3 RISK ASSESSMENT

44 CFR Requirement §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure within Polk County, Iowa to these hazards. The goal of the risk assessment is to estimate the potential loss in the planning area, including loss of life, personal injury, property damage, and economic loss, from a hazard event. The risk assessment process allows communities in the planning area to better understand their potential risk to the identified hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

The risk assessment for Polk County and participating jurisdictions followed the methodology described in the FEMA publication 386-2, *Understanding Your Risks: Identifying Hazards and Estimating Losses* (2002), which includes a four-step process:

Step 1—Identify Hazards
Step 2—Profile Hazard Events
Step 3—Inventory Assets
Step 4—Estimate Losses

This chapter is divided into five main parts:

- **Section 3.1 Hazard Identification** identifies the hazards that threaten the planning area and the methodology utilized to score or rank the hazards;
- **Section 3.2 Assets at Risk p**rovides the planning area's total exposure to natural hazards, considering critical facilities and other community assets at risk;
- **Section 3.3 Future Land Use and Development** discusses areas of planned future development
- **Section 3.4 Hazard Profiles and Vulnerability** For each hazard, this section is divided into two parts: 1) <u>Hazard Profile</u> discusses the threat to the planning area, the geographic location/extent at risk, previous occurrences of hazard events, and probability of future occurrence; and 2) <u>Vulnerability Assessment</u> further defines and quantifies populations, buildings, critical facilities, and other community assets at risk to natural hazards;
- **Section 3.5 Hazard Analysis Summary** provides a tabular summary of the hazard ranking for each jurisdiction in the planning area as well as a consequence analysis summary for each hazard based on Emergency Management Accreditation Program (EMAP) risk assessment standards.

3.1 Hazard Identification

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the type…of all natural hazards that can affect the jurisdiction.

The 20 hazards identified for this plan update are listed below in alphabetical order

- Animal/Plant/Crop Disease
- Dam Failure
- Drought
- Earthquake
- Expansive Soils
- Extreme Heat
- Flash Flooding
- Grass/Wildland Fire
- HAZMAT Incident
- Human Disease
- Infrastructure Failure
- Levee Failure
- River Flooding
- Sinkholes/Landslide
- Structural Fire
- Thunderstorm/Lightning/Hail
- Tornado
- Transportation Incident
- Windstorm
- Winter Storm

Sections 3.1.1 through 3.1.3 describe how these hazards were identified for this plan update.

3.1.1 Review of Existing Mitigation Plans

Prior to 2009, Hazard Mitigation Planning in Polk County was accomplished on a jurisdictional basis. In 2009, the unincorporated county and incorporated municipalities came together to coordinate mitigation planning for the entire Polk County planning area. This coordinated effort resulted in the Polk County Multi-jurisdictional Hazard Mitigation Plan, approved by FEMA on July 9, 2009 (hereafter referred to as the *2009 Polk County Hazard Mitigation Plan*).

To identify hazards to include in the Risk Assessment updates, a comparison was performed of the draft hazard identification for the *2013 Iowa State Hazard Mitigation Plan*, and the *2009 Polk County Hazard Mitigation Plan*. **Table 3.1** provides the details of the comparison.

Table 3.1. Hazard Comparison Chart

Draft 2013 Iowa State Hazard Mitigation Plan Hazards	2009 Polk County Hazard Mitigation Plan
River Flooding	Floods-Flash and Riverine
Flash Flood	
Tornado/Windstorm	Tornadoes
	Windstorms
Severe Winter Storm	Winter Storms
Levee/Dam Failure	Levee Failure
	Dam Failure
Terrorism	-
Animal/Plant/Crop Disease	-
HAZMAT Incident	-
Radiological Incident	-
Thunderstorm/Lightning/Hail	Thunderstorms-including lightning and hail
Drought	-
Human Disease	-
Transportation Incident	-
Infrastructure Failure	-
Extreme Heat	-
Grass/Wild Land Fire	Fire-Wildfire, Rural Fire, Urban Fire
Sinkholes	-
Landslide	-
Earthquake	-
Expansive Soils	-

"-"= Not Included

After a review of the hazards, it was agreed that the hazards/hazard naming for this update will be consistent with the 2013 State Plan with the following exceptions:

- Severe Winter Storm will be called "Winter Storm",
- Tornado/Windstorm will remain as two separate hazards,
- Levee/Dam Failure will remain as two separate hazards,
- Structural Fire will be profiled separate from Infrastructure Failure,
- Sinkholes and Landslide will be combined,
- Terrorism will not be included, and
- Radiological Incident will not be included.

The rational for the hazards not included is provided below:

Terrorism: Polk County utilizes other planning mechanisms to perform risk assessment for terrorism in the planning area. In addition, since the Hazard Mitigation Plan has a strong emphasis on public participation, it was determined that discussion of vulnerabilities to terrorism should not be included in this public document.

Radiological Incident: Polk County is not within the Emergency Planning Zone of any nuclear power plant facilities. Therefore, it was determined that Radiological Incident would not be analyzed as a separate hazard. However, transportation incidents involving radioactive materials can occur within the planning area. The Transportation Incident Hazard will include assessment of this component of radiological incidents.

3.1.2 Review Disaster Declaration History

Information utilized to identify hazards relevant for Polk County was obtained by examining events that triggered federal disaster declarations. Federal and/or state declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. If the disaster is so severe that both the local and state governments' capacities are exceeded; a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

FEMA also issues emergency declarations, which are more limited in scope and do not include the long-term federal recovery programs of major disaster declarations. Determinations for declaration type are based on scale and type of damages and institutions or industrial sectors affected.

Table 3.2 lists federal disaster declarations that included Polk County from 1965 to 2013.

Table 3.2. FEMA Disaster Declarations that included Polk County, Iowa, 1965-2013

Disaster Number	Description	Declaration Date Incident Period	Individual Assistance (IA) Public Assistance (PA)
DR-1930	Severe Storms, Flooding, & Tornadoes	7-29-2010 6-1-2010 to 8-31-3010	IA & PA
DR-1763	Severe Storms, Tornadoes, & Flooding	5-27-2008 5-25-2008 to 8-13-2008	IA & PA
DR-1688	Severe Winter Storms	3-14-2007 2-23-2007 to 3-2-2007	PA
DR-1518	Severe Storms, Tornadoes, & Flooding	5-25-2004 5-19-2004 to 6-24-2004	IA
DR-1230	Severe Weather, Tornadoes, & Flooding	7-2-1998 6-13-1998 to 7-15-1998	IA & PA
DR-1191	Severe Snow Storm	11-20-1997 10-26-97 to 10-28-1997	PA
DR-996	Flooding, Severe Storm	7-9-1993 4-13-1993 to 10-1-1993	IA & PA
DR-868	Flooding, Severe Storm	5-26-1990 5-18-1990 to 7-6-1990	IA & PA
DR-443	Flooding, Severe Storm	6-24-1974 / 6-24-1974	IA & PA
DR-269	Heavy Rains, Flooding	8-14-69 / 8-14-69	IA & PA
DR-259	Flooding	4-25-1969 4-25-1969 to 4-25-1969	IA & PA
DR-193	Flooding	4-22-1965 4-22-1965 to 4-22-1965	IA & PA

Source: Federal Emergency Management Agency, www.fema.gov/

3.1.3 Research Additional Sources

Additional data on locations and past impacts of hazards in the planning area was collected from the following sources:

- Iowa Hazard Mitigation Plan (September 2013);
- Polk County Hazard Mitigation Plan (July 2009);
- Federal Emergency Management Agency (FEMA);
- Iowa Department of Natural Resources;
- National Drought Mitigation Center Drought Reporter;
- Polk County Health Department Hazard Vulnerability Assessment (August 2012);
- US Department of Agriculture's (USDA) Risk Management Agency Crop Insurance Statistics;
- Data Collection Guides completed by each jurisdiction
- Des Moines Area Regional GIS Partnership
- Environmental Protection Agency
- Flood Insurance Administration
- Goods Movement in the Des Moines Metropolitan Area, 2002
- Hazards US (HAZUS)
- Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation
- Iowa Department of Education, Bureau of Information and Analysis Services
- Iowa Department of Public Safety
- Iowa Department of Transportation, Office of Traffic and Safety
- Iowa Flood Center
- Iowa State Fire Marshal Division
- Iowa Utilities Board
- National Fire Incident Reporting System (NFIRS)
- National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center;
- National Oceanic and Atmospheric Administration's (NOAA) National Weather Service, Des Moines Weather Forecast Office
- Pipeline and Hazardous Materials Safety Administration
- Polk County Comprehensive Plan
- Polk County Emergency Management
- Polk County Preliminary Digital Flood Insurance Rate Map, FEMA
- Polk County Preliminary Flood Insurance Study, FEMA
- SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin
- The Tomorrow Plan: Partnering for a Greater, Greener Des Moines, July 2013 Draft
- U.S. Army Corps of Engineers
- U.S. Department of Transportation
- United States Geological Survey
- Various articles and publications available on the internet (sources are indicated where data is cited).

3.1.4 Hazards Identified

Through the hazard identification review process, 20 natural and human-caused/technological hazards that have the potential to significantly affect the planning area were chosen for further analysis in the risk assessment. The hazards identified for this plan update are listed below in alphabetical order

- Animal/Plant/Crop Disease
- Dam Failure
- Drought
- Earthquake
- Expansive Soils
- Extreme Heat
- Flash Flooding
- Grass/Wildland Fire
- HAZMAT Incident
- Human Disease
- Infrastructure Failure
- Levee Failure
- River Flooding
- Sinkholes/Landslide
- Structural Fire
- Thunderstorm/Lightning/Hail
- Tornado
- Transportation Incident
- Windstorm
- Winter storm

Although 20 hazards with the potential to significantly affect the planning area were identified and selected for additional analysis, not all hazards impact every jurisdiction. **Table 3.3** provides a summary of the jurisdictions impacted by each hazard. An “x” indicates the jurisdiction is impacted by the hazard. A "-" indicates the hazard is not applicable to that jurisdiction.

Table 3.3. Hazards Identified for Each Jurisdiction

Jurisdiction	Animal/Plant/Crop Disease	Dam Failure	Drought	Earthquake	Expansive Soils	Extreme Heat	Flash Flooding	Grass/Wildland Fire	HAZMAT incident	Human Disease	Infrastructure Failure	Levee Failure	River Flooding	Sinkholes/Landslide	Structural Fire	Thunderstorm/Lightning/Hail	Tornado	Transportation Incident	Windstorm	Winter Storm
Polk County	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
Cities																				
City of Alleman	x	-	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Altoona	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Ankeny	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Bondurant	x	-	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Clive	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Des Moines	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
City of Elkhart	x	-	x	x	x	x	x	x	x	x	x	-	-	x	x	x	x	x	x	x
City of Grimes	x	-	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Johnston	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Mitchellville	x	-	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Pleasant Hill	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Polk City	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Runnels	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of Urbandale	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
City of West Des Moines	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
City of Windsor Heights	x	-	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
Des Moines Water Works	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
School Districts																				
Ankeny, 261	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
Bondurant-Farrar, 720	x	-	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
Dallas Center-Grimes, 1576	x	-	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
Des Moines Independent, 1737	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Johnston, 3231	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
North Polk, 4779	x	-	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
Saydel, 5805	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
Southeast Polk, 6101	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
Urbandale, 6579	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x
West Des Moines	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

3.1.5 Multi-Jurisdictional Risk Assessment

For this multi-jurisdictional plan, the risks are assessed for each jurisdiction where they deviate from the risks facing the entire planning area. The planning area is fairly uniform in terms of climate and topography as well as building construction characteristics. Accordingly, the geographic areas of occurrence for weather-related hazards do not vary greatly across the planning area for most hazards. The more urbanized areas within the planning area have more assets that are vulnerable to the weather-related hazards and varied development trends impact the future vulnerability. Similarly, more rural areas have more assets (crops/livestock) that are vulnerable to animal/plant/crop disease. These differences are discussed in greater detail in the vulnerability sections of each hazard.

The hazards that have the potential to vary across the planning area in terms of geographic areas at risk include dam failure, flash flood, grass or wildland fire, landslide, levee failure, river flood,.

Bi-county Cities

There are several cities within Polk County that have portions of their city limits in adjacent counties. These cities are treated in one of two ways for purposes of participation in this plan:

1) Official Plan Participants: The following cities are bi-county/multiple-county cities that are either a part of the Des Moines Metro Area that have portions of their city limits in other counties, or cities that have the majority of their corporate limits in Polk County. These cities will be invited as official plan participants in the Polk County plan. The Risk Assessment will include incorporation of analysis of building exposure/critical facilities of the entire city limits for these jurisdictions:

- Clive-parts in Dallas County,
- Urbandale-parts in Dallas County,
- West Des Moines-parts in Dallas County, Madison County, & Warren County,
- Grimes-parts in Dallas County,
- Des Moines-parts in Warren County, and
- Mitchellville-parts in Jasper County.

2) Stakeholder Participants: To provide a comprehensive analysis, the Risk Assessment includes incorporated areas of several cities that have a portion of their city limits in Polk County, but are considered official cities of adjacent counties. The Risk Assessment will include analysis of building exposure/critical facilities ONLY for those portions of the incorporated areas that are within the Polk County boundary. Although these cities are not official participants of the Polk County Multi-jurisdictional Hazard Mitigation Plan, they are stakeholders in the planning process and as such, were invited to planning meetings and to comment on plan drafts.

- Carlisle-parts in Warren County,
- Granger-parts in Dallas County,
- Norwalk-parts in Warren County, and
- Sheldahl-parts in Story County & Boone County.

3.1.6 Hazard Scoring Methodology

To maintain reporting format consistent with the 2010 Iowa State Hazard Mitigation Plan, the Polk County HMPC used the same methodology to score and prioritize the hazards. This prioritization was based on a hazard scoring system that considers four elements of risk: probability, magnitude/severity, warning time, and duration. **Table 3.4** provides definitions for each of the four elements along with associated rating levels.

Table 3.4. Hazard Score Element Definitions and Rating Scales

Element/Score	Definitions
Probability: Reflects the likelihood of the hazard occurring again in the future, considering both the hazard's historical occurrence and the projected likelihood of the hazard occurring in any given year	
1—Unlikely	Less than 10% probability in any given year (up to 1 in 10 chance of occurring), history of events is less than 10% likely or the event is unlikely but there is a possibility of its occurrence.
2—Occasional	Between 10% and 20% probability in any given year (up to 1 in 5 chance of occurring), history of events is greater than 10% but less than 20% or the event could possibly occur.
3—Likely	Between 20% and 33% probability in any given year (up to 1 in 3 chance of occurring), history of events is greater than 20% but less than 33% or the event is likely to occur.
4—Highly Likely	More than 33% probability in any given year (event has up to a 1 in 1 chance of occurring), history of events is greater than 33% likely or the event is highly likely to occur.
Magnitude / Severity: Assessment of severity in terms of injuries and fatalities, personal property, and infrastructure and the degree and extent with which the hazard affects the jurisdiction.	
1—Negligible	Less than 10% of property severely damaged, shutdown of facilities and services for less than 24 hours, and/or injuries /illnesses treatable with first aid.
2—Limited	10% to 25% of property severely damaged, shutdown of facilities and services for more than a week, and/or injuries/illnesses that do not result in permanent disability.
3—Critical	25% to 50% of property severely damaged, shutdown of facilities and services for at least 2 weeks, and/or injuries/illnesses that result in permanent disability.
4—Catastrophic	More than 50% of property severely damaged, shutdown of facilities and services for more than 30 days, and/or multiple deaths.
Warning Time: Rating of the potential amount of warning time that is available before the hazard occurs. This should be taken as an average warning time.	
1	More than 24 hours warning time
2	12 to 24 hours warning time
3	6 to 12 hours warning time
4	Minimal or no warning time (up to 6 hours warning)
Duration: A measure of the duration of time that the hazard will affect the jurisdiction.	
1	Less than 6 hours
2	Less than 1 day
3	Less than 1 week
4	More than one week

Using the rating scales described in the table above, the formula used to determine each hazard's score, including weighting factors, is provided below:

(Probability x .45) + (Magnitude/Severity x .30) + (Warning Time x .15) + (Duration x .10) = SCORE

Based on the hazard's overall weighted score, the hazards are categorized as follows: High (3.0-4.0), Moderate (2.0-2.9), and Low (1.1-1.9)

These terms relate to the level of planning analysis to be given to the particular hazard in the risk assessment process and are not meant to suggest that a hazard would have only limited impact. In order to focus on the most critical hazards, those assigned a level of high or moderate were given more extensive attention in the remainder of the risk assessment (e.g., quantitative analysis or loss estimation), while those with a low planning significance were addressed in more general or qualitative ways.

The Hazard Mitigation Planning Committee determined overview hazard ranking scores for the planning area as a whole. The results of this overview are provided below in **Table 3.5**. Additionally, the hazard ranking overview is provided at the beginning of each hazard profile and vulnerability section. A detailed hazard summary by jurisdiction is provided at the conclusion of each hazard profile and vulnerability section to provide a summary of how the hazard varies by jurisdiction.

Table 3.5. Polk County Planning Area Hazard Ranking Results

Hazard	Probability	Magnitude	Warning Time	Duration	Weighted Score	Level
Animal/Plant/Crop Disease	1	2	1	4	1.60	Low
Dam Failure	1	3	4	4	2.35	Moderate
Drought	3	2	1	4	2.50	Moderate
Earthquake	1	1	4	1	1.45	Low
Expansive Soils	2	1	1	1	1.45	Low
Extreme Heat	2	2	1	3	1.95	Low
Flash Flood	4	3	2	1	3.10	High
Grass/Wildland Fire	4	1	1	1	2.35	Moderate
HAZMAT Incident	4	2	4	1	3.10	High
Human Disease	2	3	2	4	2.50	Moderate
Infrastructure Failure	2	2	4	4	2.50	Moderate
Levee Failure	2	3	4	4	2.80	Moderate
River Flooding	4	3	1	4	3.25	High
Sinkholes/Landslide	1	1	4	1	1.45	Low
Structural Fire	4	2	4	1	3.10	High
Thunderstorm/Lightning/Hail	4	1	3	1	2.65	Moderate
Tornado	4	2	3	1	2.95	Moderate
Transportation Incident	4	2	4	1	3.10	High
Windstorm	4	1	3	2	2.75	Moderate
Winter Storm	4	2	3	3	3.15	High

3.2 Assets at Risk

This section assesses the population, structures, critical facilities and infrastructure, and other important assets in the planning area that may be at risk to hazards.

3.2.1 Total Exposure of Population and Structures

3.2.1.1 Unincorporated County and Incorporated Cities

Table 3.6 shows the total population, building count, estimated value of buildings, estimated value of contents and estimated total exposure to parcels for the unincorporated county and each incorporated city. For multi-county cities, the population and building data is broken down by county. Note that for Carlisle, Granger, Norwalk and Sheldahl, the data is for the portions of those cities in Polk County only. **Table 3.7** that follows provides the building value exposures for the county and each city in the planning area broken down by usage type. Finally, **Table 3.8** provides the building count total for the county and each city in the planning area broken out by building usage types (residential, commercial, industrial, and agricultural).

Population data is based on the 2010 data from the U.S. Census Bureau. Building counts and Building Exposure values are based on parcel data provided by the Des Moines Area Regional Geographic Information Systems (GIS) Partnership. Data maintained by this partnership is provided by the Polk, Dallas, Madison, and Warren County assessor's offices. Contents Exposure Values were calculated by factoring a multiplier to the Building Exposure Values based on usage type. The contents multipliers were derived from the HAZUS MH 2.1 and are defined below the table. Land values have been purposely excluded because land remains following disasters, and subsequent market devaluations are frequently short term and difficult to quantify. Additionally, state and federal disaster assistance programs generally do not address loss of land or its associated value (other than crop insurance). It should be noted that the total valuation of buildings is likely an underestimate. Roughly 40% of parcels in Des Moines are not taxed, and often the assessed value on those buildings is missing, outdated, or underestimated in the county assessor data. These include some of Des Moines' largest facilities such as government-owned properties in downtown Des Moines (i.e. Neal Smith Building, Iowa Events Center, etc.).

The total exposure tables include assets owned by Des Moines Water Works as well as public school buildings.

Table 3.6. Maximum Population and Building Exposure by Jurisdiction-Unincorporated County and Incorporated Areas

Jurisdiction	County	2010 Population	Building Count	Building Exposure ($)	Contents Exposure ($)	Total Exposure ($)
City of Alleman	Polk	432	402	$24,364,900	$14,377,450	$38,742,350
City of Altoona	Polk	14,541	7,367	$957,693,680	$644,438,730	$1,602,132,410
City of Ankeny	Polk	45,580	19,685	$2,936,209,050	$1,834,012,700	$4,770,221,750
City of Bondurant	Polk	3,860	2,478	$204,495,420	$120,044,470	$324,539,890
City of Carlisle*	Polk	82	162	$13,561,600	$14,145,450	$27,707,050
City of Clive	Dallas	4,713	1,410	$445,052,560	$236,546,090	$681,598,650
City of Clive	Polk	10,728	4,155	$982,393,130	$658,516,230	$1,640,909,360
City of Des Moines	Polk	204,122	122,729	$9,450,540,160	$6,457,429,715	$15,907,969,875
City of Des Moines	Warren	625	333	$3,365,700	$3,365,700	$6,731,400
City of Elkhart	Polk	683	537	$23,919,600	$14,507,050	$38,426,650
City of Granger*	Polk	212	88	$15,440,500	$7,720,250	$23,160,750
City of Grimes	Dallas	14	11	$1,084,210	$628,755	$1,712,965
City of Grimes	Polk	8,232	5,045	$542,973,990	$354,848,065	$897,822,055
City of Johnston	Polk	17,278	7,074	$1,473,397,350	$917,516,475	$2,390,913,825
City of Mitchellville	Jasper	26	14	$0	$0	$0
City of Mitchellville	Polk	2,228	1,467	$59,238,800	$36,160,700	$95,399,500
City of Norwalk*	Polk	0	0	$0	$0	$0
City of Pleasant Hill	Polk	9,009	4,301	$524,475,690	$319,521,840	$843,997,530
City of Polk City	Polk	3,416	2,041	$216,399,800	$116,581,150	$332,980,950
Polk County	Polk	26,624	34,077	$1,820,273,890	$1,174,154,040	$2,994,427,930
City of Runnells	Polk	507	392	$18,350,900	$9,670,050	$28,020,950
City of Sheldahl*	Polk	134	190	$5,266,100	$2,696,050	$7,962,150
City of Urbandale	Dallas	6,339	1,740	$671,548,200	$342,895,585	$1,014,443,785
City of Urbandale	Polk	33,070	15,135	$2,368,099,500	$1,530,120,550	$3,898,220,050
City of West Des Moines	Dallas	11,764	2,696	$1,595,932,050	$1,294,177,850	$2,890,109,900
City of West Des Moines	Madison	3	0	$38,900	$38,900	$77,800
City of West Des Moines	Polk	44,999	18,747	$3,111,386,910	$1,982,248,905	$5,093,635,815
City of West Des Moines	Warren	41	44	$417,600	$417,600	$835,200
City of Windsor Heights	Polk	4,860	3,077	$275,606,100	$160,422,800	$436,028,900
Total		**454,165**	**255,397**	**$27,741,526,290**	**$18,247,203,150**	**$45,988,729,440**

Sources: * Data is for the portion of these cities that is in Polk County only. Population, 2010 U.S. Census; Building Count and Building Exposure, Des Moines Area Regional GIS Partnership, 2013; Contents Exposure derived by applying multiplier to Building Exposure based on HAZUS MH 2.1 standard contents multipliers per usage type as follows: Residential (50%), Commercial (100%), Industrial (150%), Agricultural (100%). For purposes of these calculations, government, school, and utility were calculated at the commercial contents rate.

Table 3.7. Building Values/Exposure by Usage Type

Jurisdiction	Residential	Commercial	Industrial	Agricultural	Total
Alleman	$19,974,900	$3,550,700	$0	$839,300	$24,364,900
Altoona	$634,229,000	$313,249,680	$7,719,100	$2,495,900	$957,693,680
Ankeny	$2,304,595,600	$528,805,750	$100,202,900	$2,604,800	$2,936,209,050
Bondurant	$171,625,400	$29,038,820	$2,723,500	$1,107,700	$204,495,420
Carlisle*	$3,654,300	$4,742,000	$4,822,000	$343,300	$13,561,600
Clive (Dallas)	$417,012,940	$27,858,560	$0	$181,060	$445,052,560
Clive (Polk)	$656,379,900	$317,387,130	$8,626,100	$0	$982,393,130
Des Moines (Polk)	$6,147,421,890	$3,135,299,670	$161,201,000	$6,617,600	$9,450,540,160
Des Moines (Warren)	$0	$2,370,100	$0	$995,600	$3,365,700
Elkhart	$18,923,100	$3,825,000	$98,000	$1,073,500	$23,919,600
Granger*	$15,440,500	$0	$0	$0	$15,440,500
Grimes (Dallas)	$910,910	$0	$0	$173,300	$1,084,210
Grimes (Polk)	$384,452,350	$148,046,340	$8,200,500	$2,274,800	$542,973,990
Johnston	$1,113,085,750	$357,670,100	$1,324,000	$1,317,500	$1,473,397,350
Mitchellville (Jasper)	$0	$0	$0	$0	$0
Mitchellville (Polk)	$49,313,700	$6,144,300	$3,157,500	$623,300	$59,238,800
Norwalk*	$0	$0	$0	$0	$0
Pleasant Hill	$414,079,700	$106,015,190	$4,172,000	$208,800	$524,475,690
Polk City	$199,793,300	$15,756,300	$156,000	$694,200	$216,399,800
Polk County Unincorporated	$1,350,808,000	$288,397,690	$58,568,300	$122,499,900	$1,820,273,890
Runnells	$17,361,700	$945,200	$0	$44,000	$18,350,900
Sheldahl*	$5,140,100	$55,700	$0	$70,300	$5,266,100
Urbandale (Dallas)	$657,305,230	$12,199,440	$0	$2,043,530	$671,548,200
Urbandale (Polk)	$1,685,391,400	$670,823,100	$9,433,500	$2,451,500	$2,368,099,500
West Des Moines (Dallas)	$603,508,400	$988,245,860	$0	$4,177,790	$1,595,932,050
West Des Moines (Madison)	$0	$0	$0	$38,900	$38,900
West Des Moines (Polk)	$2,285,661,210	$795,863,100	$27,385,200	$2,477,400	$3,111,386,910
West Des Moines (Warren)	$0	$344,000	$0	$73,600	$417,600
Windsor Heights	$230,366,600	$45,239,500	$0	$0	$275,606,100
Totals	**$19,386,435,880**	**$7,801,873,230**	**$397,789,600**	**$155,427,580**	**$27,741,526,290**

Source: Des Moines Area Regional GIS Partnership, 2013; Note: Commercial Building Category includes those values coded as "government", "school", "exempt" "header", and "unknown"; * Data is for the portion of these cities that is in Polk County only

Table 3.8. Building Counts by Usage Type

Jurisdiction	Residential Counts	Commercial Counts	Industrial Counts	Agricultural Counts	Total
Alleman	263	100	0	39	402
Altoona	6,067	1,082	141	77	7,367
Ankeny	17,030	2,364	100	191	19,685
Bondurant	2,071	307	9	91	2,478
Carlisle*	95	36	8	23	162
Clive (Dallas)	1,351	52	0	7	1,410
Clive (Polk)	3,665	471	19	0	4,155
Des Moines (Polk)	111,185	10,598	574	372	122,729
Des Moines (Warren)	238	56	0	39	333
Elkhart	288	239	2	8	537
Granger*	88	0	0	0	88
Grimes (Dallas)	0	0	0	11	11
Grimes (Polk)	3,347	1,516	49	133	5,045
Johnston	5,872	1,118	28	56	7,074
Mitchellville (Jasper)	12	0		2	14
Mitchellville (Polk)	1,186	173	25	83	1,467
Norwalk*	0	0	0	0	0
Pleasant Hill	3,474	760	21	46	4,301
Polk City	1,864	131	1	45	2,041
Polk County Unincorporated	21,589	3,147	130	9,211	34,077
Runnells	342	44	0	6	392
Sheldahl*	140	18	0	32	190
Urbandale (Dallas)	1,659	6	0	75	1,740
Urbandale (Polk)	13,939	1,097	24	75	15,135
West Des Moines (Dallas)	2,156	418	0	122	2,696
West Des Moines (Madison)	0	0	0	0	0
West Des Moines (Polk)	16,468	2,042	76	161	18,747
West Des Moines (Warren)	42	1	0	1	44
Windsor Heights	2,937	140	0	0	3,077
Totals	**217,368**	**25,916**	**1,207**	**10,906**	**255,397**

Source: Des Moines Area Regional GIS Partnership, 2013; * Data is for only the portions of these jurisdictions that are in Polk County; Note: Commercial Building Category includes those values coded as “government”, “school”, “exempt” “header”, and “unknown”; * Data is for the portion of these cities that is in Polk County only

3.2.1.2 Public School Districts

Although the total assets discussed above, include public school buildings, this information is provided separately to provide additional details. The enrolled number of students at the ten participating public school districts is provided **Table 3.9** below as well as the number of buildings, building values (building exposure) and contents value (contents exposure). These numbers represent the total enrollment and building count for the public school districts regardless of what county they are located in.

