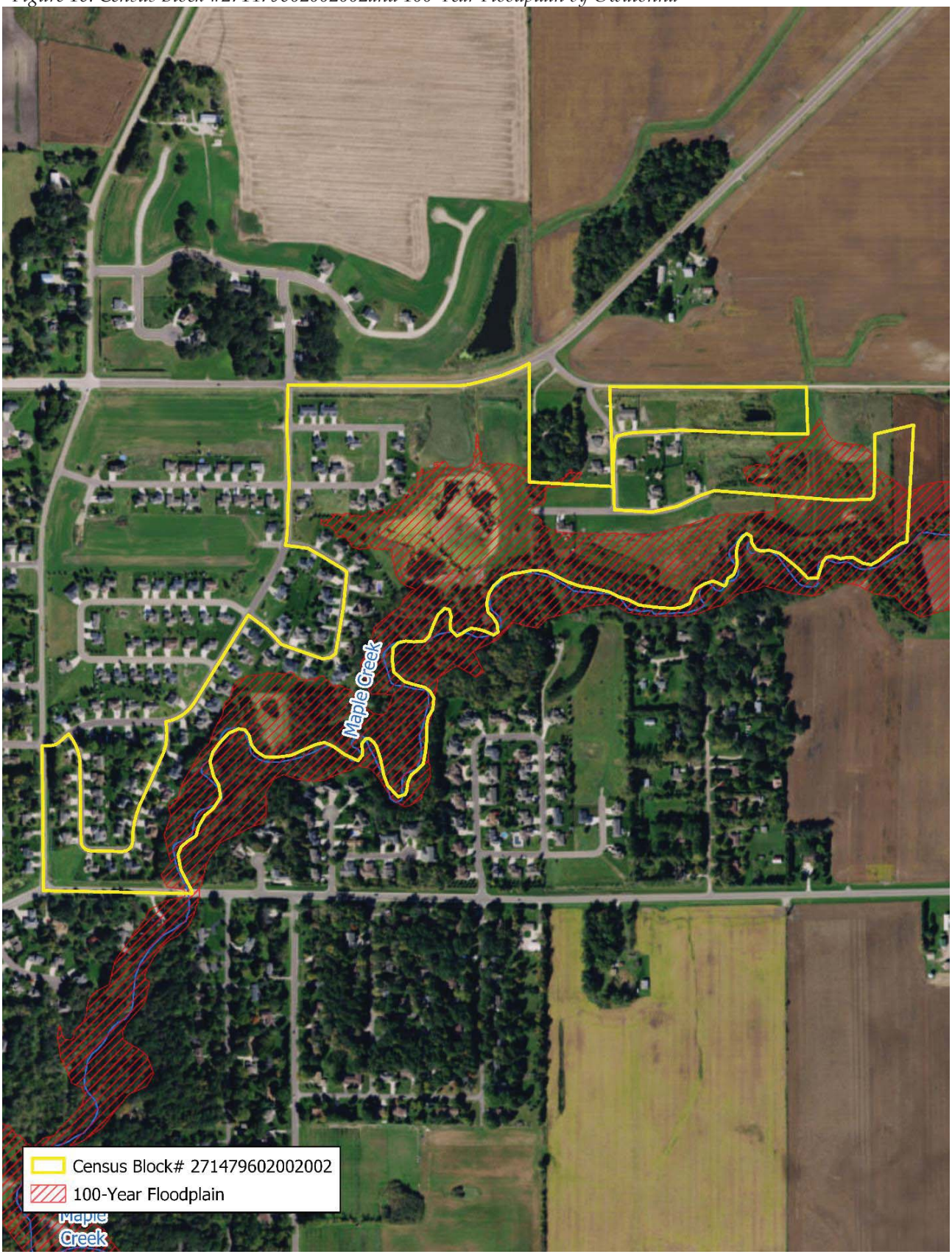


Figure 17. Census Block #271479602002016 and 100-Year Floodplain by Owatonna

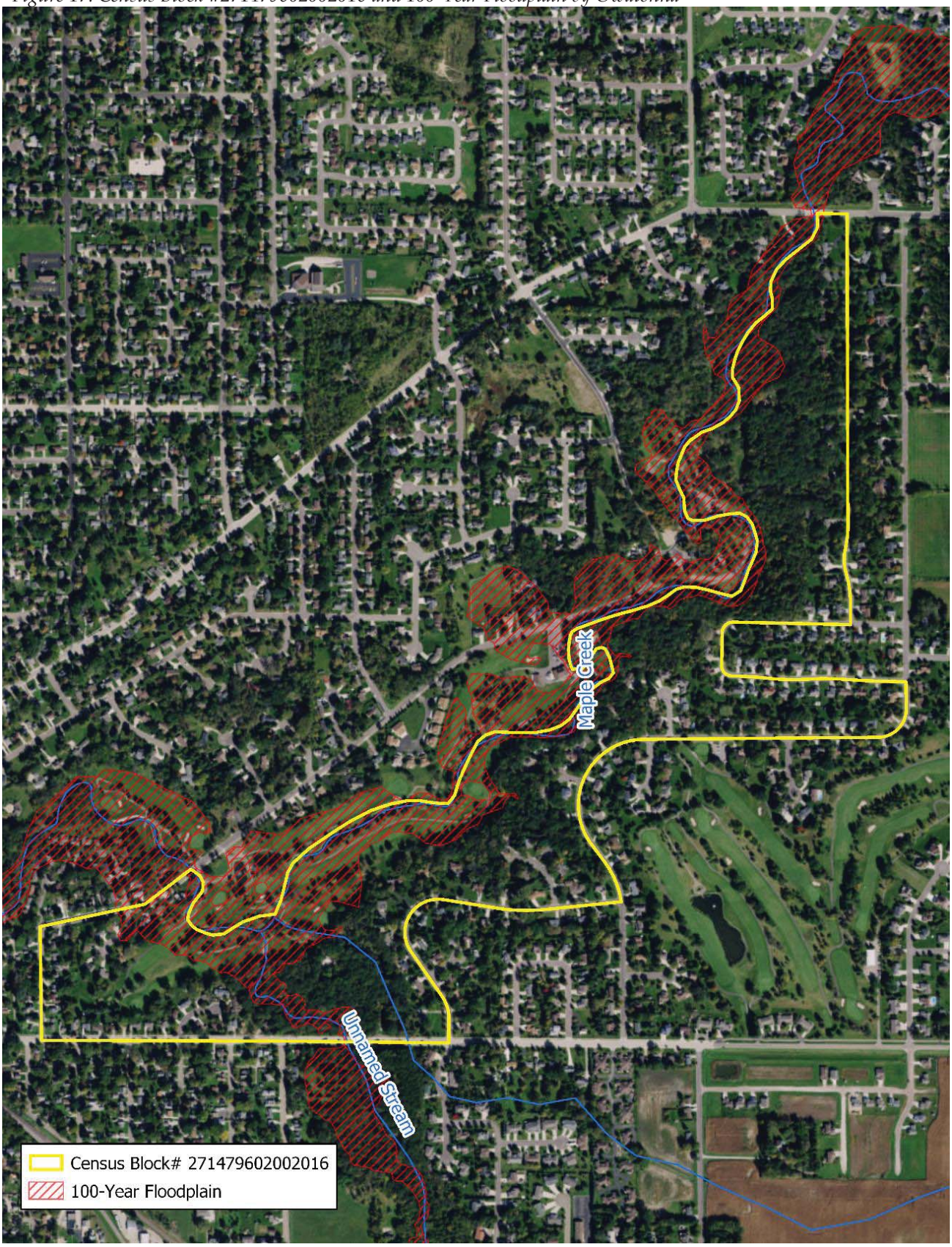
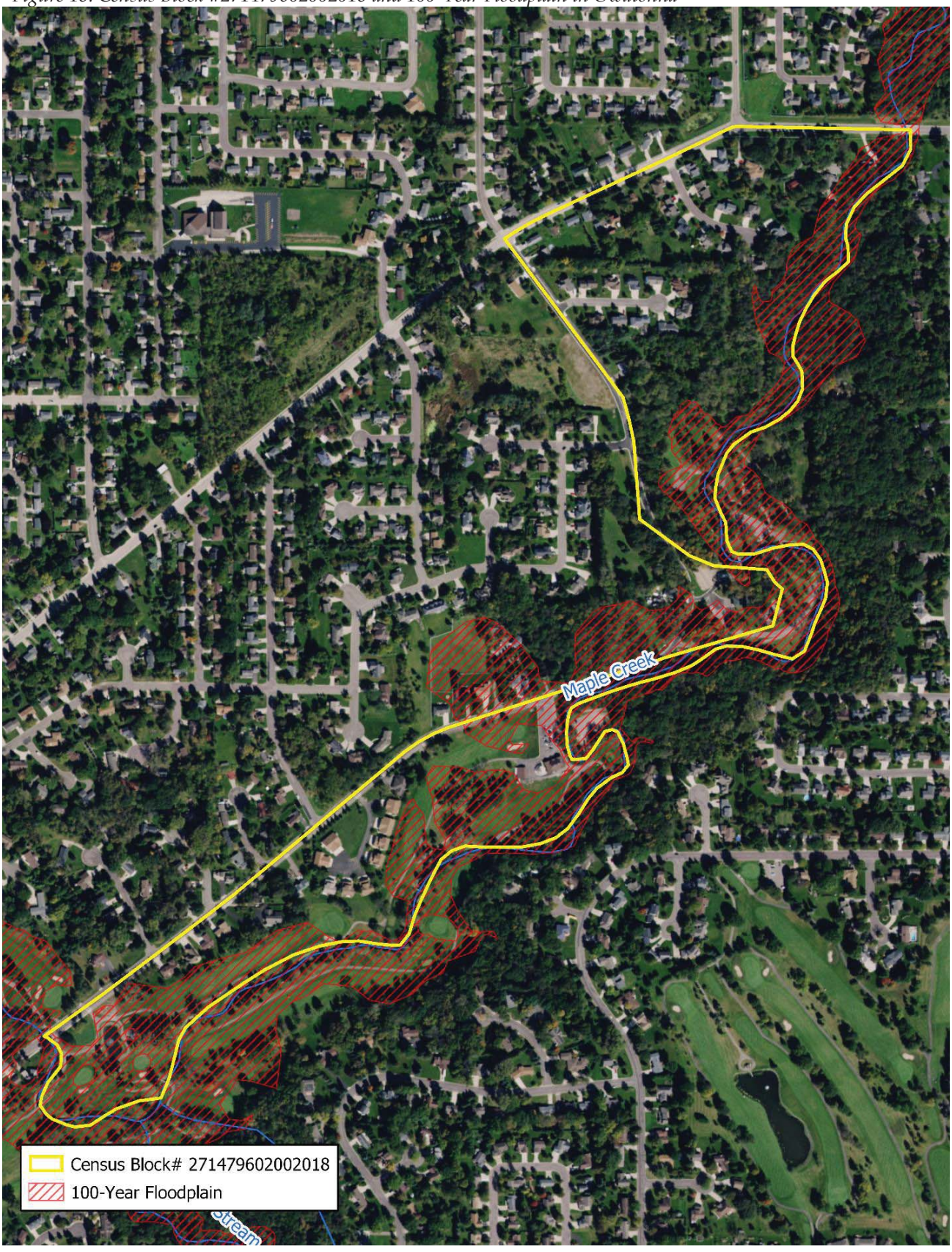