Table 3.9. Population and Building Exposure by Jurisdiction-Public School Districts

Public School District	Enrolment	Building Count	Building Exposure ($)	Contents Exposure ($)	Total Exposure ($)
Ankeny	9,486	20	Not Reported	Not Reported	Not Reported
Bondurant-Farrar	1,611				
Dallas Center-Grimes	2,435*	6*	$75,318,149	$8,044,230	$83,362,379
Des Moines Independent	33,278	67	Not Reported	Not Reported	Not Reported
Johnston	6,570	13	$175,281,923	$18,457,394	$193,739,317
North Polk	1,438	4	$121,684,000	$10,000,000	$131,684,000
Southeast Polk	6,735	11	Not Reported	Not Reported	Not Reported
Urbandale	4,099	8	$126,056,045	$18,676,696	$144,732,741
West Des Moines	9,289	19	$250,029,000	$51,631,000	$301,660,000

Source: Enrollment Statistics from 2012-2013 Iowa Public School PreK-12 Enrollments by District – Iowa Department of Education, Bureau of Information and Analysis Services; Building Count and Exposure from Data Collection Guides from Public School Districts. *Includes schools located in Dallas County

3.2.2 Critical and Essential Facilities and Infrastructure

As part of the update to the Polk County Hazard Mitigation plan, participating jurisdictions assessed the vulnerability of critical, essential, high potential loss, and transportation and lifeline facilities to identified hazards. Definitions of each of these types of facilities are provided below:

- Critical Facility: Those facilities that are essential in providing utility or direction either during the response to an emergency or during the recovery operation.
- Essential Facility: Those facilities that if damaged, would have devastating impacts on disaster response and/or recovery.
- High Potential Loss Facilities: Those facilities that would have a high loss or impact on the community.
- Transportation and lifeline facilities: Those facilities and infrastructure that is critical to transportation, communications, and necessary utilities.

Table 3.10 is a summary of the inventory of 2,852 critical and essential facilities and infrastructure in the planning area. This list was compiled from an inventory of critical facilities that was developed by the City of Des Moines and Regional GIS partners in 2011 as part of a FEMA funded effort to map hazards and infrastructure. This inventory was revised with an updated inventory of Tier II chemical facilities as well as an updated inventory of state-regulated dams from the Iowa Department of Natural Resources. Updates were also provided by each jurisdiction.

At Meeting #2, each jurisdiction was provided with the inventory of their jurisdiction's critical and essential facilities for validation. Additions/deletions, and corrections were then noted by the individual jurisdictions and AMEC incorporated the changes in the inventory. The validated critical facility inventory for all jurisdictions was then utilized in analysis of geographic hazards, such as riverine flooding and fixed chemical facilities. The full list of critical and essential facilities, as well as tables indicating critical and essential facilities to the 1-percent annual chance floodplain and within ½ mile of chemical facilities, is provided in Appendix E. The Des Moines Area Regional GIS Partnership maintains the GIS-based data set of this critical facility inventory. The Critical Facility Inventory is "For Official Use Only". To obtain access, contact the Polk County Emergency Manager at1907 Carpenter Street, Des Moines, Iowa.

Note: For the Fire Service category, this includes auxiliary buildings, such as storage, that are not fire stations.

Note: The critical facilities for the public school districts are reflected in the "School Facility" category in the inventory summary according to the city/county area the buildings are located in. This category also includes private school facilities. Similarly, the critical facilities owned by Des Moines Water Works are accounted for in the summary under the "Potable Water" category according to the city/county area the facilities are located. The detailed inventory in Appendix E includes each facility by owner.

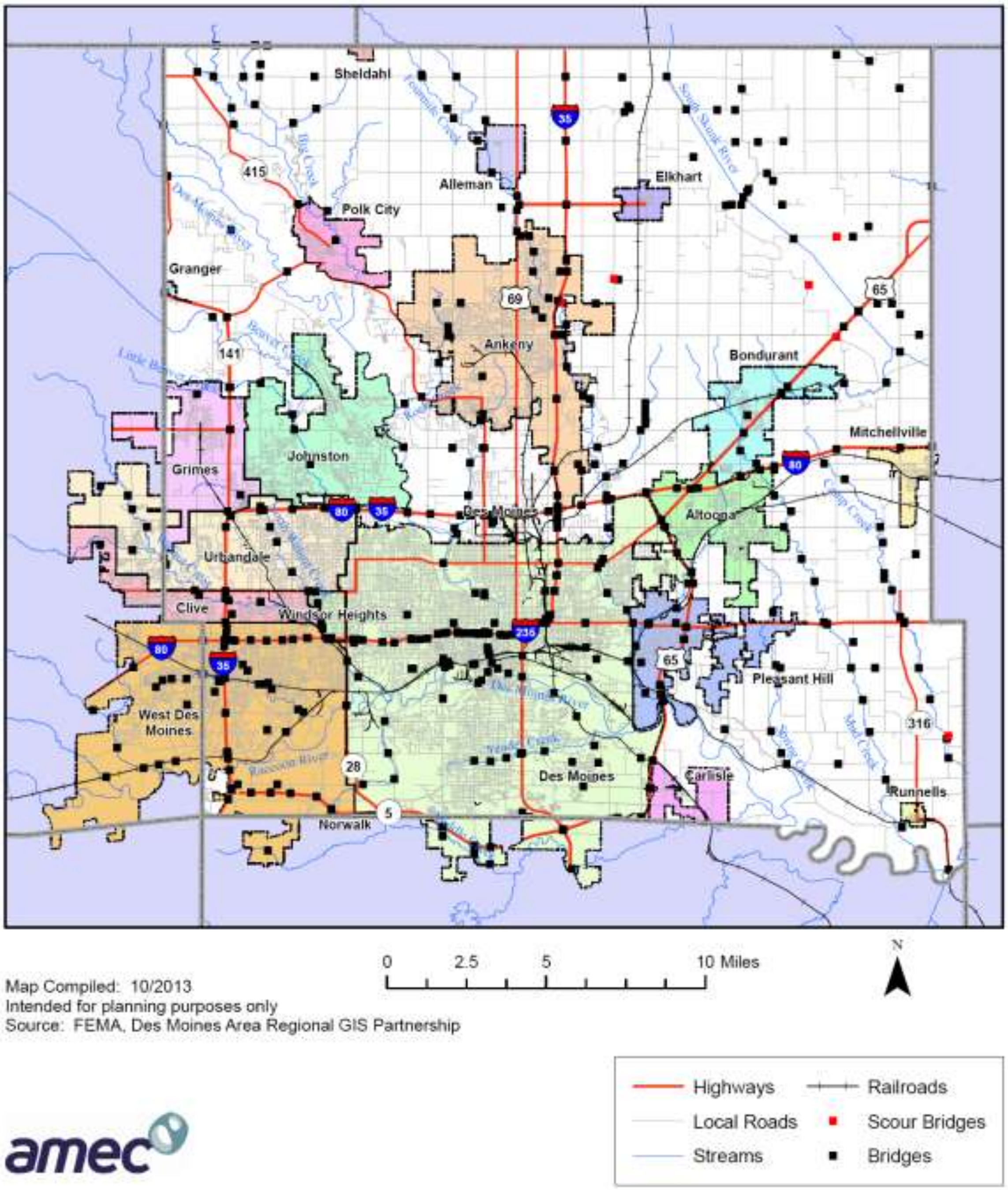
Table 3.10. Inventory of Critical/Essential Facilities and Infrastructure by Jurisdiction

Jurisdiction	Airport Facility	Bus Facility	Childcare Facility	Communications Tower	Electric Power Facility	Emergency Operations Center	Fire Service	Government	Housing	Shelters	Highway Bridge	Hospital/Health Care	Military	Natural Gas Facility	Nursing Homes	Police Station	Potable Water Facility	Rail	Sanitary Pump Stations	School Facilities	Stormwater Pump Stations	Tier II Chemical Facility	Wastewater Facility	Total
Alleman	0	1	0	50	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	3	0	1	0	58
Altoona	0	0	3	38	0	0	1	0	0	0	7	1	0	0	1	1	0	0	0	4	0	10	1	67
Ankeny	3	1	8	62	0	0	2	17	0	0	31	43	1	0	3	1	5	0	0	23	0	19	3	222
Bondurant	0	1	1	13	0	0	1	0	0	0	7	0	0	0	0	0	0	1	0	4	0	3	0	31
Carlisle*	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	13
Clive	0	0	8	33	0	0	1	0	0	0	15	8	0	0	3	1	0	1	0	2	0	6	0	78
Des Moines	1	11	28	480	3	1	14	33	6	21	145	52	3	0	34	14	14	5	31	154	34	122	1	1207
Elkhart	0	0	0	8	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	13
Granger*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grimes	0	0	1	35	1	0	1	0	0	0	4	1	0	0	0	0	0	0	0	2	0	10	0	55
Johnston	0	1	5	45	1	1	1	1	1	0	3	5	2	0	3	1	0	0	0	7	0	13	0	90
Mitchellville	0	0	1	5	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	3	1	14
Norwalk*	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Pleasant Hill	0	1	5	24	1	0	1	0	0	0	20	1	0	1	4	1	0	0	1	6	0	15	0	81
Polk City	0	0	3	7	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	1	0	2	0	17
Polk County Unincorporated	3	1	1	171	1	0	1	1	0	0	228	0	0	0	0	3	2	0	1	7	0	61	0	481
Runnells	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	4
Sheldahl*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Urbandale	0	1	5	60	0	0	2	2	0	0	24	12	0	0	5	2	2	0	0	13	0	24	0	152
West Des Moines	0	1	14	77	0	0	5	0	0	1	70	19	0	0	9	2	1	0	0	27	0	18	1	245
Windsor Heights	0	0	1	7	0	0	1	0	0	0	10	0	0	0	0	1	0	0	0	2	0	1	0	23
Totals	**7**	**19**	**84**	**1127**	**7**	**2**	**33**	**58**	**7**	**22**	**567**	**142**	**6**	**1**	**64**	**30**	**25**	**8**	**33**	**256**	**34**	**311**	**9**	**2852**

Source: Des Moines Area Regional GIS Partnership; Hazard7 mitigation Planning Committee; * Data is for only the portions of these jurisdiction that are in Polk County

Figure 3.1 shows the locations of bridges in the planning area included in the National Bridge Inventory data set within HAZUS MH 2.1. One of the database items in the National Bridge Inventory is a “scour index”, which is used to quantify the vulnerability of a bridge to scour during a flood. Bridges with a scour index between 1 and 3 are considered “scour critical”, or a bridge with a foundation element determined to be unstable for the observed or evaluated scour condition. There are six scour critical bridges identified in the planning area. Five are in unincorporated Polk County and one is in the City of Ankeny.

Figure 3.1. Polk County Bridges



3.2.3 Other Assets

Assessing the vulnerability of the planning area to disaster also involves inventorying the natural, historic, cultural, and economic assets of the area. This is important for the following reasons:

- The plan participants may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- If these resources are impacted by a disaster, knowing about them ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts is higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.
- Natural resources can have beneficial functions that reduce the impacts of natural hazards, such as wetlands and riparian habitat, which help absorb and attenuate floodwaters.
- Losses to economic assets (e.g., major employers or primary economic sectors) could have severe impacts on a community and its ability to recover from disaster.

In the planning area, specific assets include the following:

Threatened and Endangered Species: **Table 3.11** includes Federally Threatened, Endangered, Proposed and Candidate Species in Polk County, Iowa.

Table 3.11. Threatened and Endangered Species in Polk County

Common Name	Scientific Name	Status
Indiana bat	Myotis sodalist	Endangered
Prairie bush clover	Lespedeza leptostachya	Threatened
Western prairie fringed orchid	Platanthera praeclara	Threatened
Least tern	Sterna antillarum	Endangered

Source: U.S. Fish and Wildlife Service, http://www.fws.gov/midwest/endangered/lists/iowa_cty.html

Natural Resources: The Polk County Conservation Board manages 20 parks and natural areas encompassing over 11,000 acres. **Table 3.12** provides the names and locations of parks and conservation areas in Polk County.

Table 3.12. Parks in Polk County

Park Name	Address	City
Beaver Creek Greenbelt	9631 NW 121St	Granger
Brown's Woods	Brown's Woods Drive	West Des Moines
Carney Marsh	NE 70th Avenue	Ankeny
Chichaqua Bottoms Greenbelt	8700 NE 126 Avenue	Maxwell
Chichaqua Valley Trail	NE 88th Street	Bondurant
Easter Lake Park	2830 Easter Lake Drive	Des Moines
Engeldinger Marsh	Hwy 65 and NE 120th Ave.	Bondurant
Fort Des Moines Park	7200 SE 5th St	Des Moines

Park Name	Address	City
Four Mile Creek Greenbelt	NE 38th St.	Berwick
Gay Lea Wilson Trail	University Avenue	Pleasant Hill
Great Western Trail	George Flagg Parkway	Des Moines
High Testle Trail	W First St.	Ankeny
Lewis A. Jester Park	11407 NW Jester Park Drive	Granger
Mally's Weh-Weh-Neh-Kee Park	5792 NE Berwick Dr.	Berwick
Polk County Education Programs	11407 NW Jester Park Drive	Granger
Sycamore Trail	Euclid Avenue	Des Moines
Thomas Mitchell Park	4520 NE 108 St.	Mitchellville
Trestle to Trestle Trail	2309 Euclid	Des Moines
Yellow Banks Park	6801 SE 32nd Ave.	Pleasant Hill

Source: My County Parks website accessed 8/30/2013, http://www.mycountyparks.com/county/Polk/Parks.aspx

Historic Resources: The National Register of Historic Places is the official list of the Nation's cultural resources worthy of preservation. Authorized under the National Historic Preservation Act of 1966, the National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archeological resources. The National Register is administered by the National Park Service under the Secretary of the Interior. Properties listed in the National Register include districts, sites, buildings, structures and objects that are significant in American history, architecture, archeology, engineering, and culture. The properties in Polk County that are on the National Register of Historic Places are identified in **Table 3.13.**

Table 3.13. Polk County, Iowa Properties on the National Register of Historic Places

Property	Address	City	Date Listed
Abraham Lincoln High School	2600 SW 9th Street	Des Moines	10/24/2002
Ainsworth William W. and Elizabeth J. House	1310 7th St.	Des Moines	10/22/1998
Andrews Josiah House	1128 27th Street	Des Moines	11/1/1988
Ashby Manor Historic District	Roughly bounded by Beaver Ave. and Ashby Park	Des Moines	9/4/1992
Ayrshire Apartments	1815 6th Ave.	Des Moines	10/25/1996
Bailey William H. and Alice House	1810 6th Ave.	Des Moines	10/25/1996
Baker C. H. Double House	1700–1702 6th Ave.	Des Moines	10/25/1996
Baker–DeVotie–Hollingsworth Block	516-526 E Grand Ave.	Des Moines	1/10/2008
Bartlett Walter M. Double House	1416-1418 6th Ave.	Des Moines	10/22/1998
Bates Park Historic District	4th Street between Orchard and Clark Sts.	Des Moines	10/25/1996
Baum William A. and Etta Cottage	1604 8th Street	Des Moines	10/25/1996
Beeson Byron A. House	1503 5th Ave.	Des Moines	10/25/1996
Bell Hill McClelland House	1091 26th Street	Des Moines	11/1/1988
Benham F. A. House	716 19th St.	Des Moines	11/05/98
Big Creek Schoolhouse	112 3rd Street	Polk City	8/11/2004
Boyd House, Byron and Ivan	304 42nd Street	Des Moines	4/6/2004
Boyt Company Building	210 Court Ave.	Des Moines	3/10/2009
Burns United Methodist Church	811 Crocker Street	Des Moines	6/15/1977
Burnstein–Malin Grocery	1241 6th Ave.	Des Moines	10/22/1998
Camp Dodge Pool District	Buildings A22–A24 Camp Dodge	Johnston	2/17/1995
Case Larnerd House	3111 Easton Blvd.	Des Moines	6/21/1982
Chaffee–Hunter House	1821 8th St.	Des Moines	10/22/1998
Chamberlain, D.S., Building	1312 Locust St.	Des Moines	6/28/2007

Property	Address	City	Date Listed
Carpenter James Sansom House	3320 Kinsey Ave.	Des Moines	4/23/1998
Chautauqua Park Historic District	Roughly bounded by 16th Street Hickman Rd. and Chautauqua Pkwy.	Des Moines	3/22/1990
Civic Center Historic District	Des Moines River Center Street Dam to Scott Ave. Dam including both banks	Des Moines	12/7/1988
Clemens Automobile Company Building	200 10th St.	Des Moines	5/6/2009
College Corner Commercial Historic Business District	Euclid Ave. between Second and Third Aves.	Des Moines	4/23/1998
Court Avenue Bridge	Court Ave. over Des Moines River	Des Moines	5/15/1998
Crane Building	1440 Walnut	Des Moines	8/30/2001
Crawford House	2203 Grand Ave.	Des Moines	1/27/1983
Cummins Albert Baird House	2404 Forest Dr.	Des Moines	6/30/1982
Darling Jay Norwood and Genevieve Pendleton House	2320 Terrace Rd.	Des Moines	9/30/1992
Denny Professor Charles O. House	1084 Twenty-fifth Street	Des Moines	9/8/1988
Des Moines Art Center	4700 Grand Avenue	Des Moines	12/6/2004
Des Moines Saddlery Company Building	307–311 Court Ave.	Des Moines	6/27/1985
Des Moines Western Railway Freight House	625 E. Court Ave.	Des Moines	7/10/2008
Drake University Campus Historic District	Roughly two blks. Along University Ave. near Twenty-fifth Street	Des Moines	9/8/1988
Earle & LeBosquet Block	407-409 Court Ave.	Des Moines	6/11/2009
Evans, Edward B. and Nettie E., House	1410 19th St.	Des Moines	4/1/2002
Fire Station No. 4	1041 8th Street	Des Moines	6/27/1979
First Methodist Episcopal Church	10th and Pleasant Sts.	Des Moines	4/12/1984
Fish and Game Pavilion and Aquarium	Iowa State Fairgrounds	Des Moines	12/23/1991
Fleming Building	218 6th Avenue	Des Moines	5/22/2002
Flynn Farm Mansion and Barn	2600 111th Street	Des Moines	11/30/1973
Fort Des Moines Provisional Army Officer Training School	Fort Des Moines Military Reservation	Des Moines	5/30/1974
Franklin Apartments	1811 6th Ave.	Des Moines	10/25/1996
Gabriel Rees House	1701 Pennsylvania Ave.	Des Moines	12/1/1978
Goddard Bungalow Court Historic District	1410-21 Goddard Court, 1232 14th Street	Des Moines	11/21/2000
Goode Lowry W. and Hattie N. First North Des Moines House	1813 7th St.	Des Moines	10/22/1998
Grand View College (Old Main)	1200 Grandview Ave.	Des Moines	5/23/1978
Greek Orthodox Church of Saint George	1118 35th Street	Des Moines	2/28/1997
Grocers Wholesale Company Building	22 West Ninth Street	Des Moines	4/25/2008
Haley F.E. Double House	1233-1235 7th St.	Des Moines	10/22/1998
Hallett Flat—Rawson & Co. Apartment Building	1301-1307 Locust St.	Des Moines	12/1/2000
Hatton Dr. John B. and Anna M. House	1730 7th Street	Des Moines	4/23/1998
Hawkeye Insurance Company Building	209 Fourth Street	Des Moines	4/28/1986
Hayes William B. House	1547 Arlington Ave.	Des Moines	10/25/1996
Hawkeye Transfer Company Warehouse	702 Elm St.	Des Moines	3/22/2010
Hazen, Allen Water Tower	4800 Hickman Road	Des Moines	8/11/2004
Henshie-Briggs Row House	1106 High Street	Des Moines	8/8/2001
Herndon Hall	2000 Grand Ave.	Des Moines	7/27/1977
Herring Motor Car Company Building	110 W. 10th Street	Des Moines	12/6/2004
Herrold Bridge	NW 88th Ave. over Beaver Creek	Herrold vicinity	5/15/1998
Highland Park Historic Business District at Euclid and Sixth Avenues	Roughly jct. of Euclid Ave. and Sixth Ave.	Des Moines	7/15/1998
Hohberger Building	502-506 E. Locust St.	Des Moines	9/12/2002
Home of Marshall's Horseradish	1546 2nd Place	Des Moines	10/22/1998

Property	Address	City	Date Listed
Homestead Building	303 Locust Street	Des Moines	3/5/1982
Hotel Fort Des Moines	10th and Walnut Sts.	Des Moines	9/16/1982
Hotel Kirkwood	400 4th Street, a.k.a. 400 Walnut Street	Des Moines	12/10/2003
Hotel Randolph	200-204 4th St.	Des Moines	6/11/2009
Hubbell Building	904 Walnut Street	Des Moines	8/11/2004
Hubbell Warehouse	340 SW 5th St	Des Moines	11/12/2010
Ingersoll Place Plat Historic District	28th St., Linden and High Sts.	Des Moines	11/21/2000
Iowa Commission for the Blind Building	524 4th St	Des Moines	7/1/2010
Iowa-Des Moines National Bank Building	520 Walnut Street	Des Moines	7/10/1979
Iowa State Capitol	Grand Ave. and E. 12th Street	Des Moines	10/21/1976
Iowa State Fair and Exposition Grounds Historic District	E. Thirtieth Street and Grand Ave.	Des Moines	9/14/1987
Iowa State Historical Building	E. 12th and Grand Ave.	Des Moines	11/14/1978
Johnson Capt. Nicholas W. and Emma House	Jct. of 21st Street and University Ave.	Des Moines	12/6/1990
Johnstone Dr. Anna E. and Andrew A. House	1810 8th Street	Des Moines	10/25/1996
Jordan House	2251 Fuller Rd.	West Des Moines	12/10/1973
Keeler Rev. R. W. and Fannie E. House	1430 10th Street	Des Moines	11/4/1993
Kingman Place Historic District	27th to 31st Sts., Kingman Blvd., Rutland St. and Cottage Ave.	Des Moines	11/21/2000
Kirkham Francis M. House	1026 Twenty-fourth Street	Des Moines	9/8/1988
Knotts Nellie and Thomas House	1021 Twenty-sixth Street	Des Moines	9/8/1988
Kromer Flats	1433–1439 6th Ave.	Des Moines	10/25/1996
Lexington	The 1721 Pleasant Street	Des Moines	12/12/1976
Liberty Building	418 Sixth Ave	Des Moines	7/22/2010
Linden Heights Historic District	Foster Drive, Glenview Drive, Woodlawn, Park Hill Drive west of SW 42nd Street	Des Moines	12/10/2003
Lord Richard T. C. and William V. Wilcox House	2416 Kingman Blvd.	Des Moines	9/8/1988
Mahnke House	2707 High Street	Des Moines	10/13/1983
Maine The	1635 6th Ave.	Des Moines	10/25/1996
Maish House	1623 Center Street	Des Moines	4/11/1977
Masonic Temple of Des Moines	1011 Locust Street	Des Moines	8/29/1997
Methodist Deaconess Institute–Esther Hall	921 Pleasant St.	Des Moines	¾/2009
Middlesex Plat Historic district	Center to Woodland Ave., 31st to 35th Sts.	Des Moines	11/21/2000
Municipal Building	E. 1st and Locust Sts.	Des Moines	11/10/1977
Murillo Flats	605 16th St.	Des Moines	6/9/2009
National Biscuit Company Building	1001 Cherry St.	Des Moines	5/6/2009
Naylor House	944 W. 9th Street	Des Moines	7/10/1974
New Lawn The	1245 6th Ave.	Des Moines	10/25/1996
Newens Sanitary Dairy Historic District	2300-2312 University Avenue	Des Moines	12/17/2003
Norman Apartment Building	3103 University Ave.	Des Moines	9/8/1988
Northwestern Hotel	321 E. Walnut	Des Moines	1/12/1984
Oaklands The Historic District	Oakland and Arlington Aves. Between Franklin and College Aves.	Des Moines	10/25/1996
Odenweller F. F.–James P. and Nettie Morey House	1115 27th Street	Des Moines	11/1/1988
Owl's Head Historic District	Ridge Rd. Forest Dr. 28th and 29th Sts.	Des Moines	10/11/1978
Peak George B. House	1080 22nd Street	Des Moines	11/14/1978
Perry and Brainard Block	1601 6th Ave.	Des Moines	10/25/1996
Polk County Courthouse	6th and Mulberry Sts.	Des Moines	4/30/1979

Property	Address	City	Date Listed
Prospect Park Second Plat Historic District	Roughly along the Des Moines River S to Franklin Ave. between 6th Ave. and 9th Street	Des Moines	4/23/1998
Public Library of Des Moines	Locust Street	Des Moines	7/25/1977
Reynolds Anson O. House	1022 Twenty-sixth Street	Des Moines	9/8/1988
Riverview Park Plat Historic District	Arlington Ave. between Franklin and 6th Aves.	Des Moines	10/25/1996
Rollins Ralph House	2801 Fleur Dr.	Des Moines	11/14/1978
Rumely–Des Moines Drug Company Building	110 SW. Fourth Street	Des Moines	11/16/1989
Saint John's Roman Catholic Church	1915 University Ave.	Des Moines	9/8/1987
Salisbury House	4025 Tonawanda Dr.	Des Moines	7/20/1977
Sargent's Garage	510 College Ave.	Des Moines	10/22/1998
Savery Hotel	401 Locust St.	Des Moines	11/5/1998
Scheibe Julius Cottage	815 College Ave.	Des Moines	10/22/1998
Scott Mary A. and Caleb D. House	1014 Twenty-sixth Street	Des Moines	9/8/1988
Schmitt and Henry Manufacturing Company	309 SW 8th St.	Des Moines	3/17/2010
Scottish Rite Consistory Building	6th Ave. and Park Street	Des Moines	9/29/1983
Seth Richards Commercial Block	300-310 Court Avenue	Des Moines	3/11/2005
Sherman Hill Historic District	Roughly bounded by Woodland Ave. 19th School and 15th Sts.	Des Moines	1/25/1979
Sherman Hoyt Place	1501 Woodland Ave.	Des Moines	9/19/1977
Sherman Lampson P. House	1052 Twenty-sixth Street	Des Moines	9/8/1988
Simmons John P. House	1113 27th Street	Des Moines	11/1/1988
Southwest Fifth Street Bridge	SW Fifth Street over Raccoon River	Des Moines	5/15/1998
Sixth and Forest Historic District	Jct. of 6th and Forest Aves. NE and NW corners	Des Moines	10/25/1996
Smouse, David W., Opportunity School	2820 Center Street	Des Moines	10/24/2002
Southeast Water Trough	SE 11th and Scott Street	Des Moines	10/8/1976
St. Ambrose Cathedral and Rectory	607 High Street	Des Moines	3/30/1979
St. Paul's Episcopal Church	815 High St.	Des Moines	3/31/2010
Standard Glass and Paint Company Building	112 10th Street	Des Moines	12/6/2004
Stevenson Samuel A. and Margaret House	2940 Cottage Grove Ave.	Des Moines	1/3/1985
Stoner Thomas I. House	1030 56th Street	Des Moines	2/12/1992
Stuart Dr. Richard and Paulina House	1060 Twenty-fifth Street	Des Moines	9/8/1988
Studio Building	524 E. Grand Ave.	Des Moines	11/14/1978
Sylvan Theater Historic District	In Greenwood Park on W side of 45th Street 1 block S of jct. with Grand Ave.	Des Moines	8/15/1995
Syndicate Block	501 E. Locust	Des Moines	10/1/2001
Taft-West Warehouse	215-222 Court Avenue	Des Moines	12/20/2006
Teachout Building	500-502 E. Locust St.	Des Moines	4/29/1999
Terrace Hill	2300 Grand Ave.	Des Moines	6/14/1972
Theodore Roosevelt High School	4419 Center Street	Des Moines	10/24/2002
Trent–Beaver House	1802 6th Ave.	Des Moines	10/25/1996
Trier Paul J. and Ida House	6880 N.W. Beaver Dr.	Johnston	11/9/1988
Trinity Methodist Episcopal Church	1548 8th Street	Des Moines	4/23/1998
Turner Susie P. Double House	1420-1422 8th St.	Des Moines	10/22/1998
Universalist Church	420 4th Street	Mitchellville	9/6/2005
U.S. Post Office	2nd and Walnut Sts.	Des Moines	11/19/1974
Vail Mrs. Marian D.–Prof. Charles Noyes Kinney House	1056 26th Street	Des Moines	11/1/1988
Valley Junction-West Des Moines City Hall and Engine House	137 5th Street	West Des Moines	2/17/1983
Veneman's Bungalow Court Historic District	1101-115 Droukas Court, 1228, 1232 E. 12th St.	Des Moines	11/21/2000

Property	Address	City	Date Listed
Wallace Henry House	756 16th Street	Des Moines	5/14/1993
Warfield Pratt and Howell Company Warehouse	100 West Court Ave.	Des Moines	5/15/1985
Weitz Charles H. and Lena May House	1424 5th Ave.	Des Moines	10/22/1998
West Chester	3520 Grand Ave.	Des Moines	1/19/1984
West Ninth Streetcar Line Historic District	W. Ninth Street from University Ave. to Hickman Rd.	Des Moines	4/23/1998
Wherry Block	1600-1602 6th Ave.	Des Moines	10/22/1998
Woodland Place Historic District	25th to 27th St. to Woodland Ave.	Des Moines	11/21/2000
Youngerman Block	206-208 4th St.	Des Moines	6/10/2009
Younker Brothers Department Store	713 Walnut St.	Des Moines	3/17/2010

Source: State Historical Society of Iowa, http://www.iowahistory.org/historic-preservation/national-register-of-historic-places/properties-in-iowa.html

Economic Resources: Major employers in the planning area include the following:

Table 3.14. Major Non-Government Employers in Polk County and Greater Des Moines Region

Employer Name	Main Locations	Product or Service	Employees
1,000 or more employees			
Wells Fargo & Co.	Des Moines, West Des Moines	Financial services, home mortgage	13,500
Mercy Medical Center – Des Moines including Mercy Medical Center – West Lakes and Mercy Franklin Center	Des Moines, West Des Moines	Healthcare	7,100
Principal Financial Group	Des Moines	Financial services	6,131
Unity Point Health – Des Moines including Methodist, Lutheran, Blank Children's, and Methodist West hospitals plus Unity Point at Home	Des Moines, West Des Moines	Healthcare	5,505
Nationwide/Allied Insurance	Des Moines	Insurance	5,000
John Deere companies	Ankeny, Johnston	Agricultural machinery, GPS/ag equipment software, consumer financial services	3,100
DuPont Pioneer	Johnston	Crop inputs for worldwide agribusiness	2,849
JBS Swift	Marshalltown	Pork processing and packaging	2,300
Hy-Vee Food Stores Inc.	West Des Moines	Retail grocery and drugstore chain	2,100
YMCA of Greater Des Moines	Des Moines, West Des Moines, Waukee, Ankeny, Grimes	Non-profit youth development, health and fitness centers	1,868
Kum & Go	West Des Moines	Convenience store chain	1,820
Marsh	Urbandale	Insurance	1,800

Employer Name	Main Locations	Product or Service	Employees
UPS	Des Moines	Logistics and distribution, transportation and freight, customers brokerage	1,600
Bridgestone Americas Tire Operations	Des Moines	Agricultural tires	1,600
Wellmark Inc.	Des Moines	Health insurance, Medicare PDP/PPO/supplement, dental, flex, HSAs/HRAs	1,550
HP Enterprise Services	Des Moines	Global technology services	1,500
Aviva USA	Des Moines	Financial services	1,400
Casey's General Store, Inc.	Ankeny	Gasoline, prepared food, fountain items, groceries, other merchandise	1,400
Emerson Process Management – Fisher Division	Marshalltown	Control valves and systems – divisional headquarters	1,200
EMC Insurance Companies	Des Moines	Insurance	1,126
Lennox Manufacturing, Inc.	Marshalltown	Heating, air conditioners	1,030
Prairie Meadows Racetrack and Casino	Altoona	Slot machine and table game casino, live horse racing, entertainment	1,003
Meredith Corporation	Des Moines	Magazine, book publishing, TV, integrated marketing, interactive media	1,000
Tyson Fresh Meats	Perry	Processor and marketer of chicken, beef, and pork	1,000
500 to 999 employees			
FBL Financial Group Inc.	West Des Moines	Insurance and investments	955
CDS Global	Des Moines	Magazine and product fulfillment, data capture, direct marketing services	950
MidAmerican Energy Company	Des Moines	Energy services	929
Dahl's Foods	Des Moines	Retail food markets	900
Drake University	Des Moines	Higher education	900
American Enterprise Mutual Holding	Des Moines	Insurance	900
Mediacom Communications Corp.	Des Moines	Long-distance phone service, Internet, television	715
CenturyLink	Des Moines	Telecommunications, ISP	700
Ultimate Nursing Services	Waukee	Home care services for infants, children, young adults and adults	650
Citi Cards, a division of Citigroup	Urbandale	Credit card operations center	600
Titan Tire Corporation	Des Moines	Manufacture of agricultural and off road tires	600
ADP (Automatic Data Processing)	West Des Moines	Payroll processing, HR systems, related services	550

Employer Name	Main Locations	Product or Service	Employees
The Wittern Group Inc.	Clive	Automated dispensing and controlled access equipment manufacture and design	550
Pine Ridge Farms LLC	Des Moines	Pork products	540
GuideOne Insurance	West Des Moines	Property and casualty insurance	519
Colorfx/Rock Communications	Des Moines	Printed brochures, mailing, fulfillment, digital media	500

Source: The Greater Des Moines Partnership; Information obtained from sources deemed to be reliable: Hoover's; Des Moines Business Record *2013 Book of Lists*; Greater Des Moines Partnership; news clippings; Marshall County, Poweshiek County and Jasper County economic development groups; and company-provided information. The list is updated as changes are identified and is not to be construed as a complete profile for the region; http://www.desmoinesmetro.com/regional-economic-development/research-and-statistics/employers/

Agriculture also plays an important role in the Polk County economy. **Table 3.15** provides a summary of the agriculture-related jobs in Polk County.

Table 3.15. Agriculture-Related Jobs in Polk County

Activity	Jobs
Crop and livestock production	542
Ag processing	6,963
Ag support	3,480
Total Agricultural-related Jobs	10,984

Source: Iowa State University Extension, 2009, http://www.extension.iastate.edu/Publications/Pm2023-75.pdf

3.3 Future Land Use and Development

According to the U.S. Census Bureau, the Polk County population increased 15 percent from 2000 to 2010. **Table 3.16** provides the population growth statistics for all cities in Polk County as well as the county as a whole.

Table 3.16. Polk County Population Growth, 2000-2010

Jurisdiction	Total Population 2010	Total population 2000	2000-2010 # Change	2000-2010 % Change
Polk County	430,640	374,601	56,039	15.0%
Alleman	432	439	-7	-1.6%
Altoona	14,541	10,345	4,196	40.6%
Ankeny	45,582	27,117	18,465	68.1%
Bondurant	3,860	1,846	2,014	109.1%
Carlisle	3,876	3,497	379	10.8%
Clive	15,447	12,855	2,592	20.2%
Des Moines	204,220	198,682	5,538	2.8%
Elkhart	683	362	321	88.7%
Granger	1,244	583	661	113.4%
Grimes	8,246	5,098	3,148	61.7%
Johnston	17,278	8,649	8,629	99.8%
Mitchellville	2,254	1,715	539	31.4%
Norwalk	8,941	6,884	2,057	29.9%
Pleasant Hill	8,785	5,070	3,715	73.3%
Polk City	3,418	2,344	1,074	45.8%
Runnells	507	352	155	44.0%
Sheldahl	319	336	-17	-5.1%
Urbandale	39,463	29,072	10,391	35.7%
West Des Moines	56,609	46,403	10,206	22.0%
Windsor Heights	4,860	4,805	55	1.1%

Source: U.S. Bureau of the Census, Decennial Census; Population Statistics are for entire incorporated areas as reported by the U.S. Census bureau

Along with population growth generally comes an increase in the number of housing units. **Table 3.17** provides the change in numbers of housing units in the planning area from 2000 to 2010.

Table 3.17. Change in Housing Units, 2000-2010

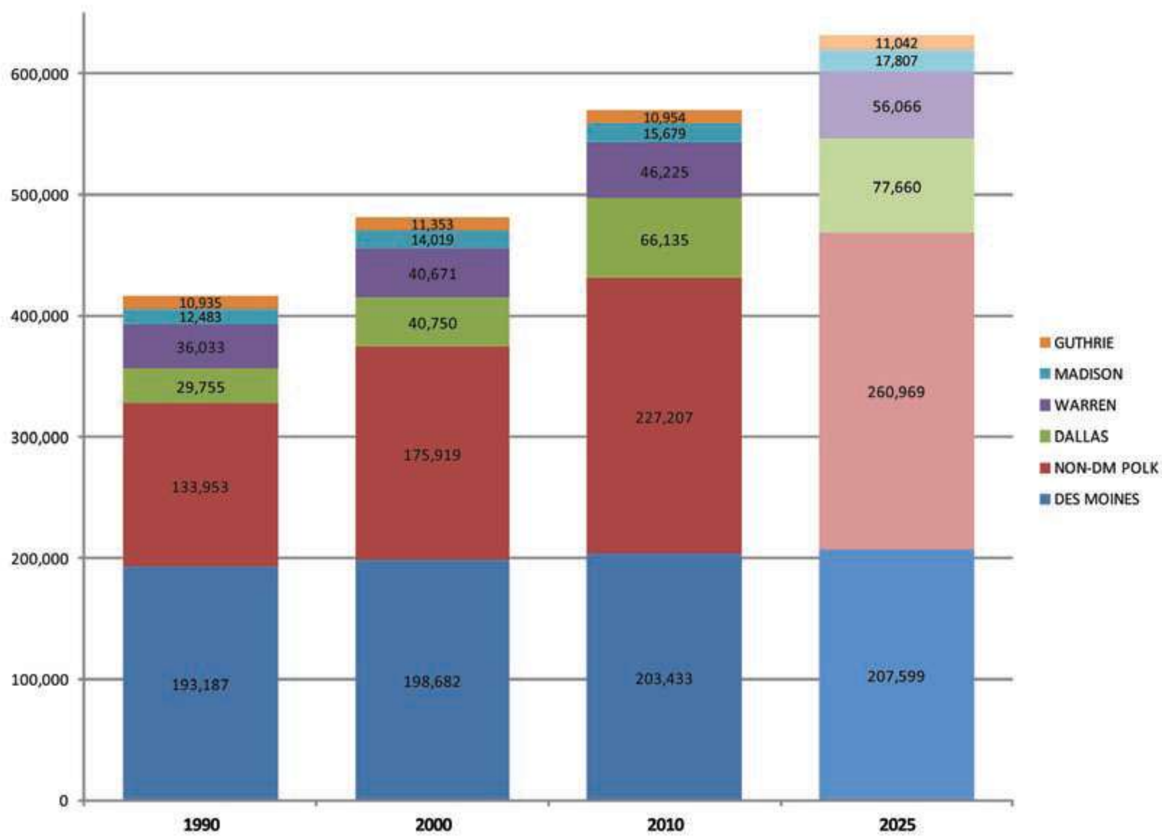
Jurisdiction	Housing Units 2010	Housing Units 2000	2000-2010 # Change	2000-2010 % change
Polk County	182,262	156,447	25,815	16.5%
Alleman	152	142	10	7.0%
Altoona	5,702	3,959	1,743	44.0%
Ankeny	18,339	10,882	7,457	68.5%
Bondurant	1,422	682	740	108.5%
Carlisle	1,524	1,379	145	10.5%
Clive	6,077	4,902	1,175	24.0%
Des Moines	89,052	85,067	3,985	4.7%
Elkhart	269	163	106	65.0%
Granger	490	265	225	84.9%
Grimes	3,272	1,958	1,314	67.1%
Johnston	6,618	3,406	3,212	94.3%
Mitchellville	693	675	18	2.7%
Norwalk	3,449	2,382	1,067	44.8%
Pleasant Hill	3,587	1,966	1,621	82.5%
Polk City	1,276	842	434	51.5%
Runnells	187	149	38	25.5%
Sheldahl	132	132	0	0.0%
Urbandale	16,319	11,869	4,450	37.5%
West Des Moines	26,219	20,815	5,404	26.0%
Windsor Heights	2,289	2,222	67	3.0%

Source: U.S. Bureau of the Census, Decennial Census; Population Statistics are for entire incorporated areas as reported by the U.S. Census Bureau

The following sections provide details regarding future growth, land use and development. The information in this section comes from information provided by each of the participating jurisdictions as well as other sources, cited throughout. Where available, maps are provided to facilitate consideration of hazard areas in future development plans as well as potential growth area.

Polk County is the largest county in the State, with a population over 400,000. Polk County, as a whole, is growing and changing. By population, it is the largest county in Iowa, and its growth well outpaces that of the state as a whole. Polk County is the core of the Des Moines-West Des Moines metropolitan area, which also includes Dallas, Warren, Madison, and Guthrie counties. **Figure 3.2** provides a chart comparing the population of Polk County (Des Moines and Non-Des Moines) and the surrounding counties that are included in the Des Moines-West Des Moines metropolitan area.

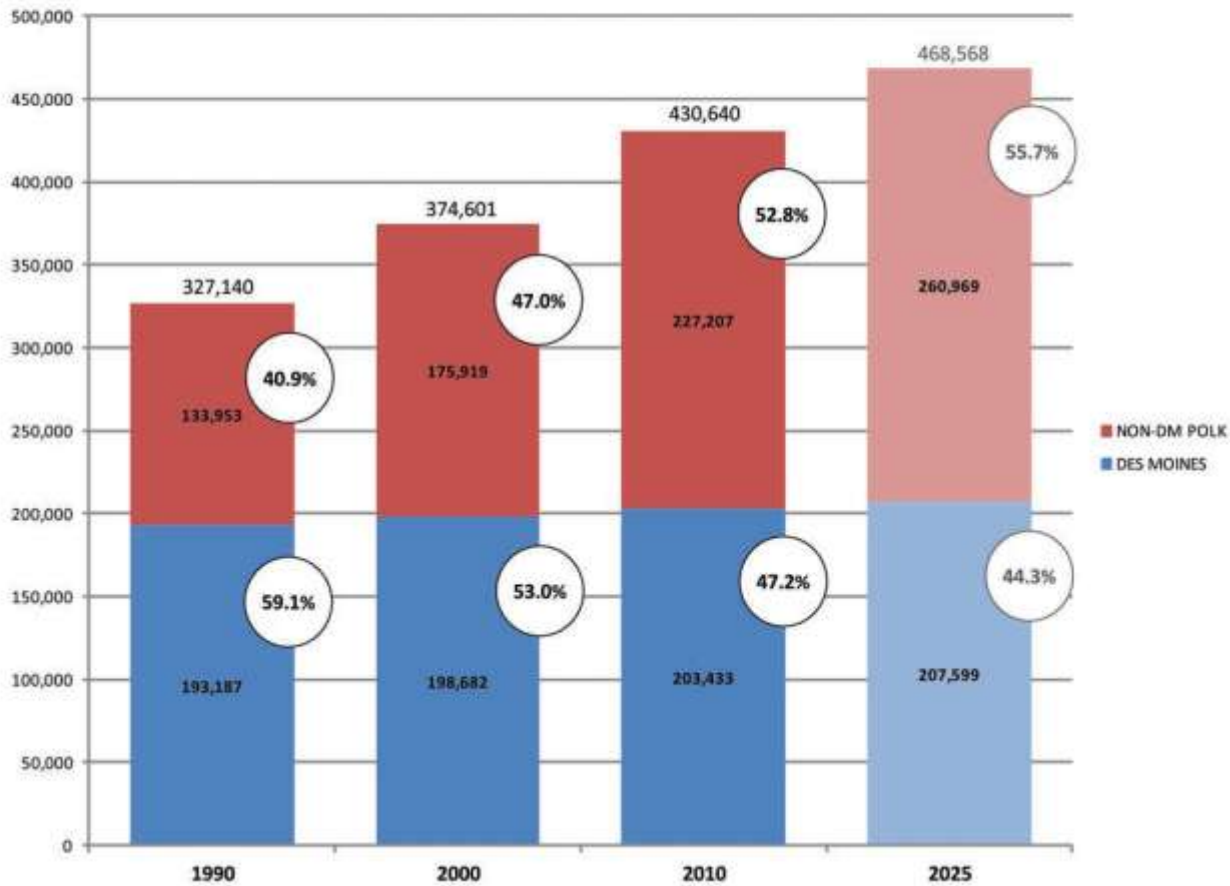
Figure 3.2. Population Comparison, Polk County and other Metro Area Counties



Source: Polk County Health Chartbook, 2013, http://cms.polkcountyiowa.gov/Health/PDFs/2013/PolkCountyChartbook2013.pdf

Over the last two decades, Iowa's population has grown by 9.7 percent, while the Des Moines metropolitan population grew 36.8 percent. By comparison, the U.S. grew 24.1 percent. Continued growth in the metropolitan area is projected through 2025. The City of Des Moines remains the economic center of the metropolitan area. But, the majority of Polk County residents now live outside Des Moines proper. Suburban Polk County continues to experience much higher rates of growth. **Figure 3.3** provides statistics comparing the population growth of Des Moines with the non-Des Moines portion of Polk County.

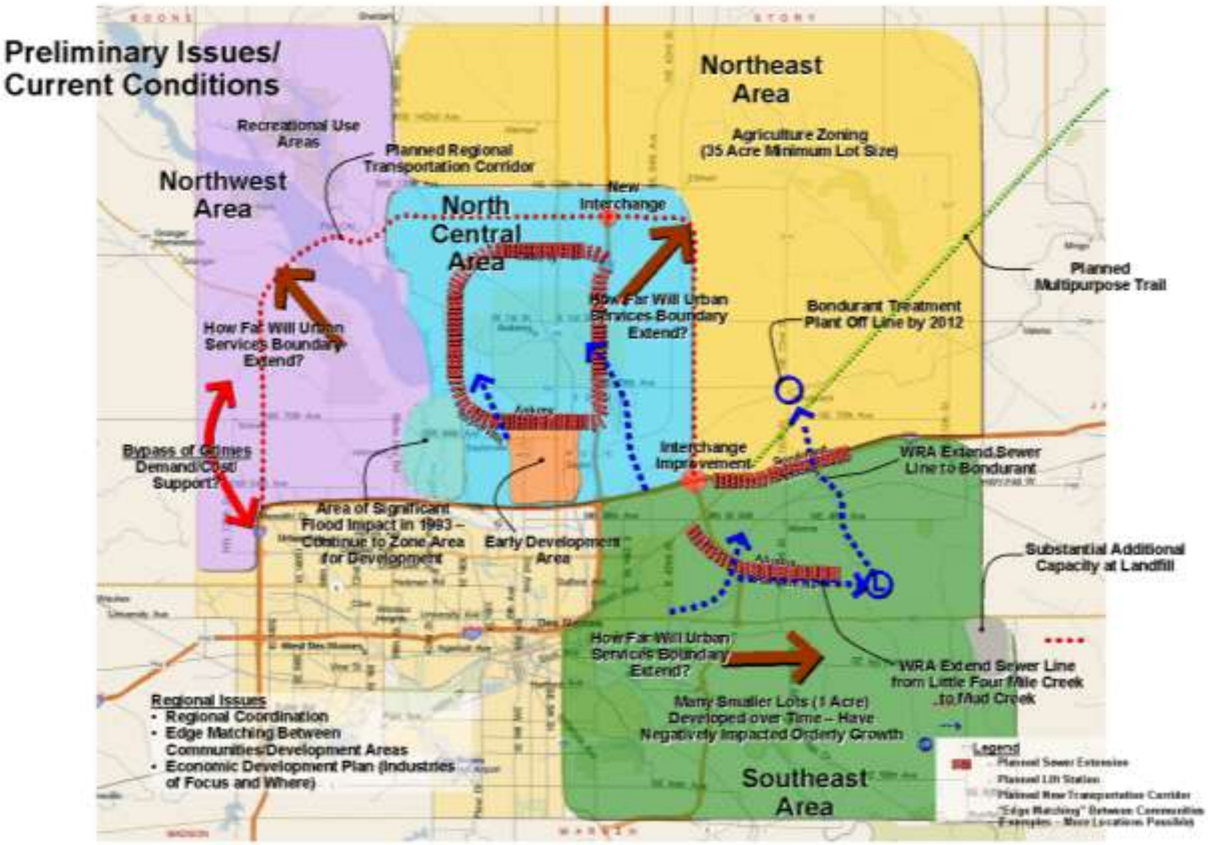
Figure 3.3. Total Population in City of Des Moines and Balance of Polk County, 1990-2025



Source: Polk County Health Chartbook, 2013, http://cms.polkcountyiowa.gov/Health/PDFs/2013/PolkCountyChartbook2013.pdf

While growth and projected growth are indicators of the vitality of the area, this growth can bring challenges for planners and community officials. **Figure 3.4** provides a map of the County with annotated preliminary issues/current conditions identified in the Polk County Comprehensive Plan.

Figure 3.4. Issues/Conditions Identified in the Polk County Comprehensive Plan



Source: Polk County Comprehensive Plan, 2006, http://www.polkcountyiowa.gov/publicworks/polk-county-comprehensive-plan-maps/

The Tomorrow Plan, coordinated by the Metropolitan Planning Organization, is a coordinated planning effort that looks forward to 2050 for Greater Des Moines. This plan focuses on the economy, environment, community vitality, and regional cooperation. The July 2013 draft of this plan is available at http://www.thetomorrowplan.com/ttp-final-draft-report/.

The remaining discussion in this section provides future growth and development information, where available, relative to each participating jurisdiction.

Alleman

No reported growth/development areas.

Altoona

Two other planning efforts important to development in Altoona were underway concurrent with the update of this Hazard Mitigation Plan: The Mud Creek Watershed Study and the update to the Altoona Comprehensive Plan. Since these plans were in development stages, the future development considerations included below are from the *2004 Altoona Comprehensive Plan*. For the 5-year update of this Hazard Mitigation Plan, the results of the mentioned studies should be integrated, where applicable.

The 2004 Comprehensive Plan identifies seven residential growth centers as follows: South, Southeast, Northeast, North, Southwest, Central, and Rural East development areas.

South Growth Center: located south of 8th Street between 1st Avenue and 17th Avenue SW and provides about 400 acres for residential development. The South Growth Center also encompasses major civic uses including the Campus, new library, fire station, aquatic center, skatepark, and wastewater treatment facility.

Southeast Growth Center: located south of 8th Street between 1st Avenue and 80th Street and provides approximately 600 acres for new residential development. Past development patterns in this growth area have included commercial growth along the 8th Street corridor and multi-family development east of 7th Avenue.

Northeast Growth Center: located in the northeast quadrant of the city adjacent on the north and east to the Sam Wise Youth Athletic complex and provides up to 160 acres for new residential development. This potential growth area is adjacent to the traditional village of Altoona and connected along 1st Street to the village center. Land between the Youth Complex and 80th Street could be used for residential development. The Iowa Interstate corridor on the north and 80th Street on the east bound this development area.

North Growth Center: located north of Adventureland Drive, bounded by 1st Avenue, Greenway Park, and Interstate 80 and provides up to 150 acres for residential or other development. This site provides opportunities for multi-family or office development along the Interstate 80 corridor.

Southwest Growth Center: includes land south of 8th Street between 17th Avenue and 34th Avenue/US 65 Beltway. It includes the Eagle ridge subdivision, the cottonwood Court plan, and rural residential development in an area currently outside the city limits. This area provides about 160 acres for potential residential development with some areas within this growth area being maintained as agricultural, open space, or rural densities due to difficulties in providing sewer service.

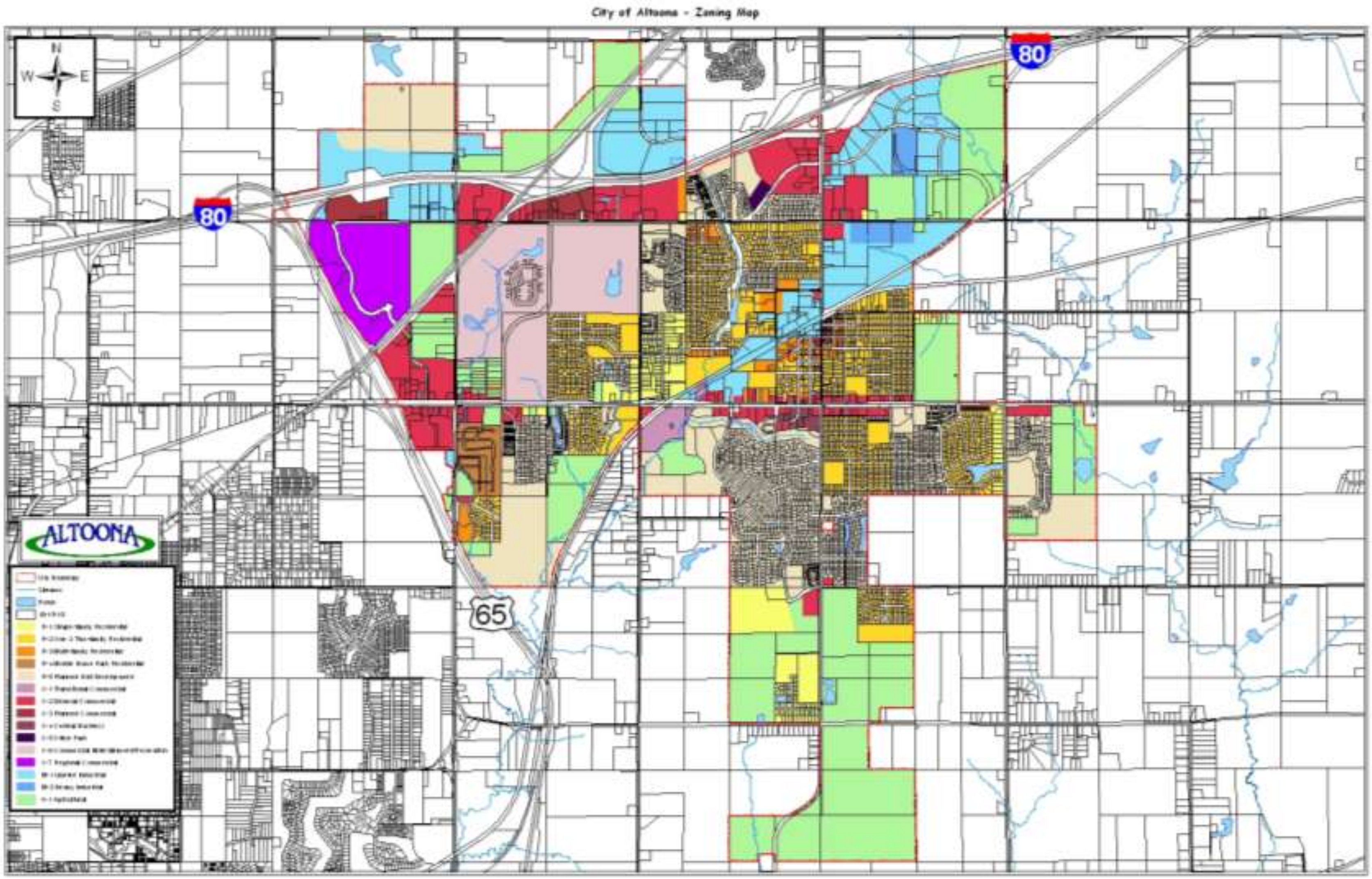
Central Growth Center: includes infill development generally along 17th Avenue SW between the Adventureland Estates and Altoona Estates neighborhoods. There is about 100 acres available for residential development in this growth center.

Rural East Growth Center: generally located east of 80th Street in the Mud Creek Watershed, and incorporates the Terrace Hills Golf Course. Residential land use in this area is limited without a new treatment facility or lift stations.

As these as well as commercial and industrial growth areas are updated in the Comprehensive Plan, identified flood risk areas will be taken into consideration.

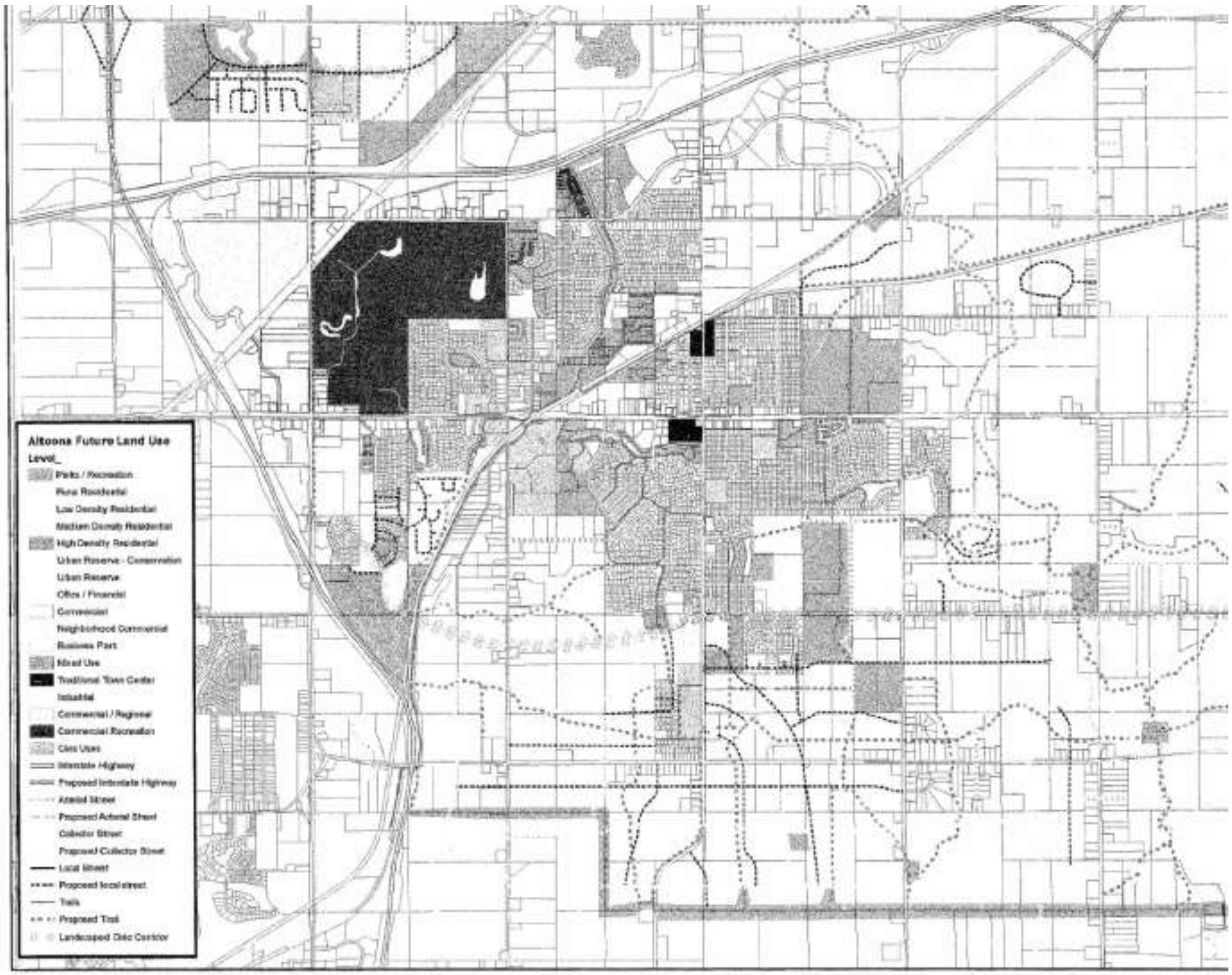
Figure 3.5 provides the Altoona Zoning Map and **Figure 3.6** provides the Altoona Future Land Use Map.