Figure 18. Census Block #271479602002018 and 100-Year Floodplain in Owatonna



Hazus-MH Essential Facility Loss Analysis

Essential facilities encounter the same impacts as other buildings within the flood boundary: structural failure, extensive water damage to the facility, and loss of facility functionality (i.e. a damaged police station will no longer be able to serve the community). None of the essential facilities (care facilities, fire stations, police stations, and schools) included in the Hazus-MH analysis falls within the flood boundary.

Hazus-MH Shelter Requirement Analysis

Hazus-MH estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus-MH also estimates those displaced people that may require accommodations in temporary public shelters. The model estimates 284 households may be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, the model estimates 439 people (out of a total population of 36,576) may seek temporary shelter in public shelters.

Hazus-MH Debris Generation Analysis

Hazus estimates the amount of debris that may be generated by the flood. The model breaks debris into 3 general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 4,740 tons of debris would be generated. Of the total amount, Finishes composes 50% of the total and Structural composes 28% of the total. If the debris tonnage is converted into an estimated number of truckloads, it would require 190 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Flooding and Climate Change

As Minnesota's climate changes, the quantity and character of precipitation is changing. Average precipitation has increased in the Midwest since 1900, with more increases in recent years. The Midwest has seen a 45% increase in very heavy precipitation (defined as the heaviest 1% of all daily events) from 1958 to 2011 (National Climate Assessment Development Advisory Committee, 2013). This precipitation change has led to amplified magnitudes of flooding. Increased precipitation may also show seasonal changes, trending toward wetter springs and drier summers and falls. An example of a recent year with this character was 2012, when many MN counties were eligible for federal disaster assistance for drought, while others were eligible for flooding, and 7 were eligible for both in the same year (Seeley M. , 2013). In 2007, 24 Minnesota counties received drought designation, while 7 counties were declared flood disasters. In 2012, 55 Minnesota counties received federal drought designation at the same time 11 counties declared flood emergencies. In addition, the yearly frequency of the largest storms – those with 3 inches or more of rainfall in a single day – has more than doubled in just over 50 years. In the past decade, such dramatic rains have increased by more than 7% (MN Environmental Quality Board, 2014).

Southeastern Minnesota has experienced three 1000-year floods in the past decade: in September 2004, August 2007, and September 2010 (Meador, 2013). The 2004 flood occurred when parts of south-central Minnesota received over 8 inches of precipitation. Faribault and Freeborn counties received over 10 inches in 36 hours. The deluge led to numerous reports of stream flooding, urban flooding, mudslides, and road closures (MN DNR, 2004). During the 2007 event, 15.10 inches fell in 24 hours in

Houston County, the largest 24-hour rainfall total ever recorded by an official National Weather Service reporting location. The previous Minnesota record was 10.84 inches in 1972. The resulting flooding from the 2007 rainfall caused 7 fatalities (MN DNR, 2007). In September 2010, a storm on the 22-23rd resulted in more than 6 inches of rain falling over 5,000 square miles in southern Minnesota. Rainfall totals of more than 8 inches were reported in portions of 10 counties. The heavy rain, falling on soils already sodden from a wet summer, led to numerous reports of major rural and urban flooding. For many monitoring locations in southern Minnesota, stream discharge resulting from the deluge was the highest ever seen during an autumn flood (Minnesota Climatology Working Group, 2010).

June 2014 was the wettest month on record in Minnesota, with a state-averaged rainfall of 8.03 inches. This broke the previous record of 7.32 inches, which occurred in both July 1897 and June 1914. Rainfall totals for much of the state ranked above the 95th percentile when compared with the historical record; in some cases, the totals tripled that of the historical rainfall average for June. Scott County received between 10-12 inches of rain during June 2014 (MN DNR, 2014). A presidential disaster declaration was declared due to the severe storms, winds, flooding, landslides, and mudslides (DR-4182), which included 37 Minnesota counties and 3 Indian Reservations.

Plans and Programs in Place

Flood Warnings – Flood warnings are initiated by the National Weather Service. The emergency warning system is activated by the dispatch center as directed. Residents receive warnings by NOAA weather radio, the Everbridge Emergency Notification System and IPAWS. Areas prone to flooding are evacuated.

National Flood Insurance Program (NFIP) – The NFIP is a federal program created by Congress to mitigate future flood losses nationwide through sound, community-enforced building and zoning ordinances and to provide access to affordable, federally-backed flood insurance protection for property owners. The NFIP is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods. Participation in the NFIP is based on an agreement between local communities and the federal government that states that if a community will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction in Special Flood Hazard Areas (SFHAs), the federal government will make flood insurance available within the community as a financial protection against flood losses. Steele County, the City of Medford, and the City of Owatonna all have FEMA mapped high risk areas and participate in the NFIP. The City of Ellendale and the City of Blooming Prairie do not have FEMA mapped high risk areas and therefore do not participate in the NFIP.

Floodplain Ordinances – Steele County and cities that have FEMA mapped high-risk areas have floodplain ordinances in place, which regulate development and setbacks on shorelines.

Program Gaps & Deficiencies

Emergency Notifications for Flood Prone Areas – There is not a specific Everbridge list created for flood-prone areas in the county to receive flood warnings.