Figure 3.5. Altoona Zoning Map



Source: Altoona City Website, http://www.altoona-iowa.com/download/maps/Zoning%20Map.jpg, accessed 1-17-2014

Figure 3.6. City of Altoona Future Land Use Map



Source: Provided with Data Collection Guide

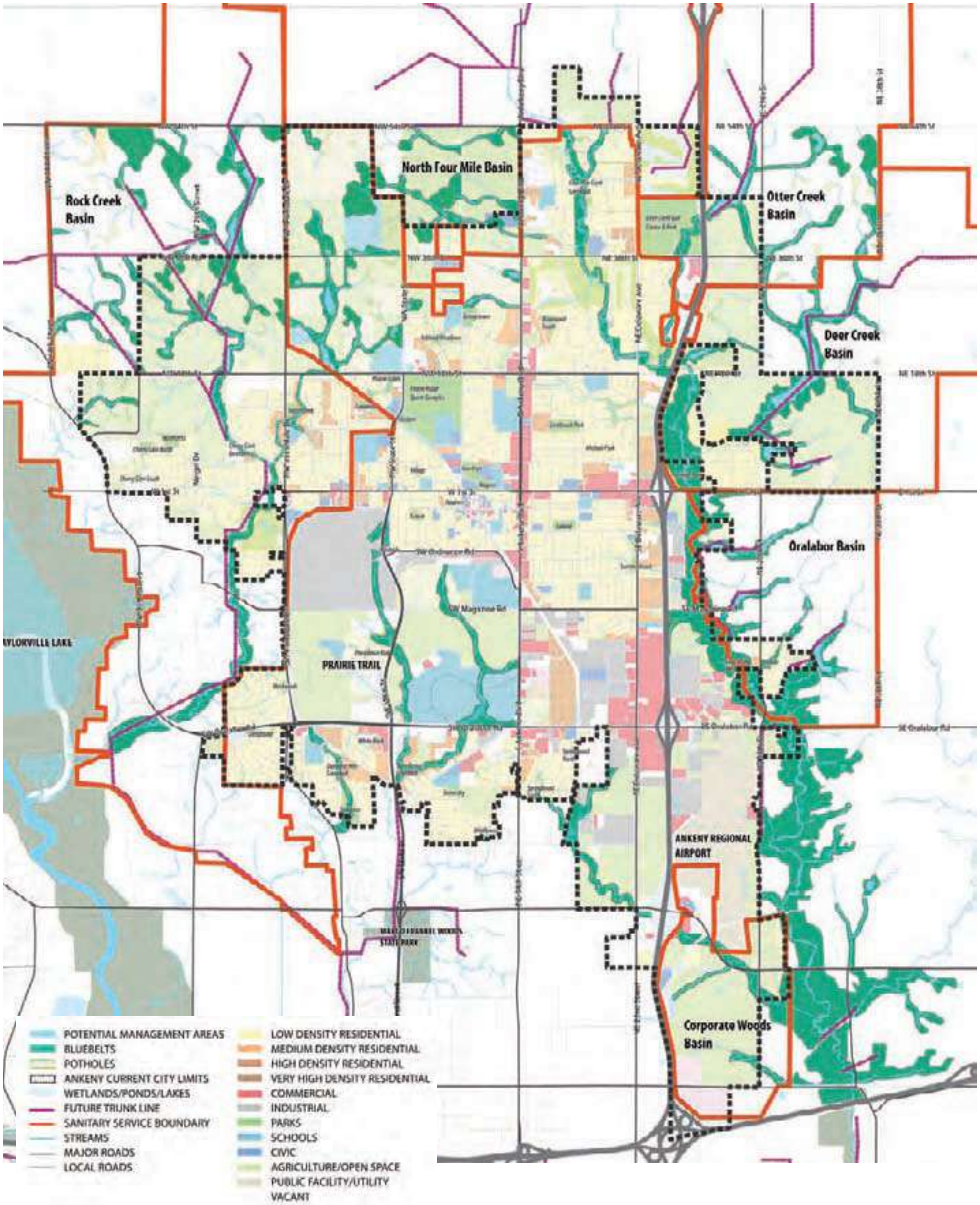
Ankeny

The 2010 Comprehensive Plan for the City of Ankeny considers existing land use characteristics and projects the amount of land needed to accommodate the City's projected 2035 population of 93,000.

It is anticipated that the projected population will generate a need for an additional 23,826 dwelling units. The additional dwelling units were recommended to consist of 65% single family detached, 20% single family attached and 15% multi-family. This creates a demand for approximately 6,254 acres of 9-10 sections of land. In addition, the Comprehensive Plan recommended 830 to 940 additional acres be designated for commercial land and 1200 to 1400 acres of new industrial land.

Chapter 4 of the Ankeny Comprehensive Plan is dedicated to Environmental and Stormwater Considerations. This chapter focuses on key environmental resources and constraints that impact Ankeny growth. The stormwater master plan is the base for development of the Future Land Use Plan, with the stormwater master plan drainage conservation areas, defined as "bluebelts", shown as undeveloped open space (see **Figure 3.7**).

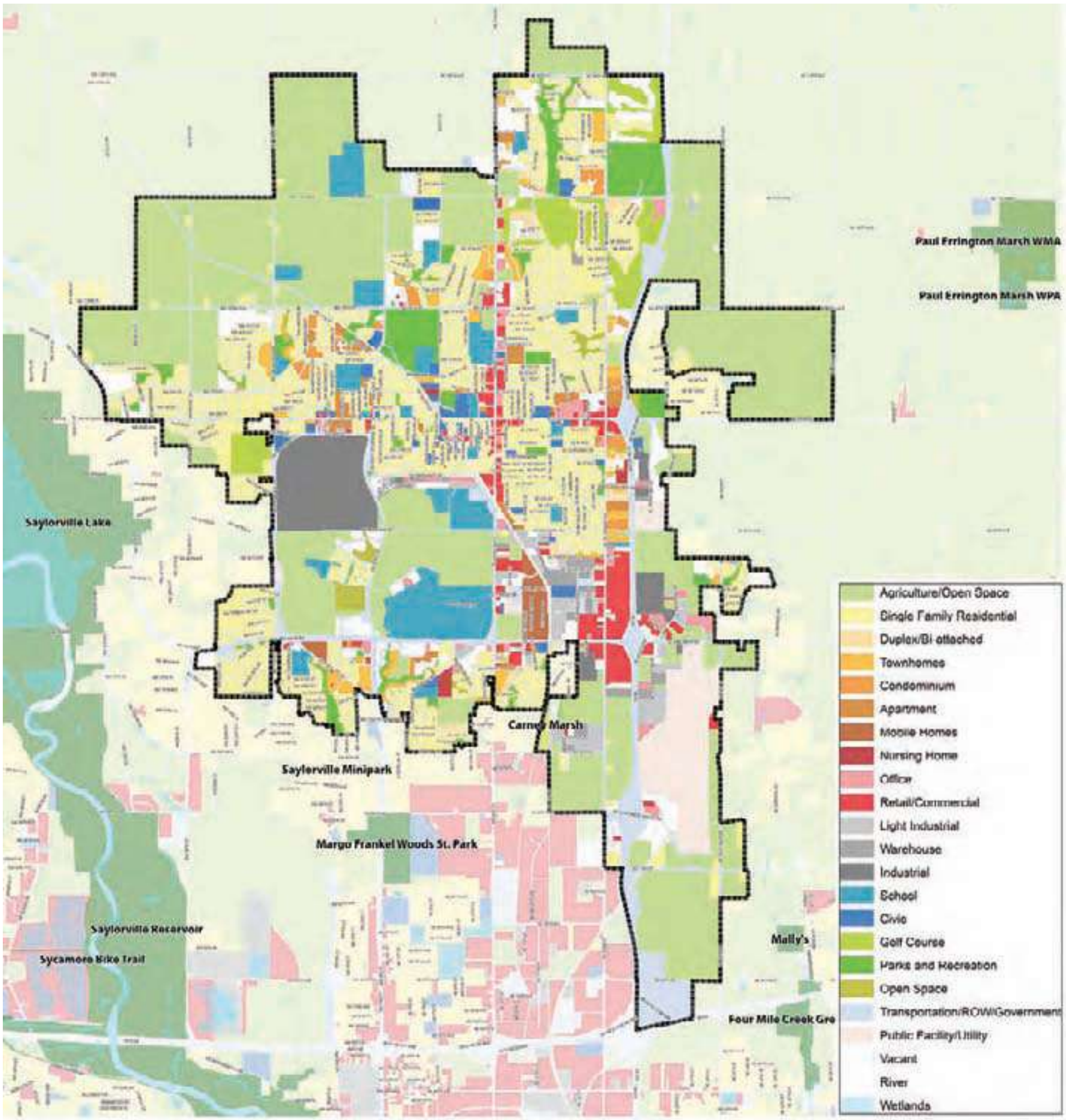
Figure 3.7. Growth Area Blue Belts



Source: 2010 Comprehensive Plan

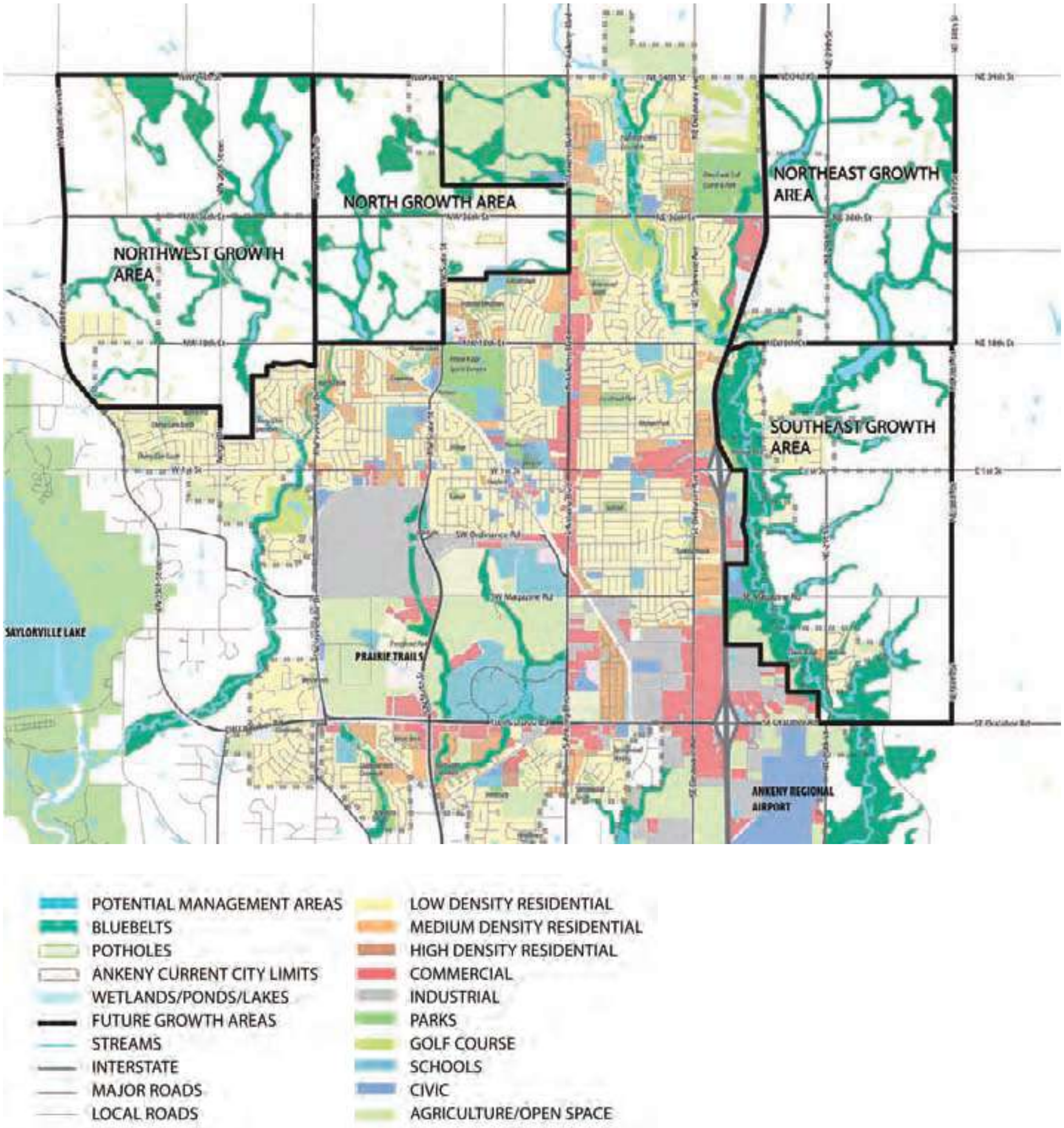
Figure 3.8 provides the 2009 Existing Land Use in Ankeny. **Figure 3.9** provides the Future Growth Areas for the City and **Figure 3.10** that follows provides the generalized development concept.

Figure 3.8. Ankeny Existing Land Use, 2009



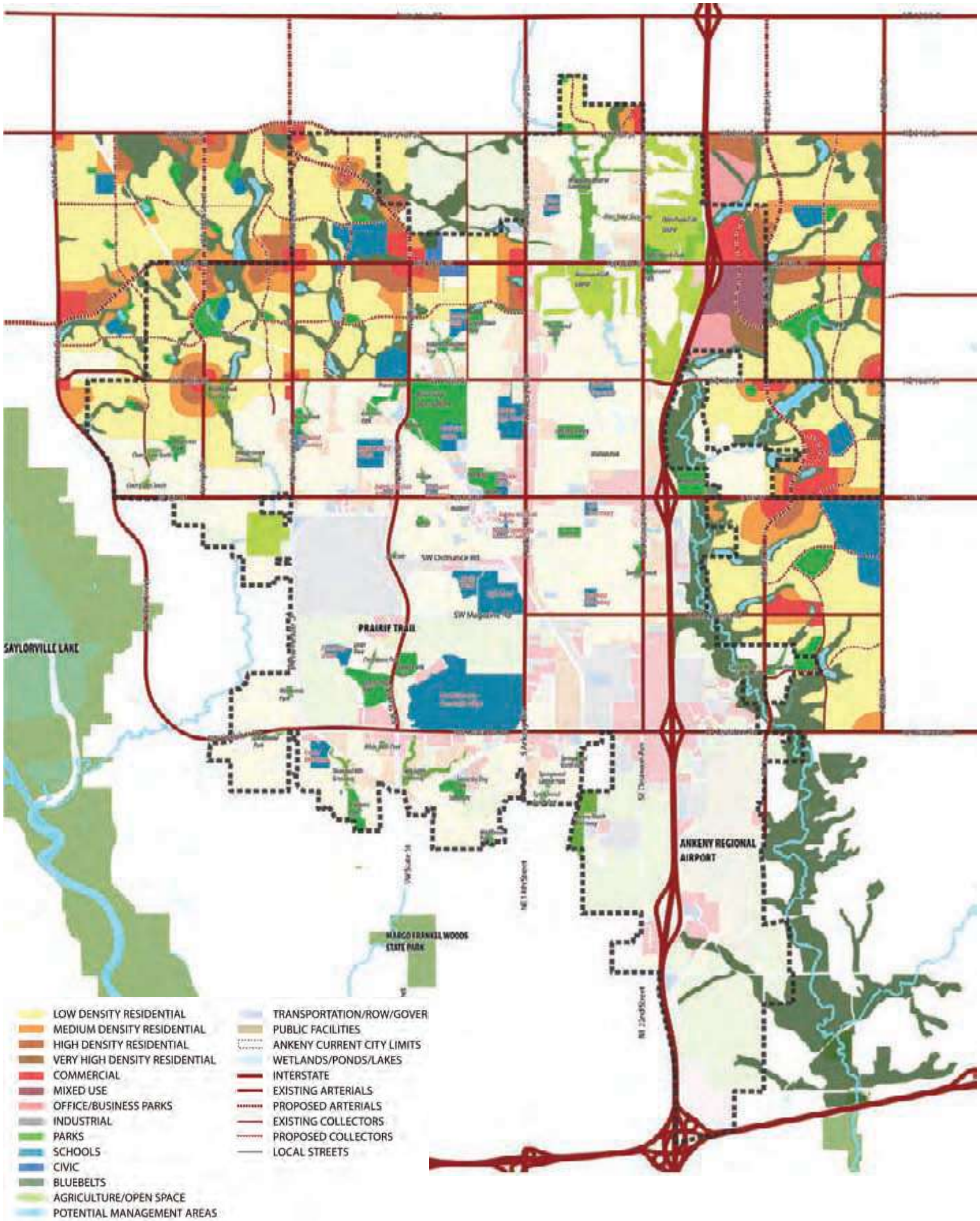
Source: Ankeny 2010 Comprehensive Plan

Figure 3.9. Ankeny Future Growth Areas



Source: Ankeny 2010 Comprehensive Plan

Figure 3.10. Generalized Development Concept



Source: Ankeny 2010 Comprehensive Plan

Bondurant

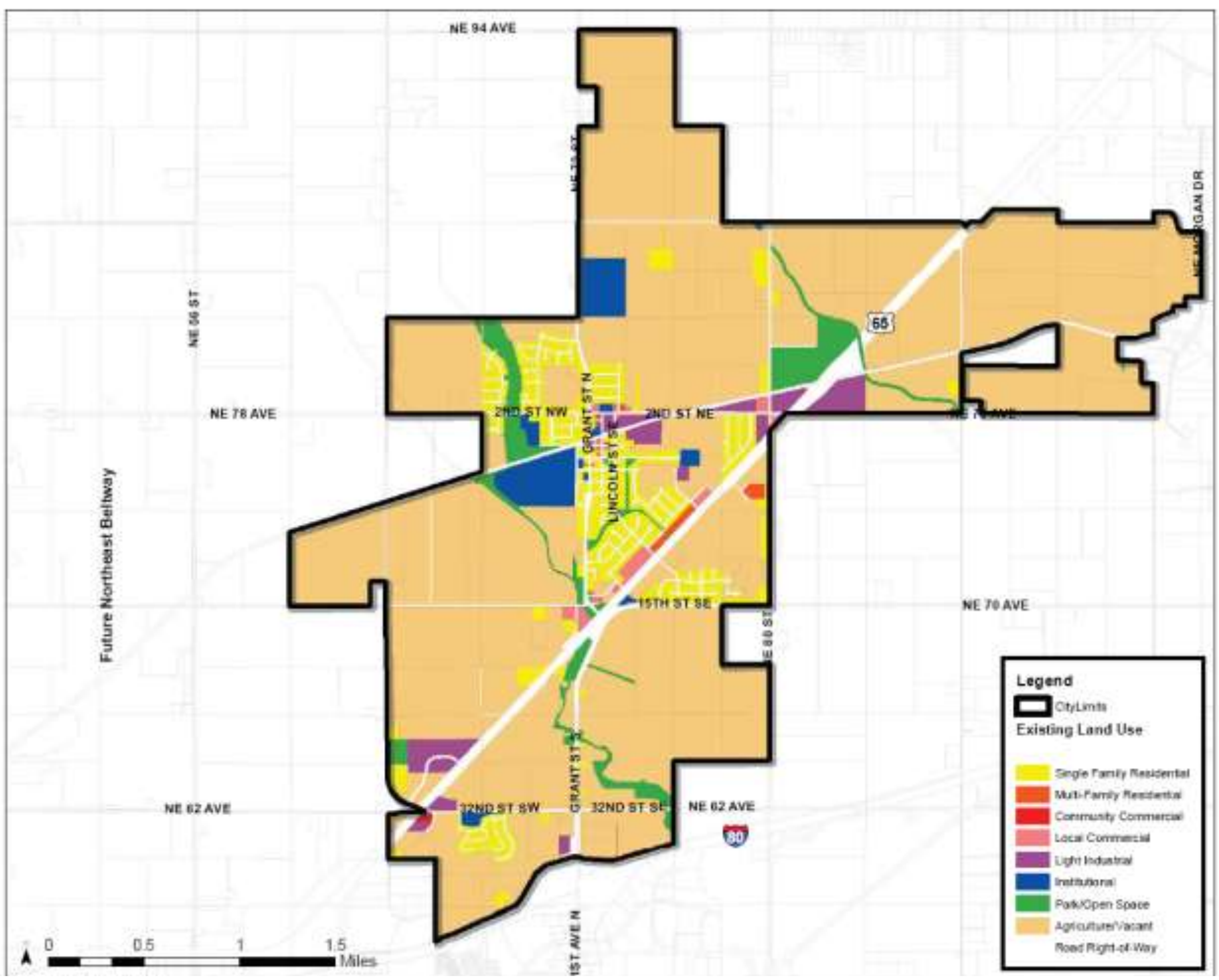
The City anticipates additional residential development in all directions in the coming years. Additional commercial development is also likely, generally along U.S. Highway 65. According to the Data Collection Guide, the new development areas do not contain any particular vulnerabilities

The May 2012 Bondurant Comprehensive Plan includes growth strategies to accommodate growth projections to 2030. It is anticipated that the population of Bondurant in 2030 could be from 7,300 to 10,000 persons.

The City of Bondurant, like Altoona, is included in the Mud Creek Watershed Plan that was under development as this Hazard Mitigation Plan update was completed.

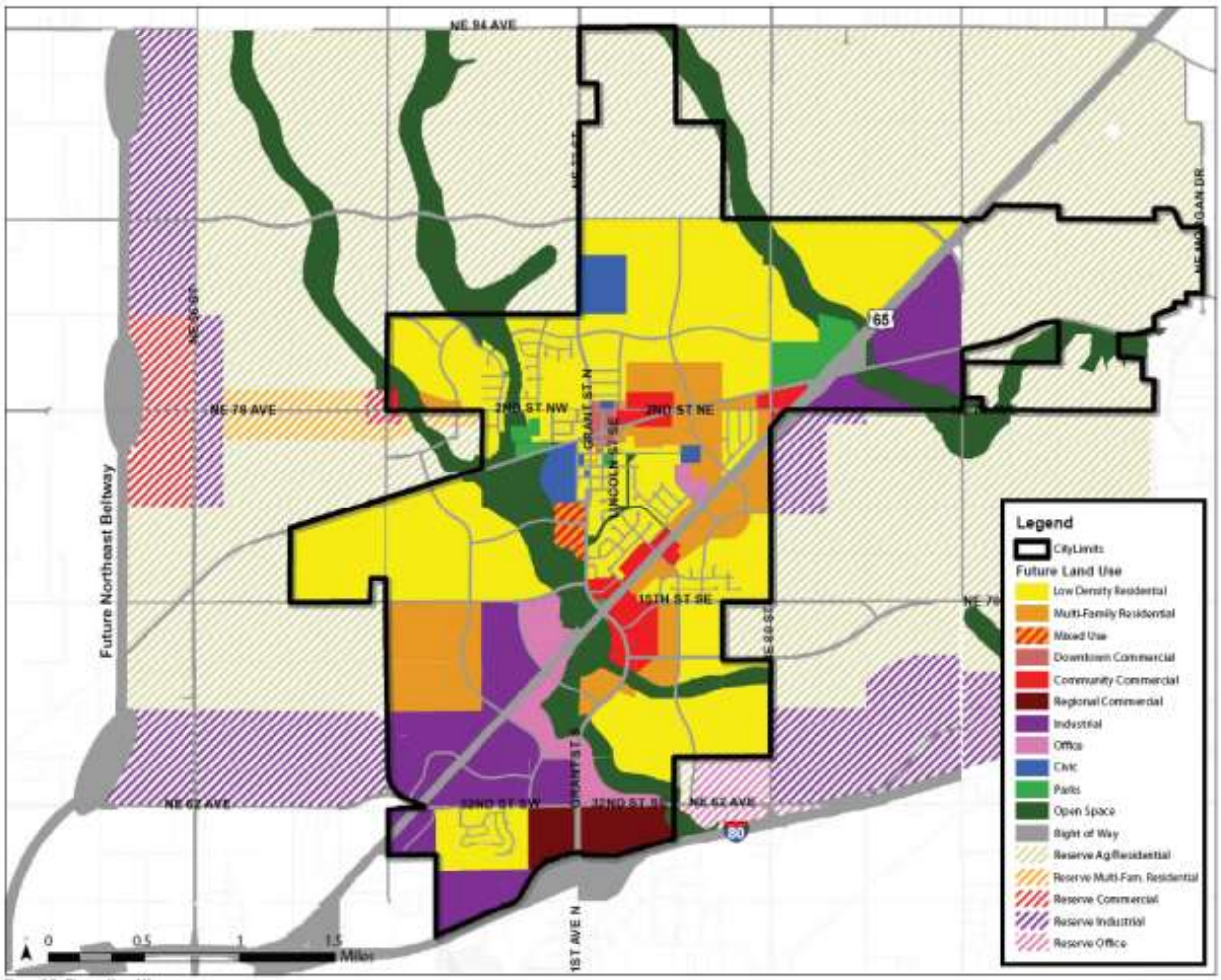
Figure 3.11 provides the existing land use in Bondurant. **Figure 3.12** shows the future land use according to the growth plan outlined in the Comprehensive Plan. **Figure 3.13** demonstrates the Growth Districts were growth is anticipated to occur.

Figure 3.11. Bondurant 2012 Existing Land Use



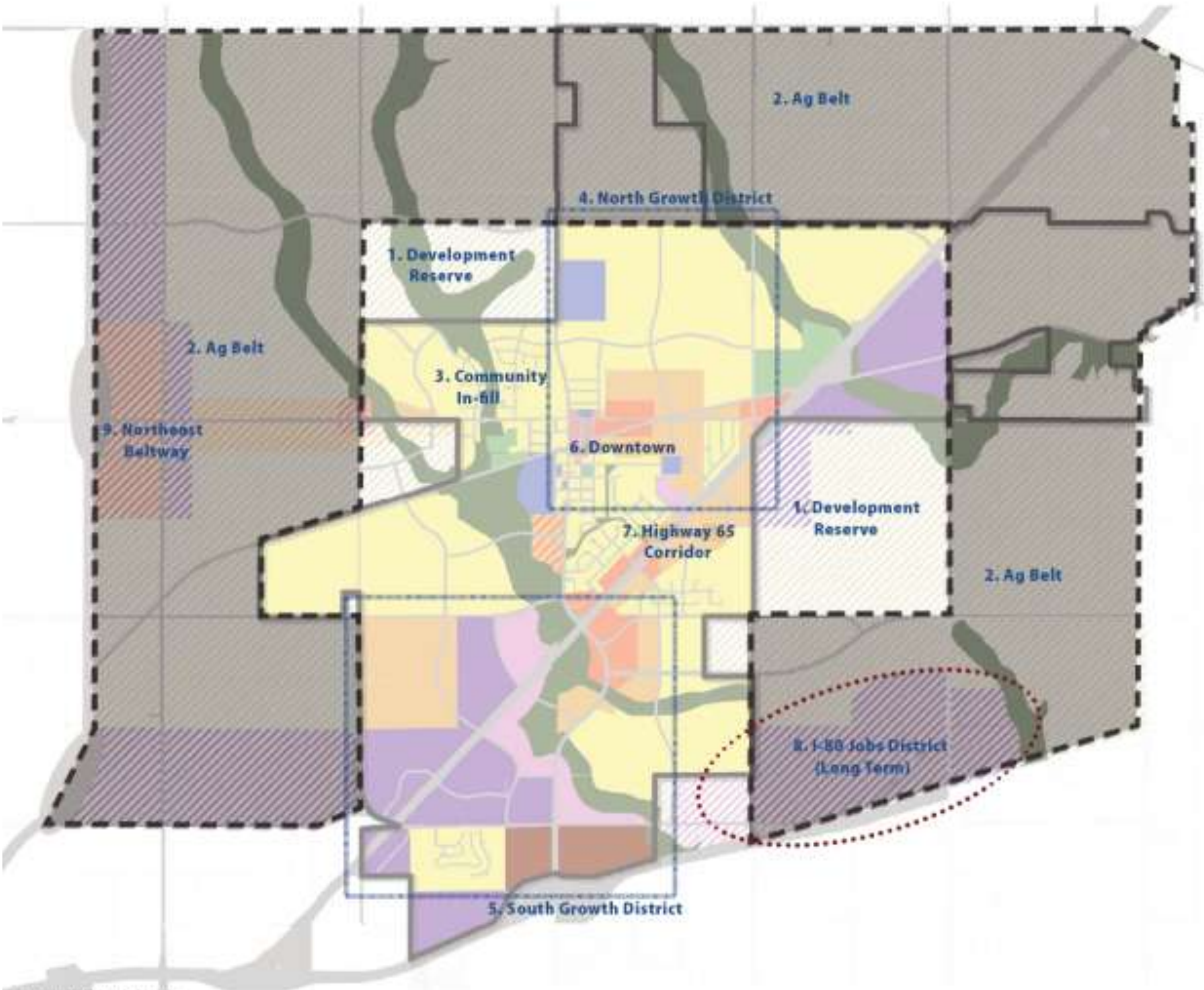
Source: Bondurant 2012 Comprehensive Plan

Figure 3.12. Bondurant Future Land Use



Source: Bondurant 2012 Comprehensive Plan

Figure 3.13. Bondurant Growth Districts

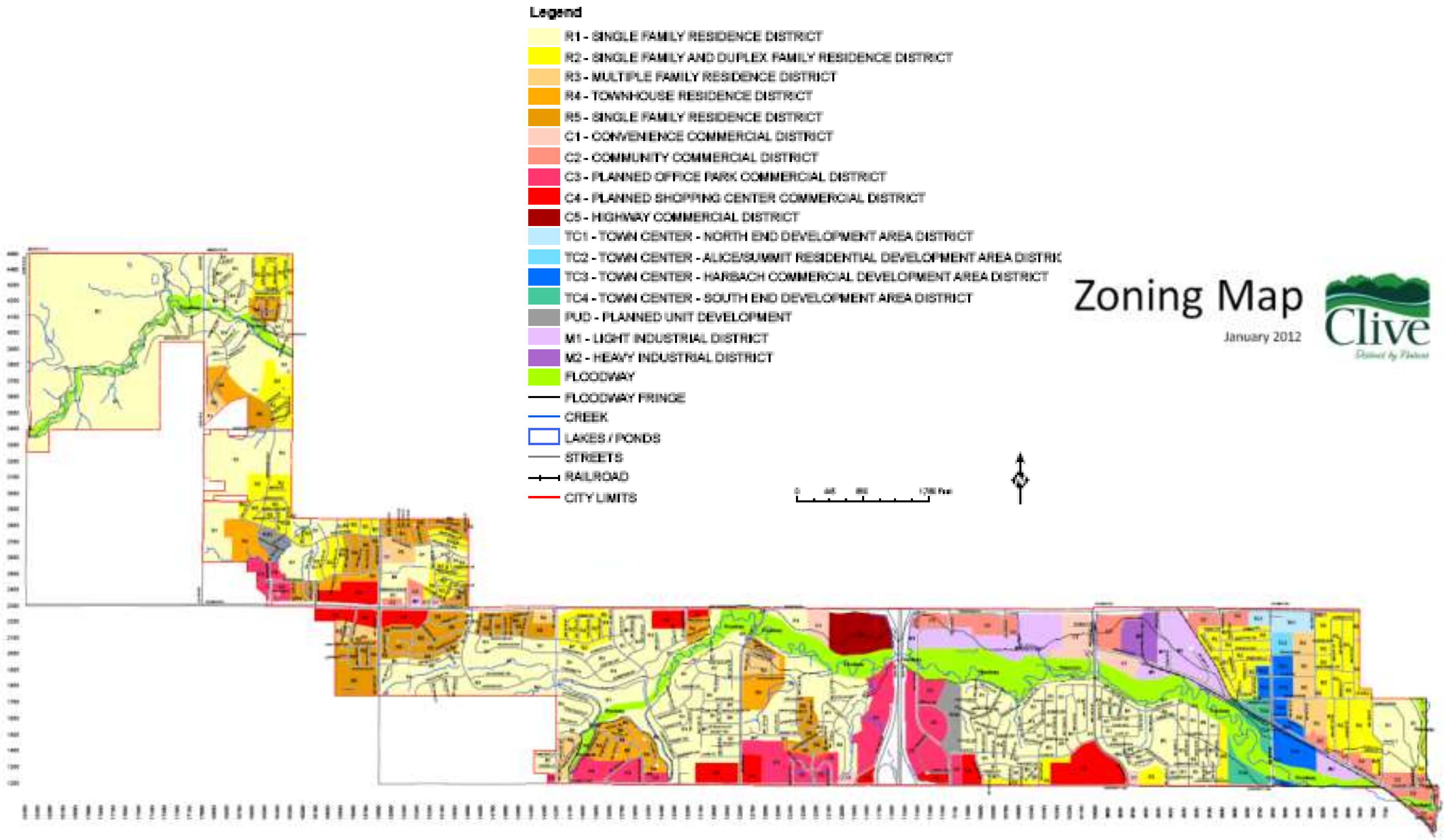


Source: Bondurant 2012 Comprehensive Plan

Clive

The City of Clive is in the process of updating their Comprehensive Plan. The current effective Comprehensive Plan during the update of the Hazard Mitigation plan was the 1998 Clive Comprehensive Plan.

Figure 3.14. City of Clive Zoning Map



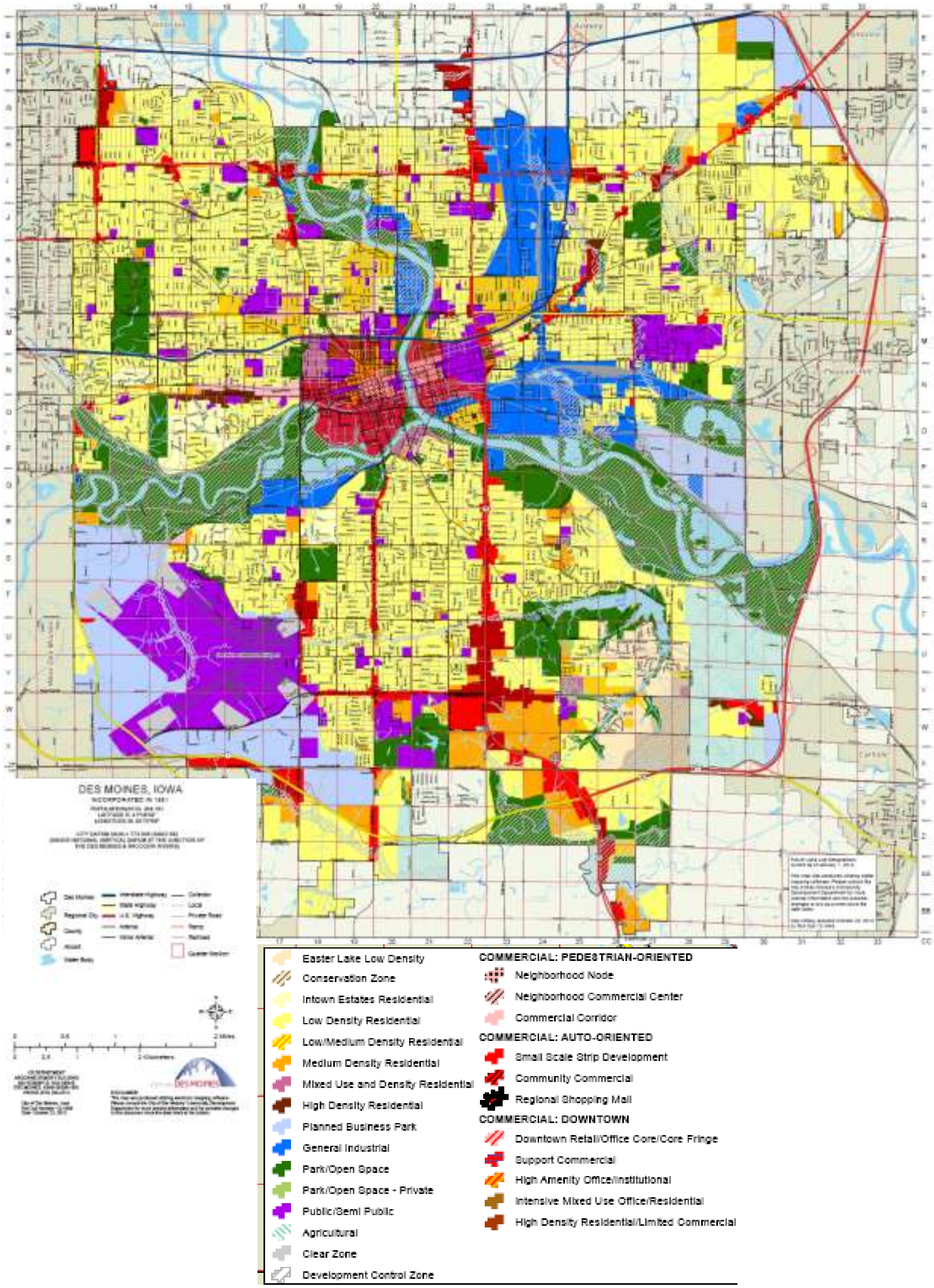
Source: City of Clive, 2013

Des Moines

The City of Des Moines remains the economic center of the metropolitan area. However, the majority of Polk County residents now live outside Des Moines proper. Population and housing units have increased somewhat in the last 10 years within the City of Des Moines. However, suburban Polk County continues to experience much higher rates of growth. Much of the construction within Des Moines is related to re-development and re-vitalization. The City of Des Moines is undergoing study for future growth into Warren County.

As a Class 7 National Flood Insurance Program Community Rating System community, the City of Des Moines maintains a proactive approach in reducing risk to damages from flooding. This also applies to considerations made in planning new development.

Figure 3.15. Des Moines Land Use Map

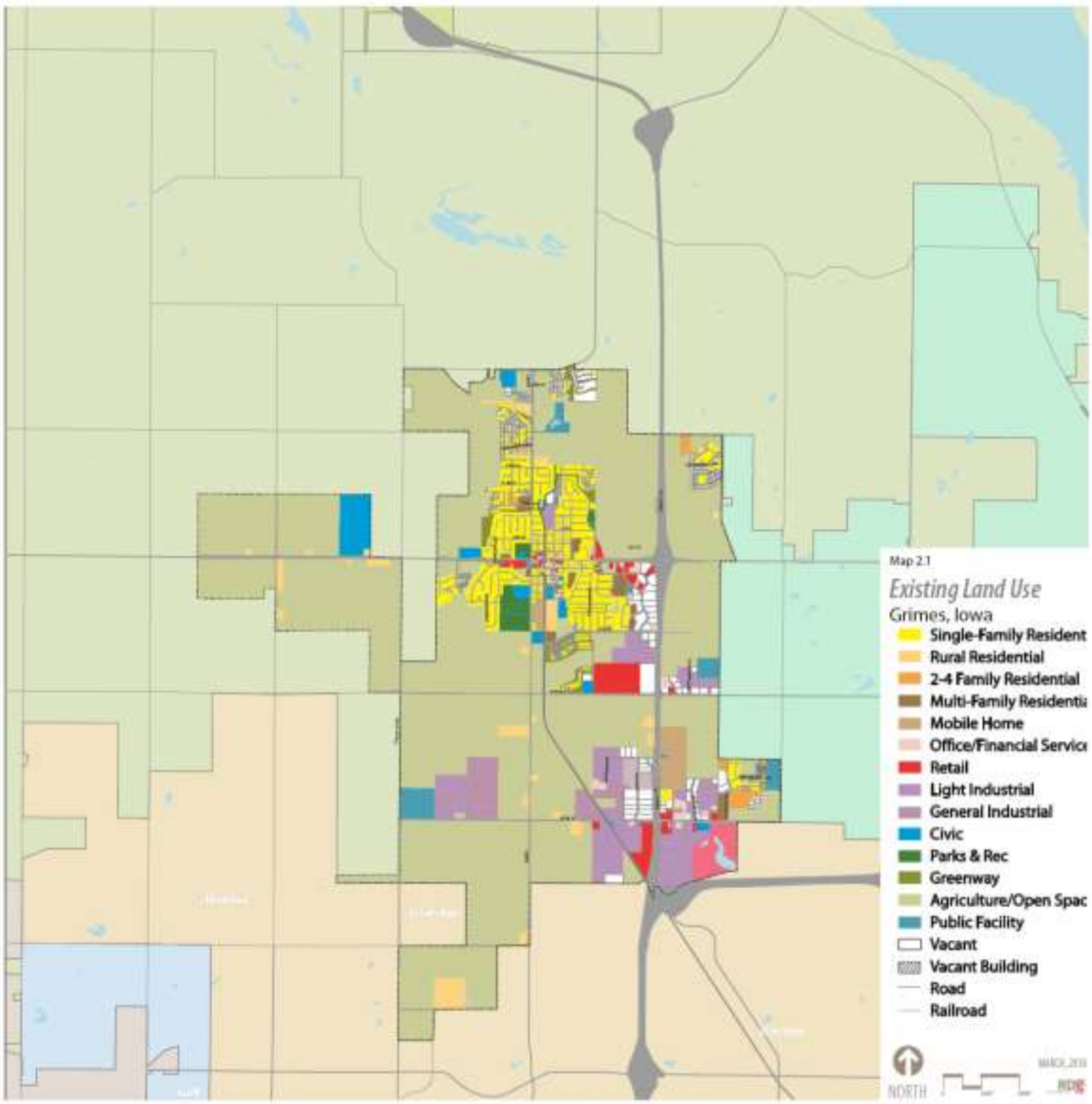


Source: Des Moines 2020 Community Character Plan

Elkhart
The City of Elkhart expects continued growth in East Elkhart Development and in North Elkhart. If proposed beltway is built, growth will occur in South Elkhart. The City is looking into building a new fire station, expanding ball fields and developing a new park in the east side of Elkhart.

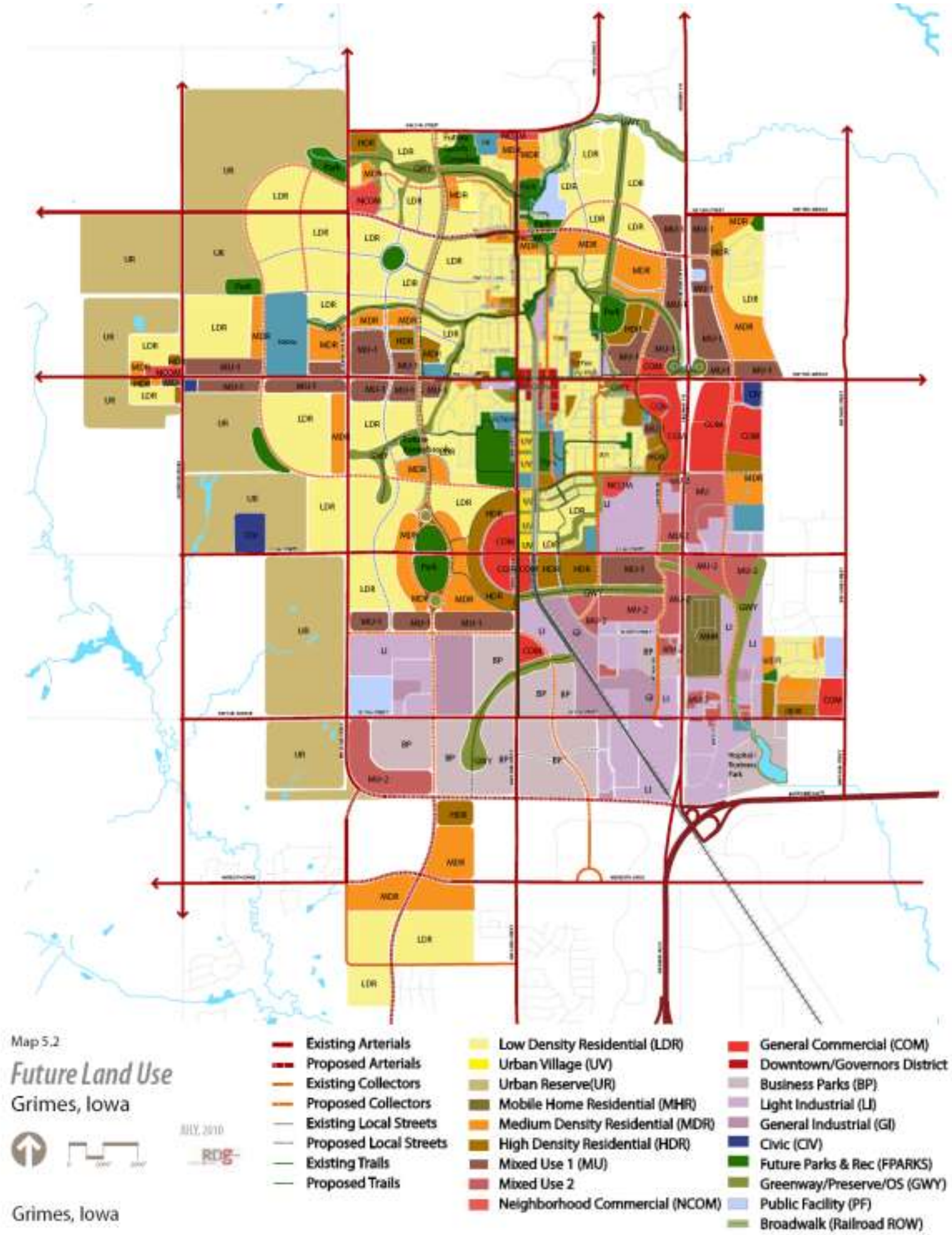
Grimes
Grimes has experienced substantial growth in both the residential and commercial areas. Per the Grimes Comprehensive plan, this trend is expected to continue into the foreseeable future. The primary identified potential hazard areas in Grimes pertain to area floodplains. The City has adopted all appropriate flood plain ordinances in accordance with National Flood insurance program protocol in order to mitigate future flood problems.

Figure 3.16. Grimes 2010 Existing Land Use



Source: 2010 Grimes Comprehensive Plan

Figure 3.17. Grimes Future Land Use



Source: 2010 Grimes Comprehensive Plan

Figure 3.18. Grimes Phased Annexation-Proposed

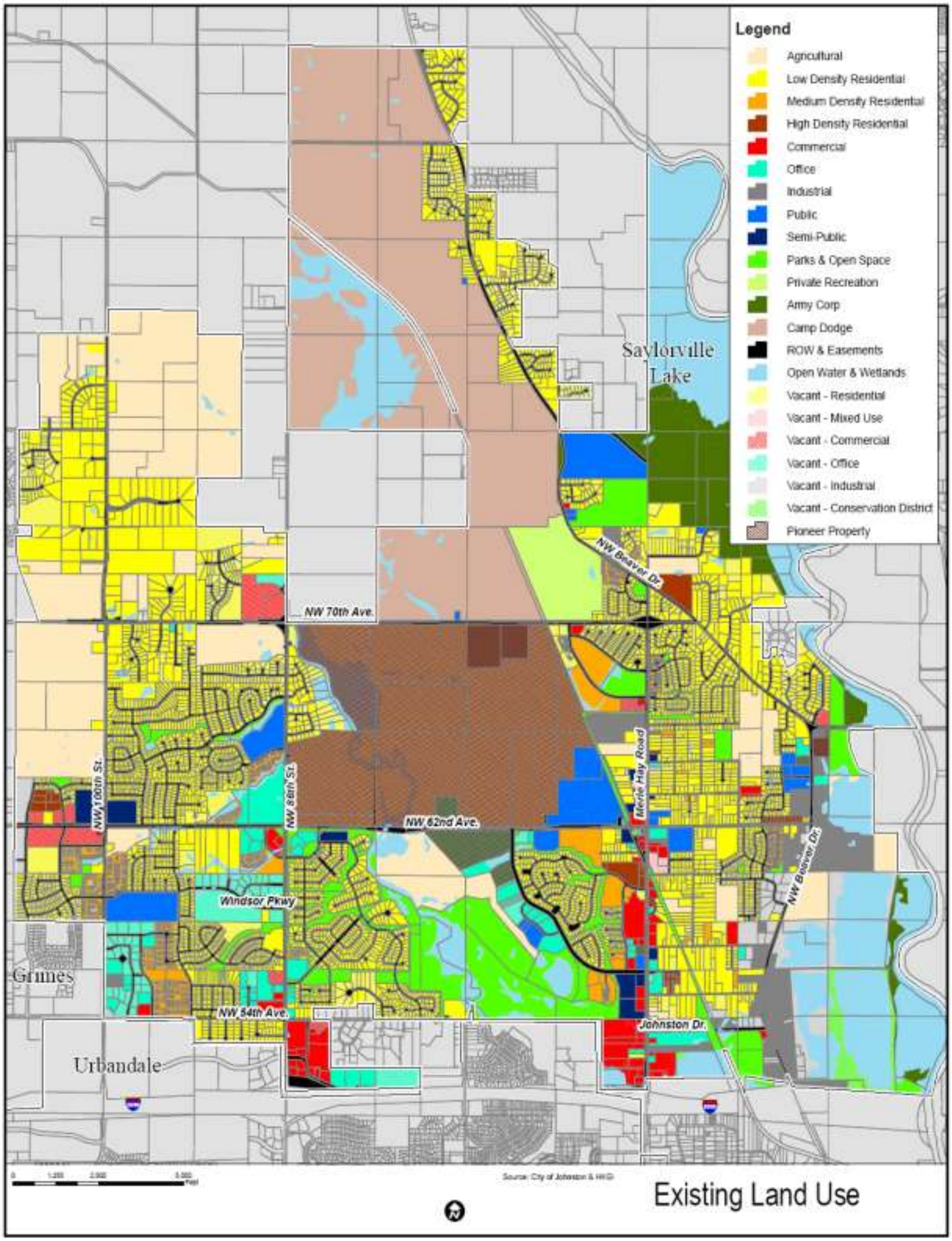
Source: 2010 Grimes Comprehensive Plan

Johnston

Expected growth areas are generally in the northwest part of the community. There is existing floodplain along Beaver Creek and Little Beaver Creek in this area. Our existing floodplain and stream buffer ordinances would protect this floodplain and limit development within it. The future growth areas are identified in Chapter 5 of the Comprehensive Plan. In terms of public facilities, a new second fire station opened in March 2013 and a new Public Safety building (combined Police/Fire) is scheduled to open in January 2014.

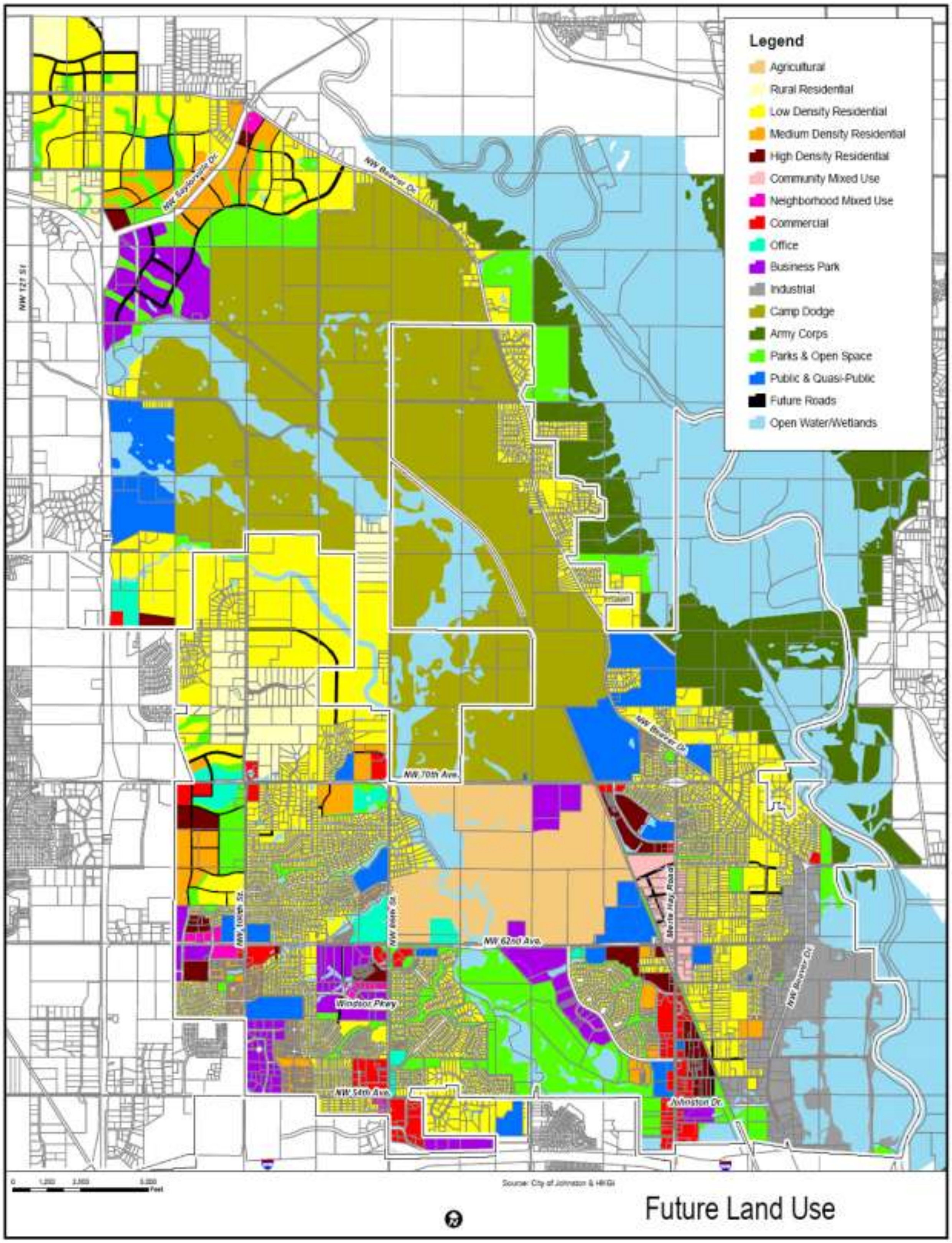
The Existing Land Use is shown in **Figure 3.19**. The Future Land Use Plan that is part of the Johnston 2030 Comprehensive Plan depicts a pattern that is expected to evolve in and around the City of Johnston over the next twenty years (see xx). Future land use designations are the product of both past, present and anticipated future influences. The Future Land Use Plan is intended to serve as a guide for land use decisions and it provides the basis for establishing and modifying zoning district boundaries. Additionally, it is intended to help direct public investments in infrastructure including roads and utility system expansions.

Figure 3.19. Johnston 2010 Existing Land Use



Source: Johnston 2030 Comprehensive Plan

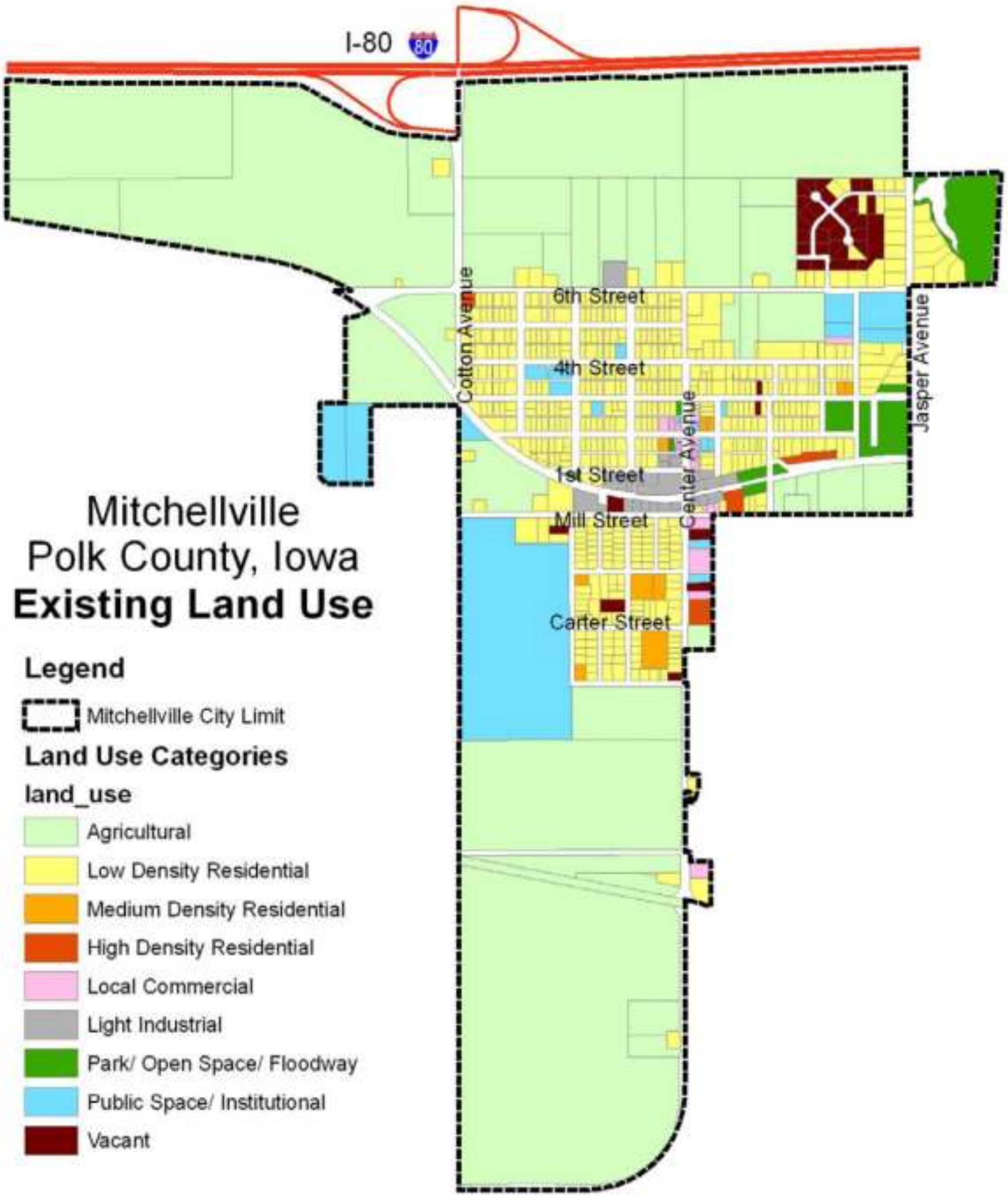
Figure 3.20. Johnston Future Land Use



Mitchellville
The following is excerpted from the 2006 Mitchellville Comprehensive Plan.

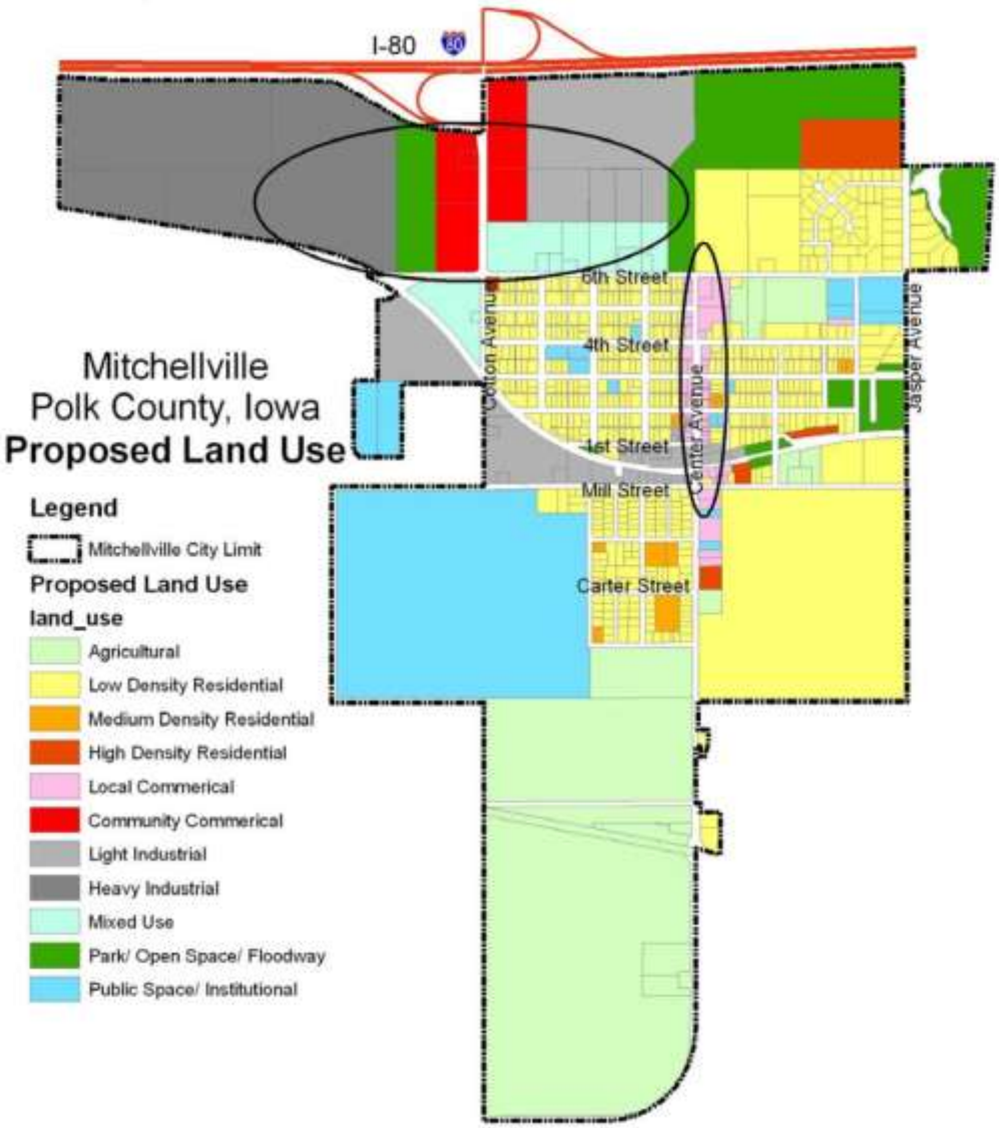
> The proposed land use map provides Mitchellville with future land uses that will allow the city to be competitive with the surrounding markets and meet the basic needs of the community according to the population projection.
>
> New land should be allocated to the Iowa Correctional Institute for Women in order to allow the city to acquire land that is currently owned by the facility, with the intention of expanding Oak Avenue further south. This will strengthen Mitchellville's infrastructure network and will give the city more control of the development imposed by the Iowa Correctional Institute for Women as it increases its capacity to meet the growing needs of the state. This swap should also provide the city with a necessary connection with the facility to increase the exchange and collaboration between the city and the facility.
>
> The area along the railroad should be zoned and marketed to provide light industrial venues that need interstate and rail access. This increase in light industrial use will increase the city's tax base and provide a much needed increase to the local employer base.
>
> Land along the interstate is best marketed for use as heavy industrial and community commercial because it is an area where high exposure to an interstate network is a high demand for large employers including manufacturing companies, hotels, motels, and distributing companies. The direct access to the railroad is another positive feature to cater to businesses that may need or want this already existing commodity.
>
> A mixed-use area should be created in conjunction with and extended central business district to make the highly traveled Center Avenue a unified business corridor linking and expanding upon the existing business corridor. The mixed-use area can provide a necessary buffer between the proposed area for increased light industrial and community commercial use with the existing residential community. The intent of the mixed-use area is to provide multi-family housing above commercial units. A new high-density residential area is proposed to the south of the new park/ open space in the northeast corner of the city. This area can be used to provide a more densely populated residential area as well as provide a space for a potential retirement home or assisted living community. This is based off its location with the established residential community and also its location relative to parks and open space.
>
> The proposed land use should provide current and future residents with a land use layout that improves upon an already solid recreational, residential, commercial, and industrial base.

Figure 3.21. Mitchellville 2006 Existing Land Use



Source: 2006 Mitchellville Comprehensive Plan

Figure 3.22. Mitchellville Proposed Land Use

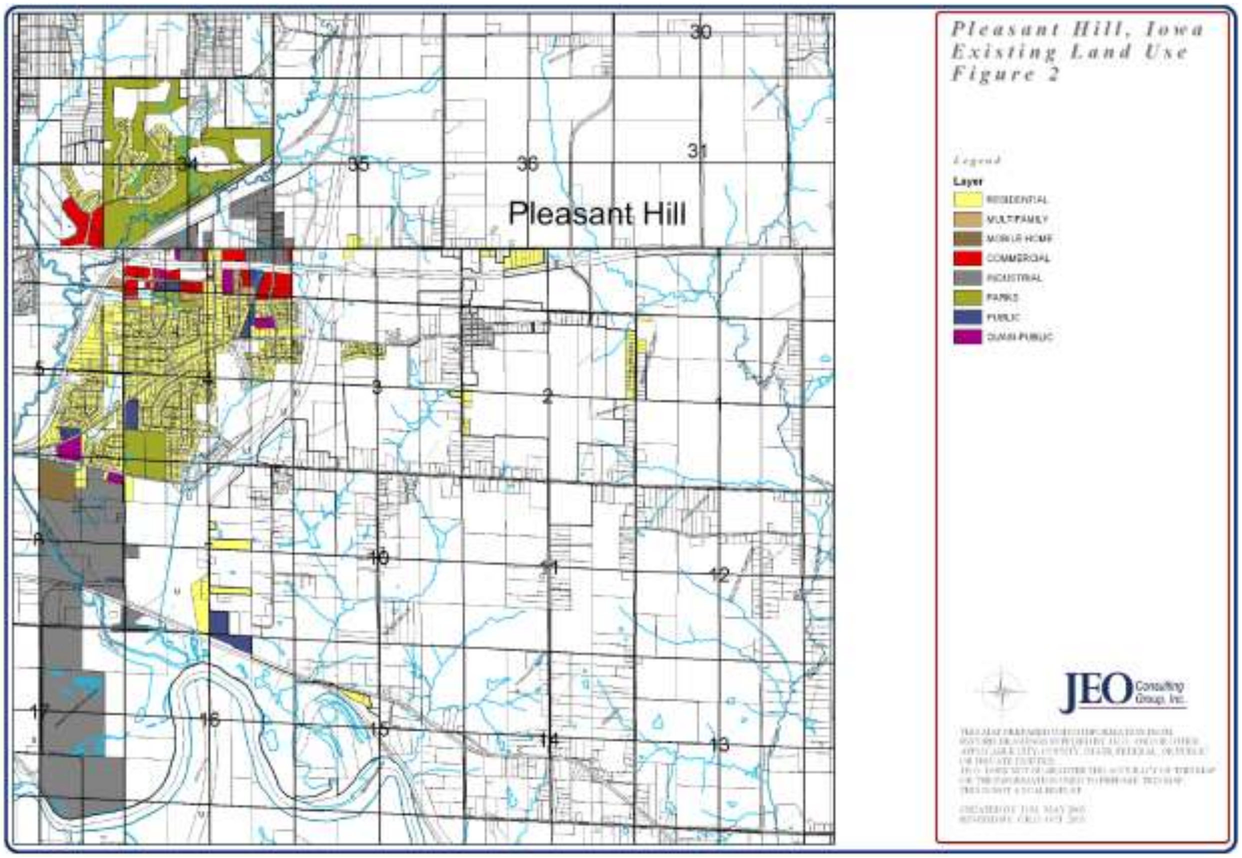


Source: 2006 Mitchellville Comprehensive Plan

Pleasant Hill

The 2005 Comprehensive Plan outlines the plan and strategies for future development of the City of Pleasant Hill. **Figure 3.23** provides the existing land use map.

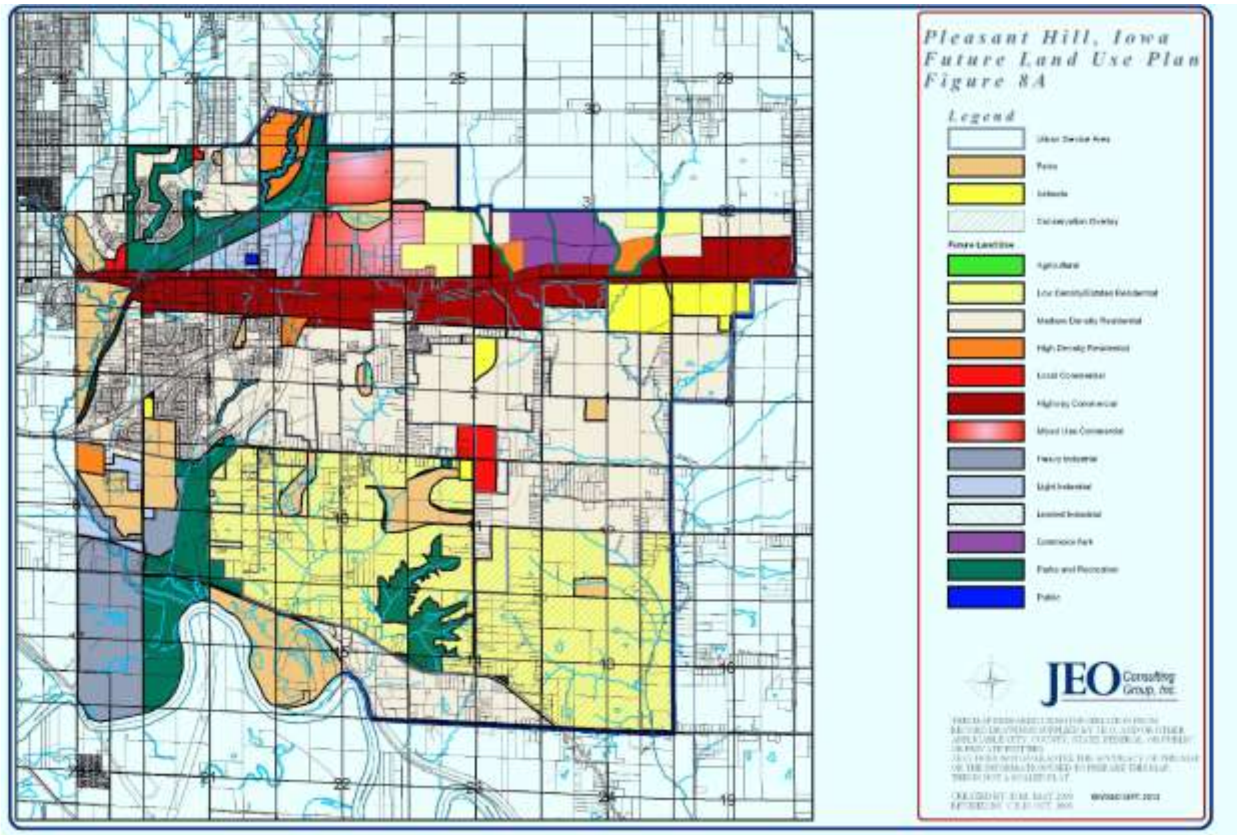
Figure 3.23. Pleasant Hill 2005 Existing Land Use Map



Source: 2005 Pleasant Hill Comprehensive Plan

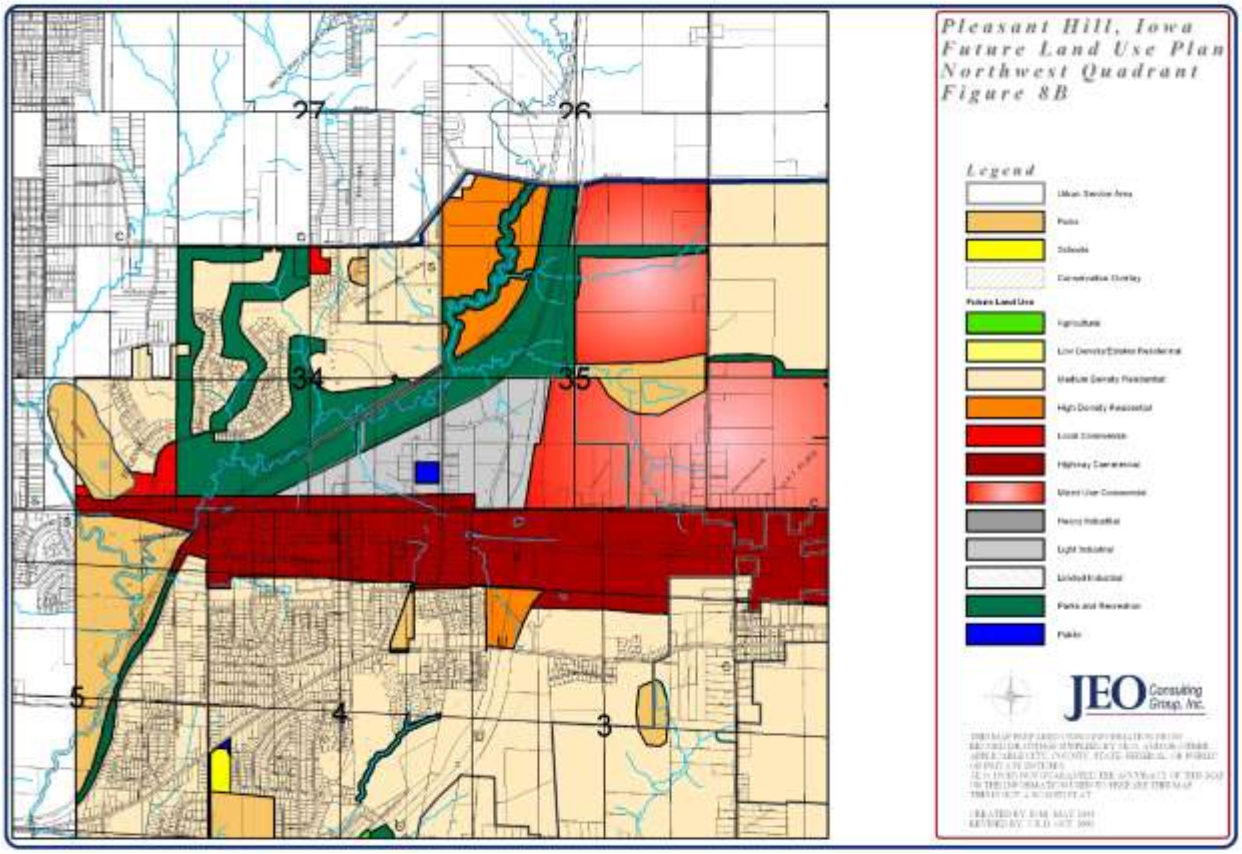
The future land use plan is laid out in the series of maps from **Figure 3.24** to **Figure 3.28**.

Figure 3.24. Pleasant Hill Future Land Use Map-A



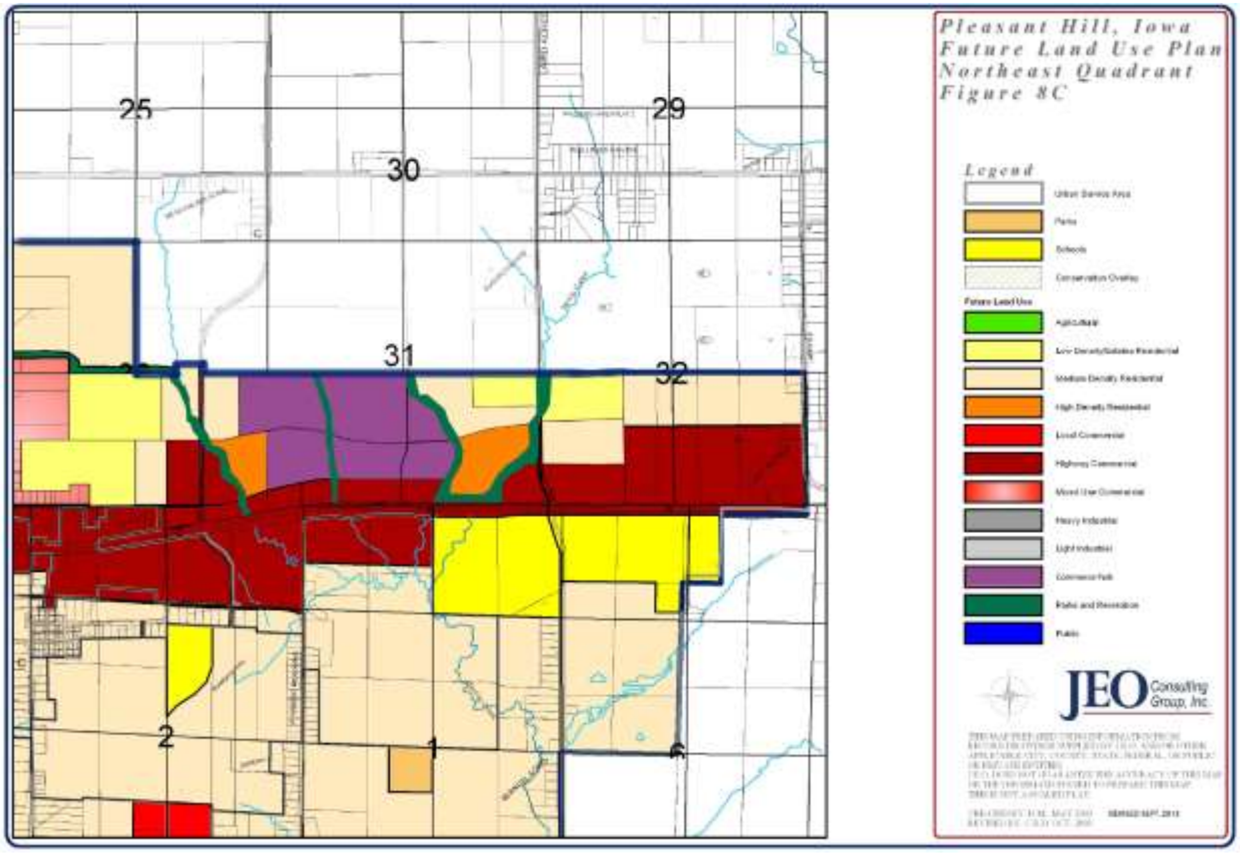
Source: 2005 Pleasant Hill Comprehensive Plan

Figure 3.25. Pleasant Hill Future Land Use Map-B



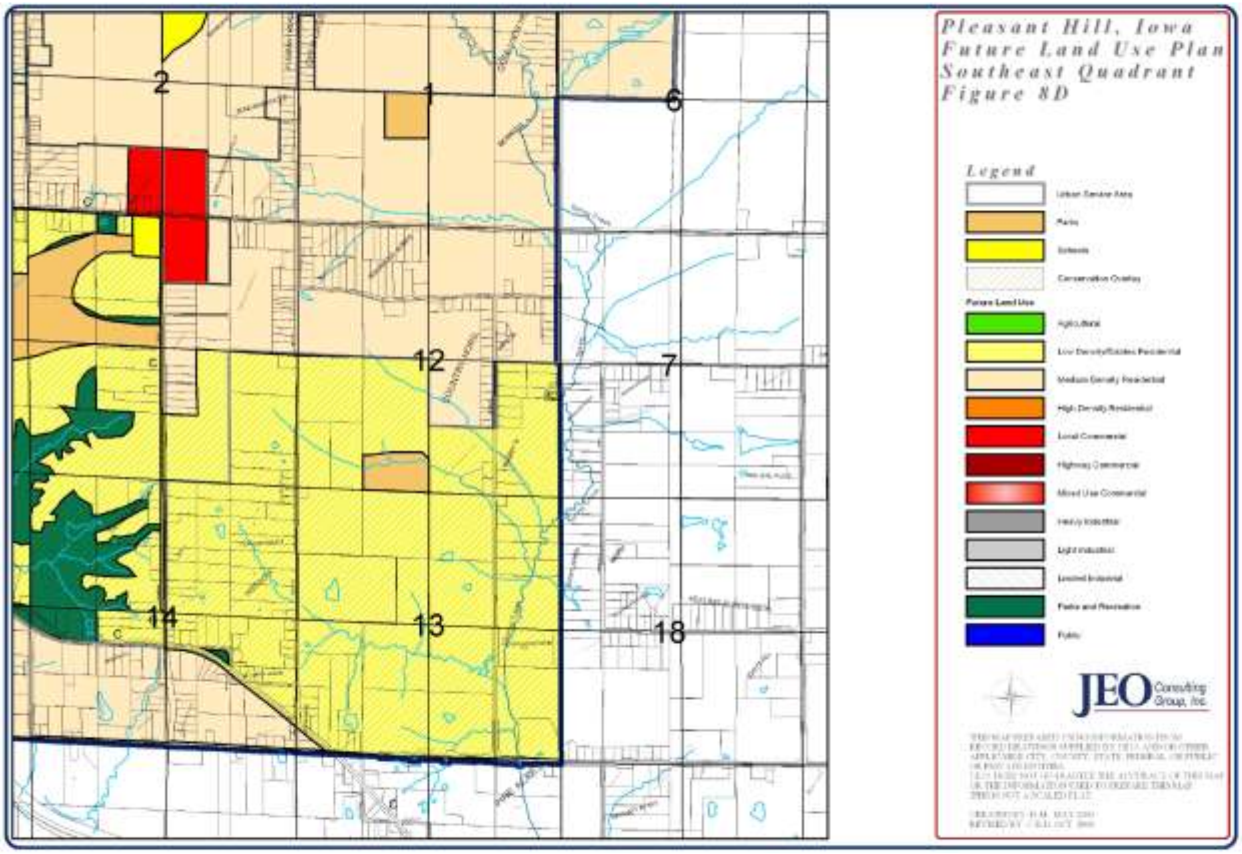
Source: 2005 Pleasant Hill Comprehensive Plan

Figure 3.26. Pleasant Hill Future Land Use Map-C



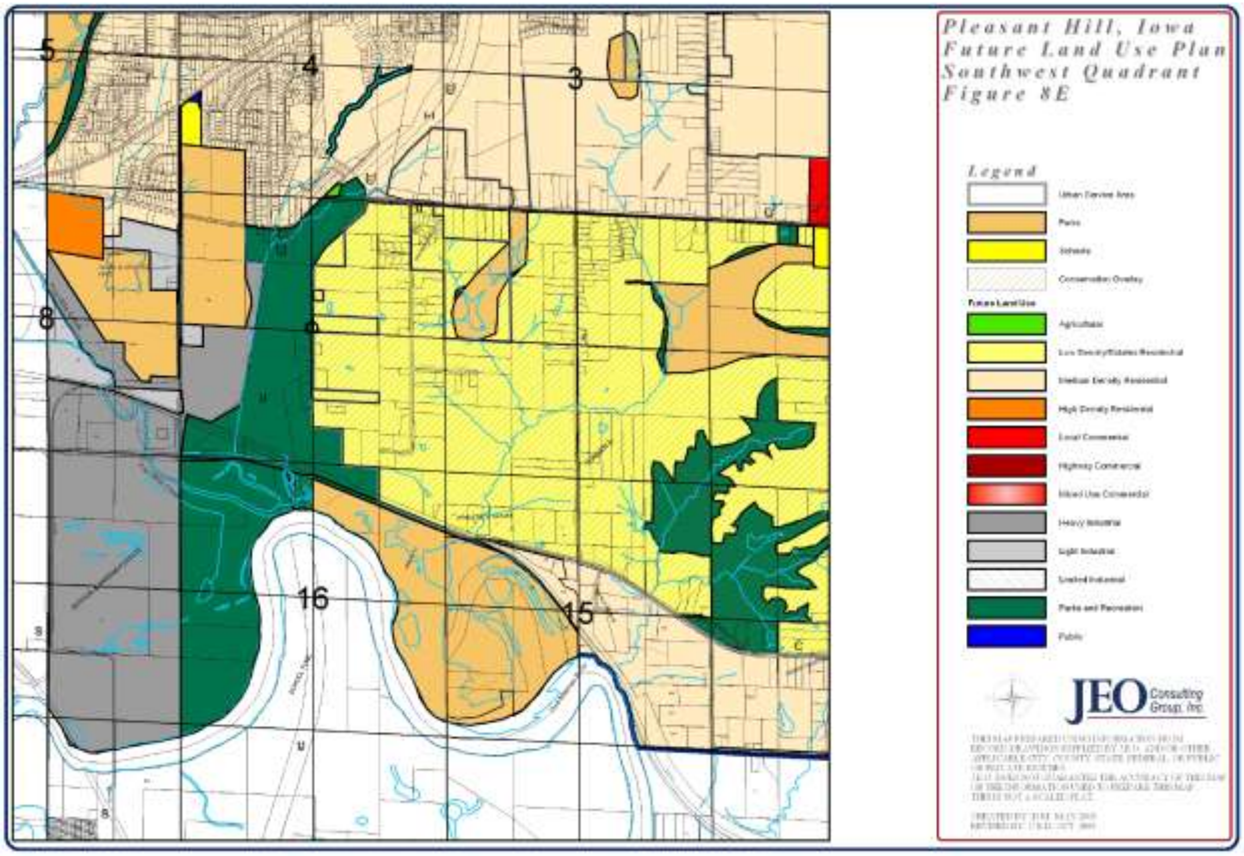
Source: 2005 Pleasant Hill Comprehensive Plan

Figure 3.27. Pleasant Hill Future Land Use Map-D



Source: 2005 Pleasant Hill Comprehensive Plan

Figure 3.28. Pleasant Hill Future Land Use Map-E



Source: 2005 Pleasant Hill Comprehensive Plan

The following statement discouraging development in flood hazard areas is excerpted from the 2005 Comprehensive Plan.

> This land use area accommodates the existing flood hazard areas along the Des Moines River which runs east along Pleasant Hill. This area protects land surrounding these areas while preserving the natural environment. Urban Development in this area is highly discouraged, although it is possible through standards set by the Federal Emergency Management Agency. Uses, if located in the best areas that would lessen the impact upon the area include; existing and future city parks and trails.

Polk City

No reported growth/development areas.

Runnells

No reported growth/development areas.

Urbandale

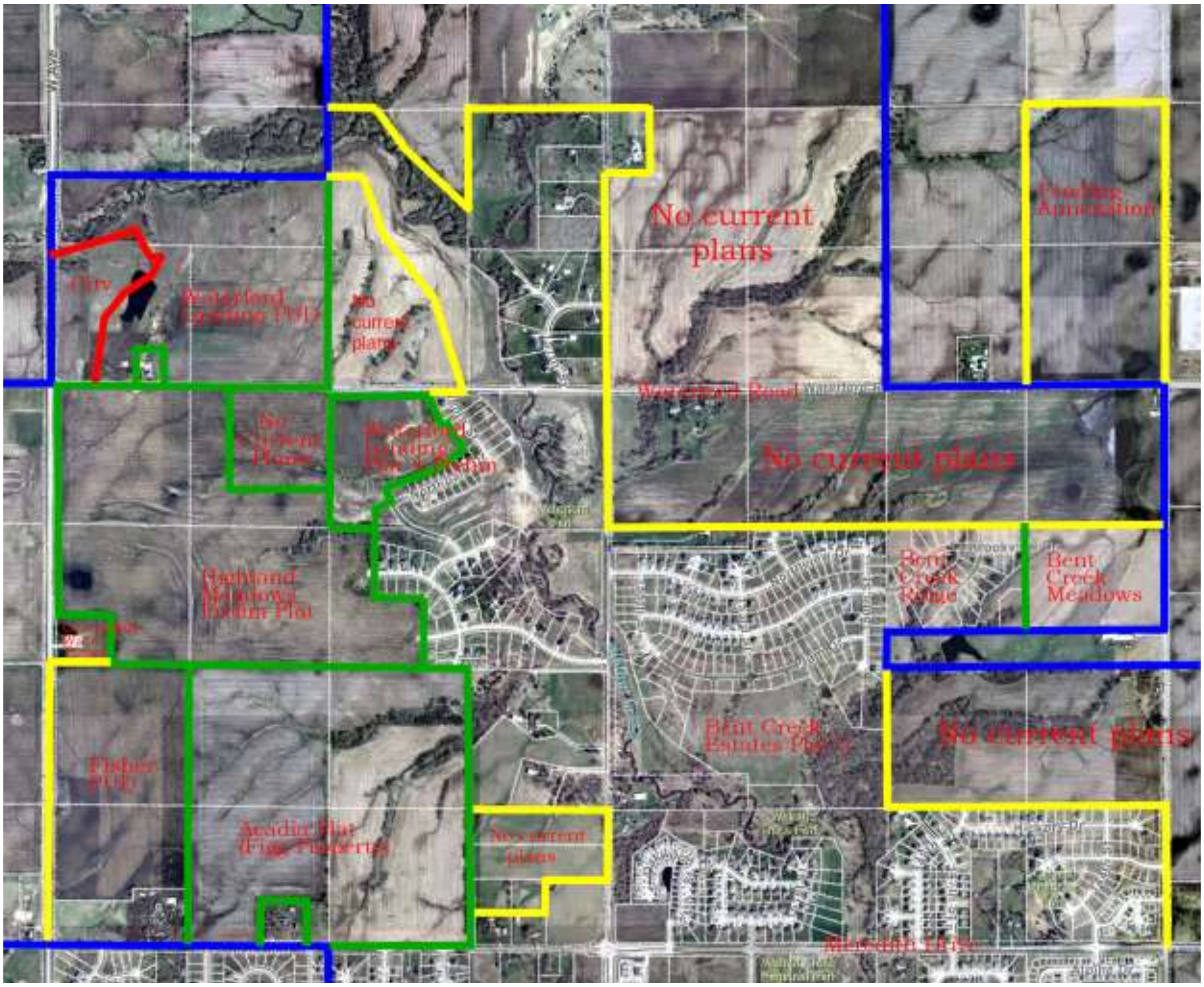
Figure 3.29 covers the expected residential growth areas for Urbandale from 2014 through approximately 2020. Beyond 2020, residential growth will be focused to the west of 170^{th} and north of Waterford, with the expectation that everything to the east/south will be mostly built out in Dallas County.

The only hazard area identified is the Walnut Creek floodplain. It's already pretty much protected by City ownership everywhere to the south of Waterford Road, except for a couple of isolated properties that the City has been unable to acquire to date. Those are protected by floodplain management regulations.

There's also vacant ground for residential development in Urbandale/Polk County, development timetable uncertain because the current owners aren't willing to sell for development. No hazard areas exist within this area.

Nonresidential development will occur in the Plum and Northpark Drive corridors, and the Paragon Office Park. No hazard areas in any of those, except a small part of the North Walnut Creek floodplain. That's protected by floodplain management regulations and by easements that prevent development within the regulated hazard area.

Figure 3.29. Urbandale Planned Residential Growth Areas



Source: Provided by Urbandale HMPC Representative

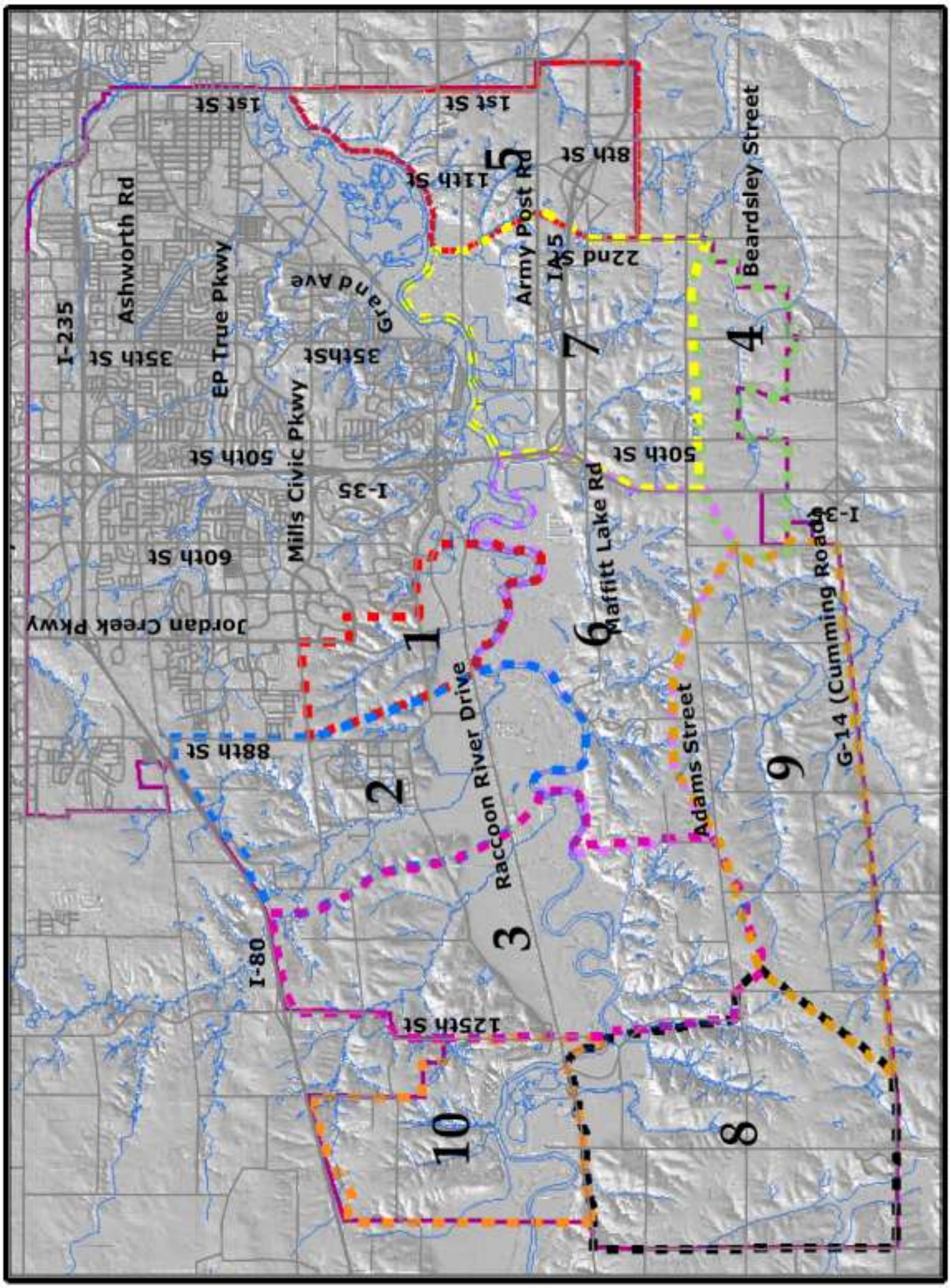
West Des Moines

The following areas are described in the Wes Des Moines Comprehensive Plan as areas that should be considered for future growth/extension. The areas are numbered in priority order and are shown in **Figure 3.30**.

- **Area 1** is generally south of Mills Civic Parkway, west of Wells Fargo and Pheasant Ridge, north of the river, and east of 88th Street. This area is designated predominately for office, residential and business park uses. The lowlands area between Booneville Road and Raccoon River Drive is a mix of business park and office uses. The area adjacent to and on the sloping portions is designated for residential usage primarily because of its proximity to the employment areas. Development in this area is expected to occur quickly.
- **Area 2** is south of Interstate 80, extending down to Raccoon River Drive. This area is primarily within the Sugar Creek drainage area with the eastern boundary generally being 88th Street, and the western boundary is the general alignment of 105th Street. Office, commercial, and high density uses are planned for the area along I-80, while light industrial and business park is designated for the area along Grand Avenue, but the balance of Area 2 is designated as residential. Existing rural subdivisions, Fox Creek and Sugar Creek Hills, as well as additional property located along Mills Civic Parkway, west of 88th Street, are presently not within the City limits. Presently the cities of West Des Moines and Waukee have an annexation agreement that will allow West Des Moines to annex the area. Annexation will be required before any major development can occur.
- **Area 3** is located between I-80 on the north and Adams Road on the south; and 125th Street on the west and the general alignment of 105th Street on the east. The area is primarily drained by Johnson Creek with the extreme northern portion being drained by Sugar Creek. Development of the area will be primarily dependent on sanitary sewer availability. There is an existing rural subdivision, Napa Valley, and an existing unincorporated community, Booneville, which consists of a cluster of houses and a few small businesses.
- **Area 4** is generally located south of the Southwest Connector and between the Orilla Road on the east and the Madison County/Warren County line on the west, this area has recently seen the extension of the WRA sanitary sewer into the area. Because of that factor, development can be expected to occur relatively sooner than when development will occur in Area 5 and even parts of Area 6.
- **Area 5** is south of the Raccoon River, north of the Polk/Warren County line, and between the City's eastern corporate limits and the drainage basin that runs along South 22nd Street on the west. The northern portion of Area 5 is either park land or has already been developed with low density single family residential, but the southern portion of the Area is largely vacant and ready for development. Development of the office, commercial, and light industrial land adjacent to Iowa Highway 5 could occur. Development in this area will most likely occur within the next five – ten years. Development north of Army Post Road may be at a slower pace than what occurs south of the road. Land uses along the Connector alignment are presently single family residential, but due to the expected traffic volumes on the road, the Comprehensive Plan Update illustrates the land uses as medium and high density residential, warehouse retail, and business park. If property owners choose not to develop, their property may continue to exist as single family residential units in perpetuity.

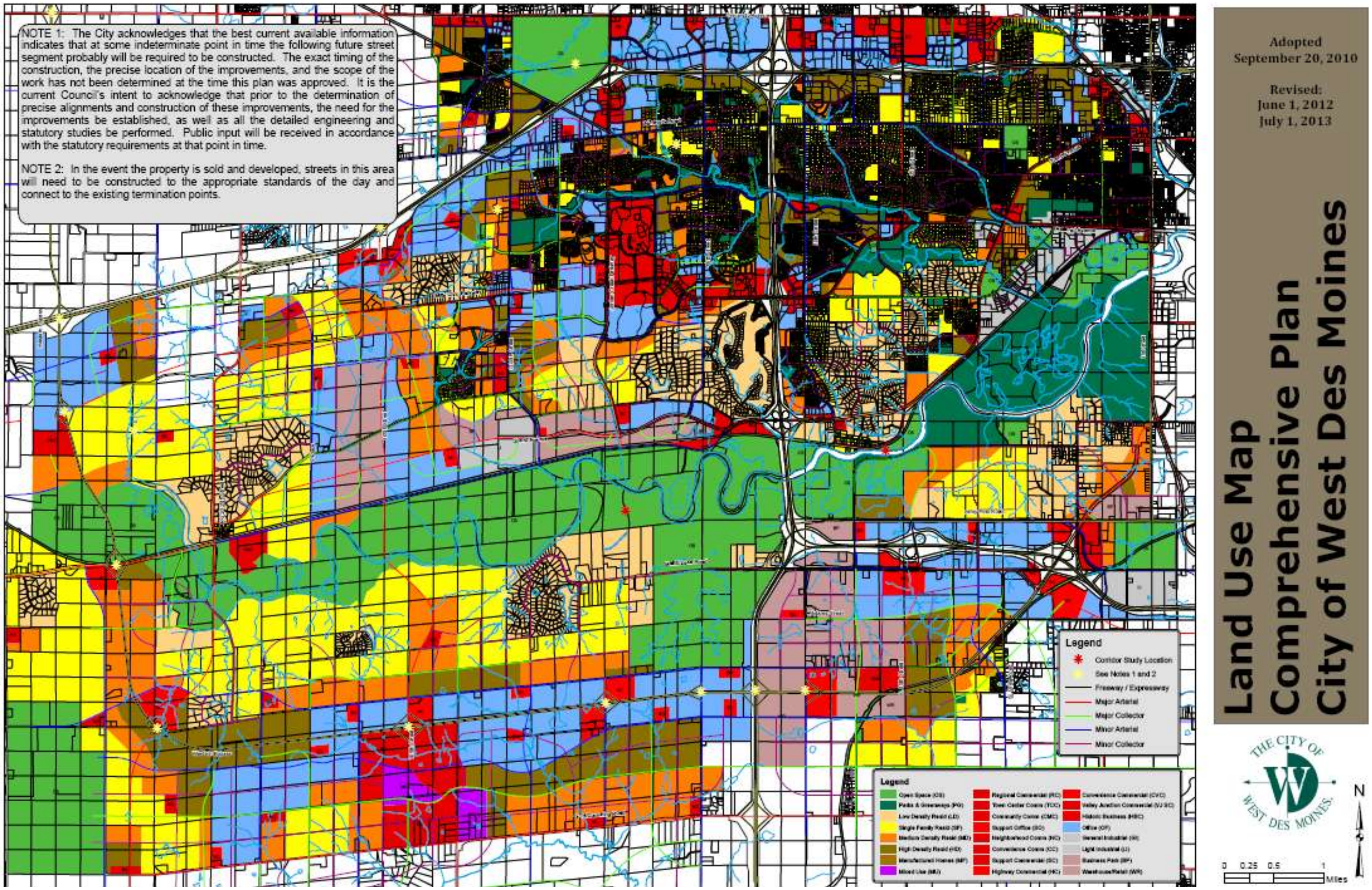
- **Area 6** is located south of the Raccoon River and west of Interstate 35. The area primarily drains to the north to the Raccoon River. Presently the area is not within the jurisdictional boundary of West Des Moines; however, there has been some interest in annexation from property owners. Sanitary sewer service for this area would be very costly. The area at this time can support only very low densities due to the topography, and its rather remote location from existing sewer lines. Whether sewer lines can be extended past the Dale Moffit Reservoir or pumped to the north to the WRA line in Grand Avenue would have to be determined. Area 6 is somewhat separated from the rest of the City and planning area due to the lack of crossings over the Raccoon River. The only crossing presently in the Area is at I-35. For any major development to occur, the need for emergency access – either through construction of a bridge or a station south of the river – will need to be considered. Once 105th Street is extended south across the river, this issue will be alleviated, however, there is no time frame for construction of the extension of 105th Street.
- **Area 7** is south of the Raccoon River, extending southward to the general alignment of the Southwest Connector, and between the drainage way along South 22nd Street on the east and I-35 on the west. It is adjacent to Area 5 and has similar land uses and development potential, but since the road network has not yet been fully determined and sanitary sewer is not as close, the expected time frame for development is not as soon as expected for Area 5. Similar to Area 5, the northern portion of Area 7 is park land with some very large single family residential holdings. There may be some change north of Army Post Road in this planning period as medium and high density projects could be built along Army Post Road, however, the majority of development change is expected to occur south of Army Post Road along Highway 5 and the Southwest Connector.
- **Area 8** is located in the extreme southwest corner of the Planning Area. The area is predominately in Madison County with the northern quarter of the area in Dallas County. The northeastern quarter of the area is presently within the jurisdictional boundary of the City of West Des Moines. The western part of the area represents a very long term service need because of its remote location. Initial development in the area will be predominately large estate lot type development on septic systems. Like Area 6, this area is also separated from the balance of the planning area by the Raccoon River. The nearest road that crosses the river is F-90. Both the construction of 105th Street and the Southwest By-pass across the river would provide additional access and improve development potential.
- **Area 9** is generally located south of Adams Street and west of I-35 within the City's planning boundary. This area represents a long term service priority to the City primarily because of its location and the undefined factors of whether or not this area will ultimately be in the City and how municipal services, in particular sanitary sewer service, will be provided. This area is located entirely within the North River drainage basin. There is some possibility on limited bases to temporarily pump sewage to the north until a North River sanitary sewer line is constructed.
- **Area 10** is generally located west of 125th Street, south of I-80, north of Raccoon River Drive, and extends west to the current planning area boundary. This area represents a long term service priority to the City primarily because of its location and the undefined factors of whether or not this area will ultimately be in the City and how municipal services, in particular sanitary sewer service, will be provided.

Figure 3.30. West Des Moines Future Identified Future Growth Areas



Source: 2010 West Des Moines Comprehensive Plan

Figure 3.31. West Des Moines 2013 Existing Land Use Map



Source: City of West Des Moines Website accessed 1/20/2014, http://www.wdm.iowa.gov/Index.aspx?page=54

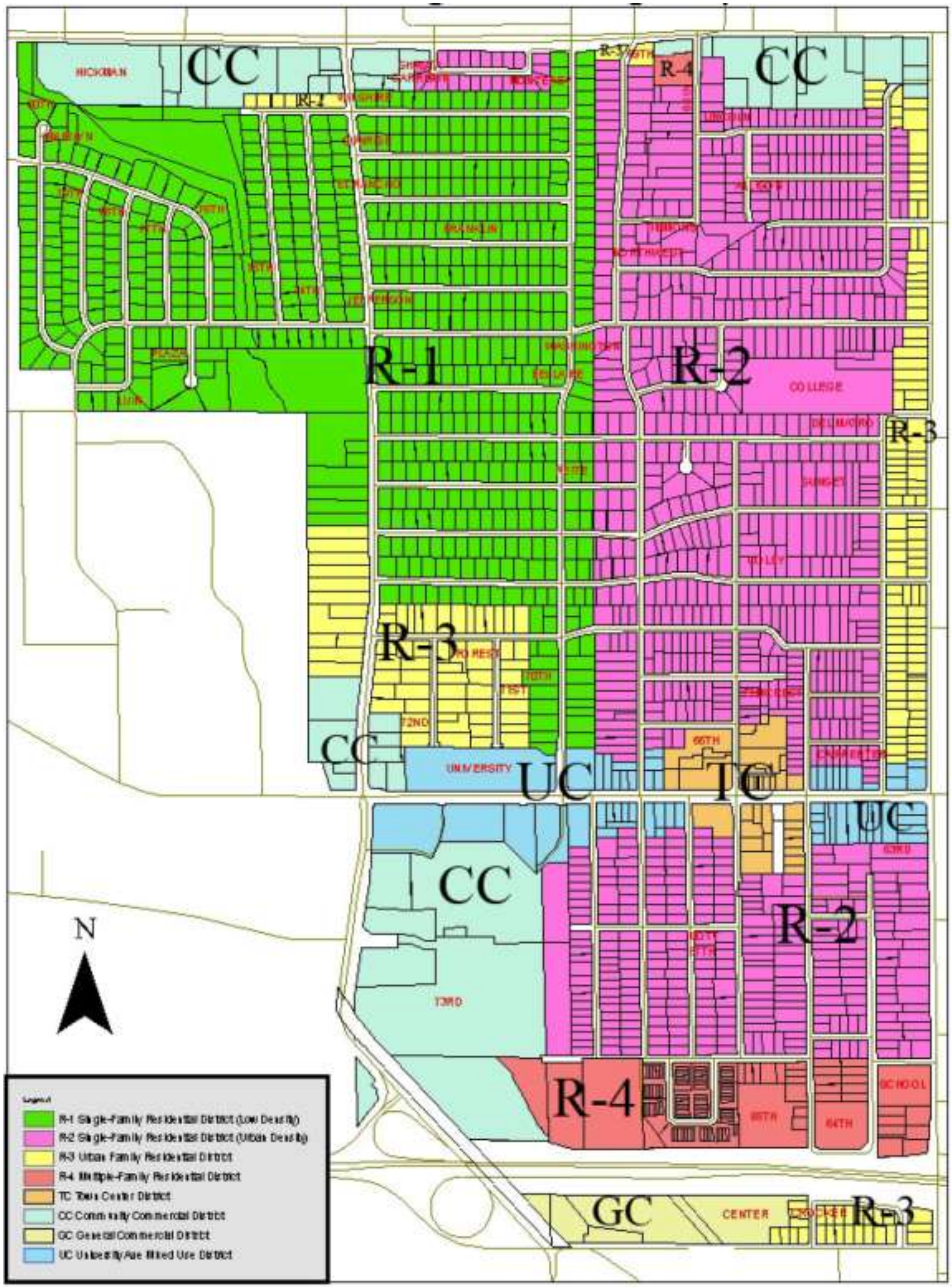
Windsor Heights
Since Windsor Heights is landlocked and has only a few open sites for new residential development, population is expected to remain relatively stable over the next decade, with perhaps a small increase of around 200 people, for a total of around 5,000. The only potential concerns/issues related to hazards would be an increased density of existing sites through redevelopment or an increase in household size.

The City of Windsor Heights July 2013 Comprehensive Plan lays out a strategy for the continued vitality of the City through 2030. The following specific construction is planned in the near future:

- The redevelopment of 63rd Street and Hickman Road will begin in the next couple of years.
- The Kum and Go site at 7229 University Avenue will be demolishing and rebuilding a new gas station.
- A communications tower is currently being erected behind City Hall.

Figure 3.32provides the City of Windsor Heights zoning map.

Figure 3.32. City of Windsor Heights Zoning Map



Source: City of Windsor Heights Website accessed 1/20/2014, http://www.windsorheights.org/planning-building/maps-gis.aspx

School District's Future Development

This section summarizes future development for the participating school Districts:

- Ankeny School District—two new elementary schools are planned, Elementary #10 is scheduled to be completed in August 2014 and Elementary #11 is proposed to start construction in November 2014, with completion in August 2017. Renovations are also scheduled to Northview Middle School.
- Bondurant-Farrar School District—no new buildings planned at this time.
- Dallas Center-Grimes School District—no new buildings planned at this time.
- Des Moines Independent School District—beginning in 2012, more than $67 million in additional renovation and construction projects were scheduled at Des Moines schools. One new building and one new addition are planned for the near future at this time:
  - Casady Education Center (pre-K and administration) to be located at 16th and Allison scheduled to be complete August 2014.
  - Merrill Middle School Addition scheduled to be complete August 2014
- Johnston School District—from 2000 to 2013, the school district has grown by 2,431 students, nearly 200 students a year. As a result, a bond referendum for $41 million was passed in June 2013. The school district plans to construct a new 10-12 high school, renovate the current high school and make it the new 8-9 Johnston Middle School, renovate the current 8-9 middle school to make it a new elementary and early learning, and renovate an existing elementary school to make it a new district administration/programming center.
- North Polk School District—the school district recently completed construction of a new high school and new outdoor facility
- Southeast Polk School District—phases I and II of the Capital Improvement Plan include various remodeling and upgrade projects as well as several maintenance projects. Phase II also includes a proposal for new bleachers and restrooms at the high school as well as a new administrative and support services building.
- Urbandale School District— new bleachers are slated to be installed at the baseball/softball fields as well as various upgrade and maintenance projects.
- West Des Moines School District—the 10-year facilities improvement plan includes the period from 2010 to 2020. Xx provides the details.

Figure 3.33. West Des Moines School District Facilities Improvement Timeline

West Des Moines CSD
Facilities Improvement Timeline (Proposed)
February 2010

$ in millions Summer of:	FY10	FY11 2010	FY12 2011	FY13 2012	FY14 2013	FY15 2014	FY16 2015	FY17 2016	FY18 2017	FY19 2018	FY20 2019	FY21 2020	Totals Through FY15	FY21
Fairmeadows					Music and classroom additions, storm water management, window replacements, parking/drive/site enhancements			Flooring, paint						
		$0.1			**$0.2**	**$2.2**		$0.3					$2.5	$2.8
Clive		Paint				Air handler, flooring, paint	Windows, entry doors, site/site drainage					Chiller, AHU, flooring, grease trap		
		$0.0					$0.7	$0.3				$0.9	$0.0	$1.9
Valley Southwoods		SpEd remodel, grease trap	Flooring	Fire alarm, lockers, hard surface flooring, cabling, etc; AHU, wtr heater			Paint		Controls, roof replacement					
		$0.5	**$1.0**	**$1.4**			$0.4		$2.2				$2.9	$5.5
Phenix						Mechanical / electrical upgrades; update finishes, grease trap								
						$0.3	$2.8						$0.3	$3.1
Valley Stadium				Flooring, paint					Roof top unit, sound system, grease trap, etc			Controls		
				$0.1					$0.5			$0.1	$0.1	$0.6
Operations							Mechanical, paint							
							$0.2						$0.0	$0.2
Hillside		Paint				Flooring, paint					Cooling tower, grease trap, wtr heater			
		$0.1				**$0.5**					$1.1		$0.5	$1.6
Western Hills		Windows		Gym floor		Paint					Flooring, paint, wtr heater			
		$0.2		**$0.1**		**$0.1**					$0.5		$0.3	$0.8
Crestview				Gym floor; police turnaround			Paint					Flooring, paint, wtr heater		
				$0.2			$0.1					$0.5	$0.2	$0.7
Annual Project Cost:	**$2.0**	**$16.1**	**$36.3**	**$24.6**	**$19.8**	**$3.7**	$4.7	$1.1	$8.5	$0.4	$1.6	$2.2		
Cum. Project Cost:	**$2.0**	**$18.1**	**$54.4**	**$79.0**	**$98.8**	**$102.5**	$107.2	$108.3	$116.8	$117.2	$118.8	$121.0	$102.5	$121.0

West Des Moines CSD
Facilities Improvement Timeline (Proposed)
February 2010

$ in millions	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	Totals Through FY15	Totals Through FY21
Summer of:		**2010**	**2011**	**2012**	**2013**	**2014**	2015	2016	2017	2018	2019	2020		
Fairmeadows		$0.1			Music and classroom additions, storm water management, window replacements, parking/drive/site enhancements $0.2	$2.2		Flooring, paint $0.3					$2.5	$2.8
Clive		Paint $0.0					Windows, entry doors, site/site drainage; Air handler, flooring, paint $0.7	$0.3				Chiller, AHU, flooring, grease trap $0.9	$0.0	$1.9
Valley Southwoods		SpEd remodel, grease trap $0.5	Flooring $1.0	Fire alarm, lockers, hard surface flooring, cabling, etc; AHU, wtr heater $1.4			Paint $0.4		Controls, roof replacement $2.2				$2.9	$5.5
Phenix						Mechanical / electrical upgrades; update finishes, grease trap $0.3	$2.8						$0.3	$3.1
Valley Stadium				Flooring, paint $0.1					Roof top unit, sound system, grease trap, etc $0.5			Controls $0.1	$0.1	$0.6
Operations							Mechanical, paint $0.2						$0.0	$0.2
Hillside		Paint $0.1				Flooring, paint $0.5					Cooling tower, grease trap, wtr heater $1.1		$0.5	$1.6
Western Hills		Windows $0.2		Gym floor $0.1		Paint $0.1					Flooring, paint, wtr heater $0.5		$0.3	$0.8
Crestview				Gym floor; police turnaround $0.2			Paint $0.1					Flooring, paint, wtr heater $0.5	$0.2	$0.7
Annual Project Cost:	$2.0	$16.1	$36.3	$24.6	$19.8	$3.7	$4.7	$1.1	$8.5	$0.4	$1.6	$2.2		
Cum. Project Cost:	$2.0	$18.1	$54.4	$79.0	$98.8	$102.5	$107.2	$108.3	$116.8	$117.2	$118.8	$121.0	$102.5	$121.0

Source: West Des Moines School District, http://www.wdmcs.org/wp-content/uploads/2012/06/finance_facility_planning_timeline.pdf accessed 1/22/2014

3.4 Hazard Profiles and Vulnerability

Hazard Profiles

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

Each hazard identified in Section **3.1.4** is profiled individually in this section in alphabetical order.

The level of information presented in the profiles varies by hazard based on the information available. With each update of this plan, new information will be incorporated to provide for better evaluation and prioritization of the hazards that affect the planning area. Detailed profiles for each of the identified hazards include information categorized as follows:

Hazard Description

This section consists of a general description of the hazard and the types of impacts it may have on a community. It also includes the ratings assigned to the hazard relative to typical warning times and duration of hazard events as described in **Table 3.4**.

Geographic Location/Extent

This section describes the geographic location of the hazard in the planning area. Where available, maps are utilized to indicate the specific locations of the planning area that are vulnerable to the subject hazard. This section also provides information as to the extent of the hazard (i.e. the size or degree of impacts). Extent is addressed in more detailed/quantified terms (where available) in the Vulnerability Section for each hazard.

Previous Occurrences

This section includes information on historic incidents and their impacts.

Probability of Future Occurrence

The frequency of past events is used to gauge the likelihood of future occurrences. Where possible, the probability or chance of occurrence was calculated based on historical data. Probability was determined by dividing the number of events observed by the number of years and multiplying by 100. This gives the percent chance of the event happening in any given year. An example would be three droughts occurring over a 30-year period, which suggests a 10 percent chance of a drought occurring in any given year. For each hazard, the probability is assigned a rating as defined in **Table 3.4**.

Vulnerability Assessments

Requirement §201.6(c)(2)(ii) :[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A) :The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.6(c)(2)(ii)(B) :[The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Requirement §201.6(c)(2)(ii): (As of October 1, 2008) [The risk assessment] must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged in floods.

Following the hazard profile for each hazard is the vulnerability assessment. The vulnerability assessment further defines and quantifies populations, buildings, critical facilities, and other community assets at risk to natural hazards. The vulnerability assessment for this plan followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses* (2002). The vulnerability assessments were conducted based on the best available data and the significance of the hazard. Data to support the vulnerability assessments was collected from the following sources:

- Statewide GIS data sets compiled by state and federal agencies;
- FEMA's HAZUS-MH loss estimation software;
- Written descriptions of assets and risks provided by participating jurisdictions;
- Existing plans and reports;
- Personal interviews with planning committee members and other stakeholders; and
- Other sources as cited.

Detailed profiles for each of the identified hazards include information categorized as follows:

Vulnerability Overview

This section consists of a general overview narrative of the planning area's vulnerability to the hazard. Within this section, the magnitude/severity of the hazard is discussed. The magnitude of the impact of a hazard event (past and perceived) is related directly to the vulnerability of the people, property, and the environment it affects. This is a function of when the event occurs, the location affected, the resilience of the community, and the effectiveness of the emergency response and disaster recovery efforts.

For each hazard, the magnitude/severity is assigned a rating as defined in **Table 3.4**.

Potential Losses to Existing Development

This section provides the potential losses to existing development. Where data is available, this section provides estimated financial losses as well as the methodology used. For hazards with an overall “Low” rating, potential losses may not be discussed.

Future Development

This section provides information on how vulnerability to this hazard will be impacted by planned future development as well as information for jurisdictions to consider in planning future development.

Hazard Summary by Jurisdiction

For hazards that vary by jurisdiction, this section will provide an overview of how the hazard varies, followed by a table indicating the probability, magnitude, warning time, and duration rankings for each jurisdiction with the resulting hazard score and level.

3.4.1 Animal/Plant/Crop Disease

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
1	2	1	4	1.60	Low

Profile

Hazard Description

Agricultural infestation is the naturally occurring infection of vegetation, crops or livestock with insects, vermin, or diseases that render the crops or livestock unfit for consumption or use. Because of Iowa's overall substantial agricultural industry and related facilities and locations, the potential for infestation of crops or livestock poses a significant risk to the economy of the State. Iowa cropland is vulnerable to disease and other agricultural pests. Iowa farmers harvested an estimated 13.7 billion acres of corn, 9.2 billion acres of soybeans, 50,000 acres of oats and 1.1 billion acres of hay and grass silage, according to USDA figures in 2011. Iowa's field and crop output reached $20.4 billion in 2011 (USDA National Agricultural Statistics Service, as of 01/01/2012).

The Polk County planning area utilizes 66 percent of the surface land in the County for agricultural uses. Agricultural infestation of crops or livestock in the planning area would affect the economy. Details on agriculture in Polk County, Iowa for 2011 and 2012 are provided in **Table 3.18.**

Table 3.18. USDA Crop Estimates in Polk County, IA for 2011 – 2012.

Crop	Area Planted (in acres) 2011	Production (in Bushels) 2011	Area Planted (in acres) 2012	Production (in Bushels) 2012
Corn	89,000	13,990,000	92,500	13,465,000
Soybeans for Beans	65,800	3,448,000	63,700	3,113,000
Oats	0	0	0	0
Alfalfa Hay	(D)	(D)	(D)	(D)

Source: USDA National Agricultural Statistics Service,
http://www.nass.usda.gov/Statistics_by_State/Iowa/Publications/County_Estimates/index.asp
Note: (D) Withheld to avoid disclosing data for individual operations.

Some level of agricultural infestation is normal in Iowa. The concern is when the level of an infestation escalates suddenly, or a new infestation appears, overwhelming normal control efforts. The levels and types of agricultural infestation appear to vary by many factors, including cycles of heavy rains and drought.

Animal Disease

Agricultural incidents are naturally occurring infection of livestock with insects, vermin, or diseases that render the livestock unfit for consumption or use. The livestock inventory for the state of Iowa includes 3,900,000 cattle and calves. With this substantial agricultural industry and related facilities throughout the State, the potential for infestation of livestock poses a significant risk to the Iowa economy.

The Iowa Department of Agriculture and Land Stewardship (IDALS) monitors and reports on the following animal reportable diseases in Iowa:

- Avian Influenza,
- Bovine Spongiform Encephalopathy (BSE) Disease,
- Chronic Wasting Disease,
- Exotic Newcastle Disease,
- Foot and Mouth Disease,
- Johne's Disease,
- Pseudo rabies,
- Scrapie, and
- West Nile Virus.

Producers are required by state law to report any of the reportable animal diseases to the IDALS's Bureau of Animal Industry. The IDALS's Bureau of The Center for Agriculture Security is the lead coordinating bureau for any emergency response for an agriculture incident.

Avian influenza continues to be of concern in Iowa as the State is number one in poultry egg layers (over 60 million), 10th nationally in turkey production (over 9 million) and 5th in turkey processing in 2012 which is even higher inventories than in 2007. Source: IDALS 2012 Newsletter.

Bovine Spongiform Encephalopathy (BSE) "mad cow" disease is a chronic, degenerative disease affecting the central nervous system of cattle. Cases have been found world-wide since 1986, but in Canada and the U.S. only a single cow was reported with BSE in 2003.

Chronic Wasting Disease (CWD) is a fatal, neurological disease of farmed and wild deer and elk. The disease has been identified in wild and captive mule deer, white-tailed deer and North American elk, and in captive black-tailed deer. Recently from 1996 to June 2002, it was diagnosed in farmed elk herds in Colorado, Kansas, Montana, Iowa, Oklahoma, South Dakota, and the Canadian Provinces of Alberta and Saskatchewan. Then from 2000 to June 2002, CWD has also been found in wild deer in northwestern Nebraska, southern New Mexico, southwestern South Dakota, south central Wisconsin, northwestern Colorado, and the Canadian Province of Saskatchewan. To date, it has not been found in Iowa. Source: http://www.iowaagriculture.gov/animalIndustry/cwdFacts.asp.

Exotic Newcastle disease (END) is a contagious and fatal viral disease affecting all species of birds. There was an epidemic of END in California in 2003 that is resulting in the death of millions of chickens and other birds, and costing millions of dollars. END is probably one of the most infectious diseases of poultry in the world. END is so virulent that many birds die without showing any clinical signs.

Foot and Mouth Disease (FMD) is a severe, highly communicable viral disease caused by a fast-spreading virus, and all cloven-hoofed animals are susceptible to the disease. Nearly 100 percent of the animals may die of the disease. In Iowa, susceptible animals to this disease include; domestic swine, cattle, captive and wild deer, sheep goats, bison, elk, llamas, cloven-hoofed zoo animals.

Johne's (yo-knees) disease is a contagious, chronic and eventually fatal infection that affects the small intestine of ruminants, including cattle, sheep and goats. Johne's, also called Para tuberculosis, is a slow progressive wasting disease with an incubation period of usually 2 or more years. Johne's is a reportable disease, but not a quarantineable disease.

Pseudo rabies is a viral disease most prevalent in swine, often causing newborn piglets to die. Older pigs can survive infection, becoming carriers of the pseudo rabies virus for life. Other animals infected from swine die from pseudo rabies, which is also known as Aujeszky's disease and "mad itch." Infected cattle and sheep can first show signs of pseudo rabies by scratching and biting themselves. In dogs and cats, pseudo rabies can cause sudden death. The virus does not cause illness in humans. Due to an extensive eradication program, Iowa & the rest of United States are free of pseudo rabies.

Scrapie is a fatal, degenerative disease affecting the central nervous system of sheep and goats that is very similar to BSE (mad cow disease), although it does not cause disease in humans, and has been present in the U.S. for over 50 years. Infected flocks that contain a high percentage of susceptible animals can experience significant production losses. In these flocks, over a period of several years, the number of infected animals increases and the age at onset of clinical signs decreases making these flocks economically unviable. Animals sold from infected flocks spread scrapie to other flocks. The presence of scrapie in the U.S. also prevents the export of breeding stock, semen, and embryos to many other countries. Currently there is a national program underway to eradicate scrapie in the U.S.

Disease outbreaks can also occur in wild animal populations. The IDALS's Bureau of Animal Industry also monitors wild animal species and game throughout the State as well as diseases that may impact them.

Crop Pests/Diseases

A plant disease outbreak or a pest infestation could negatively impact crop production and agriculturally dependent businesses. An extreme outbreak or infestation could potentially result in billions of dollars in production losses. The cascading net negative economic effects could result in wide-spread business failures, reduction of tax revenues, harm to other state economies, and affect capability for this country to compete in the global market.

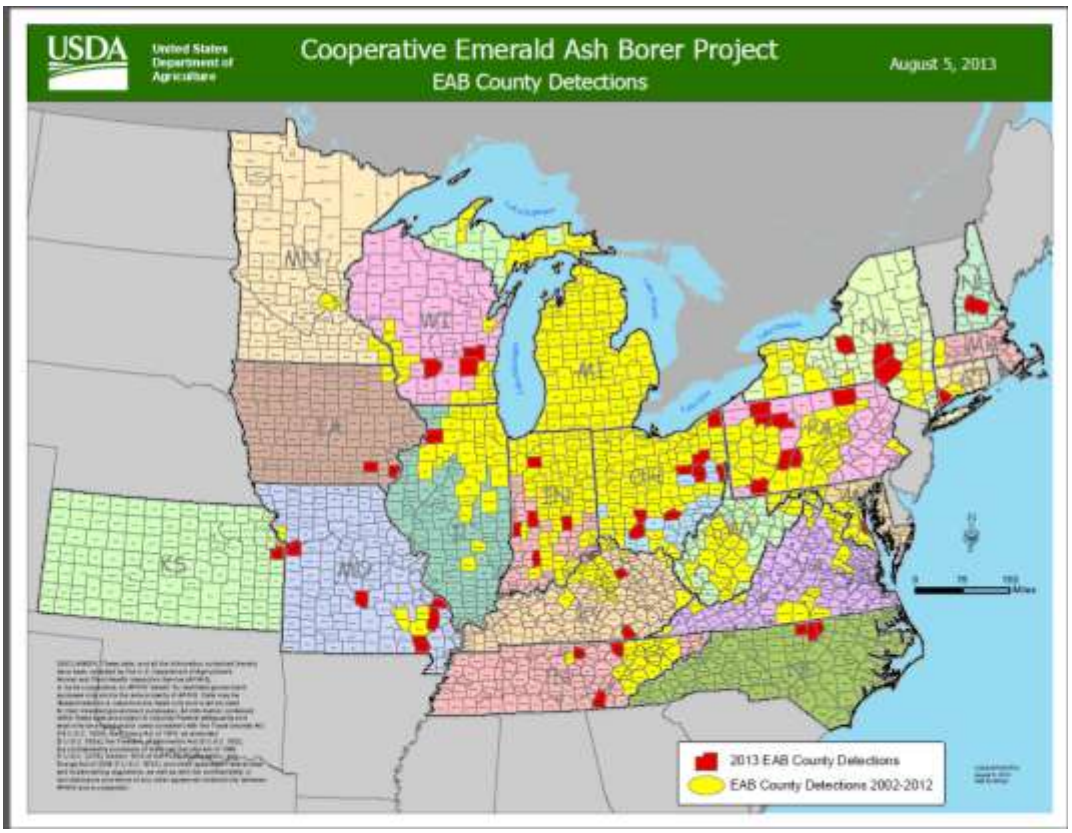
Many factors influence disease development in plants, including hybrid/variety genetics, plant growth stage at the time of infection, weather (e.g., temperature, rain, wind, hail, etc.), single versus mixed infections, and genetics of the pathogen populations. The two elements of coordination and communication are essential when plant diseases or pest infestations occur. The United States Department of Agriculture/ Animal Plant Health Inspection Service, Iowa Department of Agriculture and Land Stewardship, local producers, local government, assessment teams, and state government entities must work together to effectively diagnose the various plant hazards to determine if immediate crop quarantine and destruction is required.

Iowa State University, College of Agriculture and Life Sciences, has The Plant and Insect Diagnostic Clinic **http://www.ipm.iastate.edu/ipm/info/insects** that provides diagnosis of plant problems (plant diseases, insect damage, and assessment of herbicide damage) and the identification of insects and weeds from the field, garden, and home. Specific plant pests can vary from year to year. For complete details of all insects and diseases that can impact crops in Polk County, see the website above.

Emerald Ash Borer

The Hazard Mitigation Planning Team is also aware of the emerald ash borer pest that threatens Iowa's forests. This pest is a slender, emerald green beetle that is ½ inch long, and responsible for the destruction of approximately 20 million ash trees in Ohio, Michigan, Indiana, Illinois, and Ontario, Canada. **Figure 3.34** shows the initial counties in the U.S. and Canada in which the Emerald Ash Borer was detected.

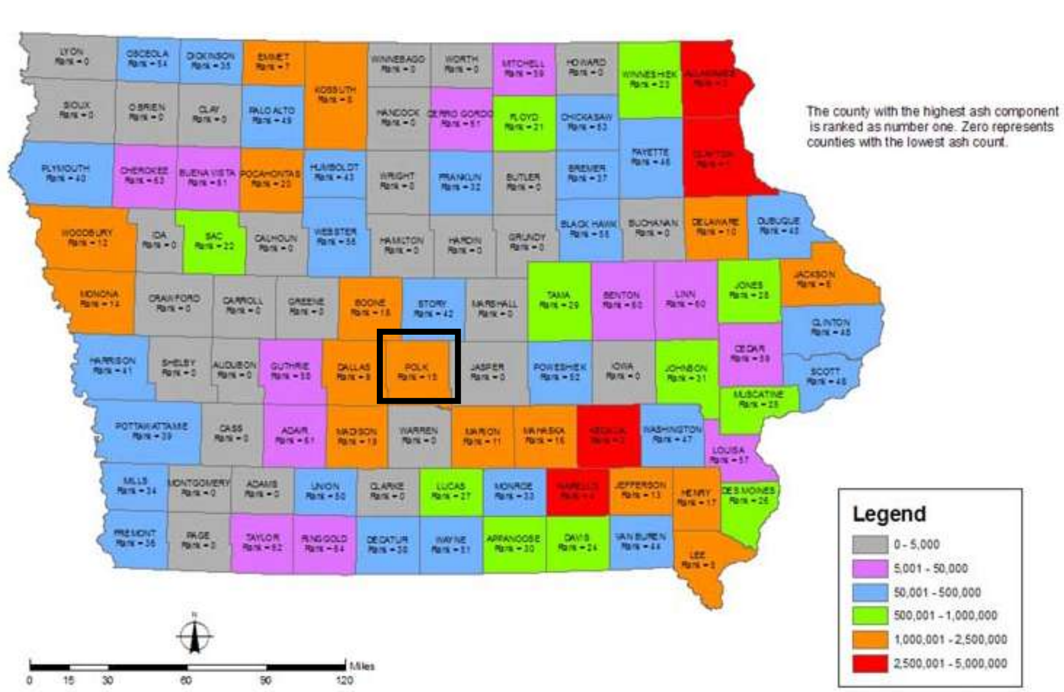
Figure 3.34. USDA Emerald Ash Borer County Detection Map



Source: http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/index.shtml

According to the Iowa Department of Agriculture and Land Stewardship in mid-year of 2013 Emerald Ash Borer was positively identified in a residential tree in the city of Burlington in Des Moines County and the city of Fairfield in Jefferson County. Previously, the pest was found in one tree on an island in the Mississippi River in Allamakee County (northeast corner of Iowa). It is estimated by the Iowa Department of Natural Resources – Forestry Bureau that approximately 15-20 percent of public trees in Iowa cities are green ash. In some communities, ash comprises more than 60 percent of the public trees. Statewide, there are over 50 million ash trees (green, white and black) in bottomland and upland forests (2005 USDA Forest Service, Forest Inventory Data) and another 30 million urban ash trees (Iowa Department of Natural Resources – Forestry Bureau). In **Figure 3.35** below, Polk County is ranked 15th in the State with 1,000,001 to 2,500,000 ash trees in the County according to data from the U.S. Forest Service. Also, a cooperative state and federal effort has developed the "Iowa Emerald Ash Borer Readiness Plan" http://www.extension.iastate.edu/pme/Publications/EAB/IAEABReadinessPlan2JAN2013FINAL.pdf to help stop this pest by education, monitoring, surveillance, containment, and communication.

Figure 3.35. Distribution of Ash Trees in Iowa



Source: Iowa State University Extension Office
http://www.extension.iastate.edu/pme/EAB%20other%20forms/Iowa%20Ash%20Tree%20Distribution%202006%20map.jpg
Note: Polk County is outlined in black.

Wildlife

Iowa farmers also lose a significant amount of crops each year as a result of wildlife foraging. This can be particularly problematic in areas where natural habitat has been diminished or in years where weather patterns such as early/late frost deep snow, or drought has caused the wild food sources to be limited.

Warning Time Score: 1—More than 24 hours warning time

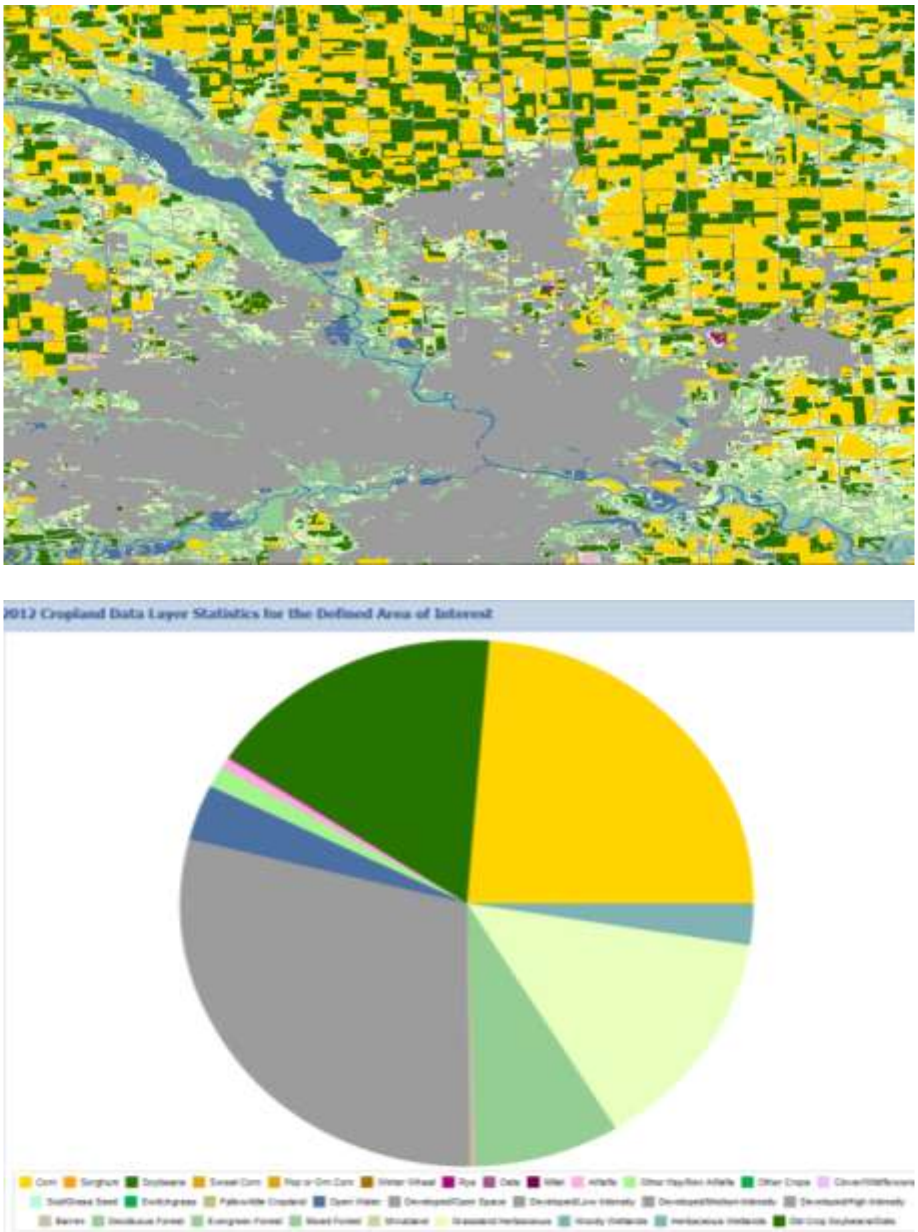
Duration Score: 4—more than 1 week

Geographic Location/Extent

All of Polk County is subject to animal/livestock incidents and agricultural infestations. There are 738 farms in the County that cover 249,427 acres of land, which accounts for 66 percent of the surface land in the county.

As can be seen **Figure 3.36**, the majority of the land use outside the city boundaries is in agriculture use of corn (yellow) and soybeans (green).

Figure 3.36. Polk County Land Use



Source: USDA, produced by CropScape http://nassgeodta.gmu.edu/cropscape

Animal Location/Extent

Table 3.19 provides the inventory of cattle and calves, horses and ponies, layers, hogs and pigs, sheep and lamb in Polk County as of January 1, 2012 compared to the ranking in the State and the 2007 Census of Agriculture.

Table 3.19. Livestock Number of Head in Polk County and Iowa as of January 1, 2012

Livestock Number of Head			
	Polk County	Ranking in State	Iowa
All Cattle & Calves	13,208	89	3,900,000
Horses and Ponies	1,081	17	12,681
Layers	1,015	63	53,793,712
Hogs & Pigs	30,223	89	19,295,092
Sheep & Lambs	1,011	73	40,199

Source: USDA National Agriculture Statistics Service Iowa Field Office; 2007 Census of Agriculture

Crop Location/Extent

Table 3.20 provides the crops harvested in Polk County compared to the State according USDA. In 2011, Polk County farmers harvested 28.2 million bushels of corn and 5.4 million bushels of soybeans.

Table 3.20. Crop Production in Polk County and Iowa, 2011

Crops				
	Polk County		Iowa	
	Corn	Soybeans	Corn	Soybeans
Acres Harvested	87,100	65,300	13,700,000	9,230,000
Production in Bushels	13,900,000	3,448,000	2,356,400,000	466,115,000

Source: USDA National Agricultural Statistics Service

Previous Occurrences

There have been a total of 77 sheep flocks in Iowa that have been found to be infected with Scrapie since the accelerated national Scrapie Eradication Program started in November 2001. In fiscal year 2005, Iowa had a high of 15 newly infected flocks. The number of new infected flocks has been decreasing since that time. Iowa's last infected flock was found in June 2010.

In 2012, there were 36 confirmed cases of West Nile Virus in horses across the State including 1 confirmed case in Polk County. This was a significant increase in the number of cases from 2011 where there were only 2 equine cases reported.

According to the Iowa Department of Public Health, Center for Acute Disease Epidemiology, there was 33 reported rabies cases in Iowa in 2012 and 25 reported in 2011. Specifically in Polk County, there was 1 reported case in 2012 from a skunk, 2 reported from bats in 2011, 1 reported from a fox in 2010 and 2 reported from bats in 2009 and 2008.

According to the U.S. Department of Agriculture's Risk Management Agency, during the 10-year period from 2003-2012, combined crop insurance payments for damages resulting from insects, Mycotoxin (Aflatoxin), and plant disease totaled $62,840. The Iowa Statewide average for farm acres with insurance is 88 percent (USDA Risk Management Agency, 2012 Iowa Crop Insurance) Profile http://www.rma.usda.gov/pubs/2012/stateprofiles/iowa11.pdf). **Table 3.21** provides a summary of insured crop losses as a result of crop infestations.

Table 3.21. Crop Insurance Payments for Crop Pests/Diseases 2003-2012

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid ($)
2004	Soybeans	Plant Disease	$246
2005	Corn	Plant Disease	$14,965
2010	Soybeans	Plant Disease	$184
2010	Corn	Mycotoxin (Aflatoxin)	$43,347
2010	Soybeans	Mycotoxin (Aflatoxin)	$3,586
2012	Corn	Insects	$513
Total			**$62,840**

Source: USDA Risk Management Agency Crop Insurance Payment FOIA Request; USDA Risk Management Agency Iowa Crop Insurance Profile, http://www.rma.usda.gov/pubs/2013/stateprofiles/iowa12.pdf

Probability of Future Occurrence
The planning area experiences agricultural losses every year as a result of naturally-occurring diseases that impact animals/livestock. There are three reportable diseases: Avian influenza, Exotic Newcastle Disease, and Scrapie that could become a problem in Iowa at any time. The IDALS is constantly monitoring livestock and extensive eradication programs in the U.S. have already wiped out several of these reportable diseases. As a result of impact management capabilities, including crop insurance and employment of various techniques to limit infestations, it was determined that the likelihood of a naturally occurring agricultural infestation event causing extensive damage is "Unlikely".

Probability Score: 1—Unlikely

Vulnerability

Overview
A widespread infestation of animals/livestock and crops could impact the economic base of the County. According to the Iowa State University, University Extension, 2007, the total economic output of livestock and crops which includes the value of agri-food processing and other ag-related manufacturing in Polk County is $79,200,000 or about 20% of Iowa agricultural production including over 540 jobs.

Magnitude Score: 2—Limited

Potential Losses to Existing Development
Buildings, infrastructure, and critical facilities are not vulnerable to this hazard. Its impacts are primarily economic and environmental, rather than structural affects.

Rough estimates of potential direct losses fall in a range of 1-75 percent of livestock receipts. The market value of all livestock in Polk County in 2007 was $12,200,000. Based on a worst case scenario where 75 percent of livestock is lost in a given year due to agricultural infestations, the total direct costs could total over $9 million.

Table 3.22 provides the annual crop losses for insurable crops. The insurable loss is adjusted to estimate losses to all insurable crops by considering that 88 percent of insurable crops in the State were insured (2011 Iowa Crop Insurance Profile from USDA's Risk Management Agency).

Table 3.22. Estimated Insurable Crop Losses Resulting From Infestation

Crop Value* (in 1,000s)	Crop Insurance Paid-10 yrs	Adjusted 10-year Losses	Annual Estimated Losses
$105,403	$62,840	$71,409	$7,140

Source: Crop value is from Iowa State University, University Extension, 2007; Crop Insurance Paid is from the USDA's Risk Management Agency for 2002-2011.
Note: This includes insurable crops that are insured

Rough estimates of potential direct losses from a maximum threat event fall in a range of 1-50 percent of annual crop receipts. Based on a worst case scenario where 50 percent of crop production is lost in a given year due to agricultural infestations, the total direct costs could approach $52,701,500.

Future Development

Future development is not expected to significantly impact the planning area's vulnerability to this hazard. However, if crop production and numbers of animals/livestock increases, the amount vulnerable to infestation also increases. Regarding the Emerald Ash Borer, the Iowa Department of Natural Resources recommends that other native tree species be planted in lieu of Ash trees to avoid increasing vulnerability to infestation of the Emerald Ash Borer.

The U.S. Forest Service estimates that Polk County has 1,000,001 to 2,500,000 ash trees in the County. Removal of debris if an infestation would occur would be challenging and costly. If only 10 percent of the Ash trees were impacted in Polk County that would translates to 250,000 trees. It is estimated that is costs $682 to replace each Ash tree. In Polk County, this translates to over $170 million.

Animal/Crop/Plant Disease Hazard Summary by Jurisdiction

The magnitude determinations discussed in the vulnerability overview sections were factored into the following hazard summary table to show how this hazard varies by jurisdiction. It has been determined that the magnitude of animal/crop/plant disease would be between 10-25 percent of property damage in the cities and for the school districts, thus their magnitude is 2. The majority damages for animal/crop/plant disease would be in the unincorporated County where the animals and crops are located.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	1	2	1	4	1.60	Low
Cities						
City of Alleman	1	2	1	4	1.60	Low
City of Altoona	1	2	1	4	1.60	Low
City of Ankeny	1	2	1	4	1.60	Low
City of Bondurant	1	2	1	4	1.60	Low
City of Clive	1	2	1	4	1.60	Low
City of Des Moines	1	2	1	4	1.60	Low
City of Elkhart	1	2	1	4	1.60	Low
City of Grimes	1	2	1	4	1.60	Low
City of Johnston	1	2	1	4	1.60	Low
City of Mitchellville	1	2	1	4	1.60	Low
City of Pleasant Hill	1	2	1	4	1.60	Low
City of Polk City	1	2	1	4	1.60	Low
City of Runnells	1	2	1	4	1.60	Low
City of Urbandale	1	2	1	4	1.60	Low
City of West Des Moines	1	2	1	4	1.60	Low
City of Windsor Heights	1	2	1	4	1.60	Low
Des Moines Water Works	N/A	N/A	N/A	N/A	N/A	N/A
School Districts						
Ankeny, 261	1	2	1	4	1.60	Low
Bondurant-Farrar, 720	1	2	1	4	1.60	Low
Dallas Center-Grimes, 1576	1	2	1	4	1.60	Low
Des Moines Independent, 1737	1	2	1	4	1.60	Low
Johnston, 3231	1	2	1	4	1.60	Low
North Polk, 4779	1	2	1	4	1.60	Low
Saydel, 5805	1	2	1	4	1.60	Low
Southeast Polk, 6101	1	2	1	4	1.60	Low
Urbandale, 6579	1	2	1	4	1.60	Low
Wes Des Moines	1	2	1	4	1.60	Low

3.4.2 Dam Failure

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
1	3	4	4	2.35	Moderate

Profile

Hazard Description

Many of Iowa's community settlements were founded along rivers and streams due to their reliance on water resources. Often, these streams or rivers later needed a dam for flood control or a reservoir for a constant water source. A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Dams are typically constructed of earth, rock, concrete, or mine tailings. Dam failure is the uncontrolled release of impounded water resulting in downstream flooding, affecting both life and property. Dam failure can be caused by any of the following: flooding; earthquakes; flow blockages; landslides; lack of maintenance; improper operation; poor construction; vandalism; or terrorism.

The thresholds for when a dam falls under State regulation are outlined in Iowa Administrative Code 567-71.3 and are listed below. The thresholds are primarily based on both dam height and water storage volumes. State regulated dams are those dams that meet the following:

In rural areas:

a. *Any dam designed to provide a sum of permanent and temporary storage exceeding 50 acre-feet at the top of dam elevation, or 25 acre-feet if the dam does not have an emergency spillway, and which has a height of 5 feet or more.*

b. *Any dam designed to provide permanent storage in excess of 18 acre-feet and which has a height of 5 feet or more.*

c. *Any dam across a stream draining more than 10 square miles.*

d. *Any dam located within 1 mile of an incorporated municipality, if the dam has a height of 10 feet or more, stores 10 acre-feet or more at the top of dam elevation, and is situated such that the discharge from the dam will flow through the incorporated area.*

In urban areas:

Any dam which exceeds the thresholds in 71.3 (1) "a", "b", or "d".

Low head dams:

Any low head dam on a stream draining 2 or more square miles in an urban area, or 10 or more square miles in a rural area.

Dams are classified by the State of Iowa into three categories based on the potential risk to people and property in the event of failure (see **Table 3.23**). The classification can change over time due to changes in development downstream from the dam. In addition, older dams may not have been built to the standards of their updated classification when this occurs. The Iowa Department of Natural Resources performs annual inspections on all high hazard dams in the State.

Table 3.23. Dam Hazard Classification Definitions

Hazard Class	Definition
High	A structure shall be classified as high hazard if located in an area where failure may create a serious threat of loss of human life or result in serious damage to residential, industrial, or commercial areas, important public utilities, public buildings, or major transportation facilities.
Moderate (Significant)*	A structure shall be classified as moderate hazard if located in an area where failure may damage isolated homes or cabins, industrial or commercial buildings, moderately traveled roads or railroads, interrupt major utility services, but without substantial risk of loss of human life. In addition, structures where the dam and its impoundment are of themselves of public importance, such as dams associated with public water supply systems, industrial water supply or public recreation, or which are an integral feature of a private development complex, shall be considered moderate hazard for design and regulatory purposes unless a higher hazard class is warranted by downstream conditions.
Low	A structure shall be classified as low hazard if located in an area where damages from a failure would be limited to loss of the dam, loss of livestock, damages to farm outbuildings, agricultural lands, and lesser used roads, and where loss of human live is considered unlikely.

Source: Iowa Department of Natural Resources; *the term "moderate" is used by the Iowa Department of Natural Resources. However, the National Inventory of Dams uses the term "significant" to identify the same general hazard classification

Warning Time Score: 4—Minimal or no warning (up to 6 hrs. warning)

Duration Score: 4—More than one week

Geographic Location/Extent

Dams in Planning Area

There are 74 regulated dams inside the county boundaries of Polk County. Of these, 13 are high hazard dams, 16 are moderate (significant) hazard dams, and 45 are low hazard dams. Of the 13 high hazard dams, 4 are owned and operated by the United States Army Corps of Engineers (USACE). These include the Saylorville dam and 3 Big Creek dam structures.

Table 3.24 provides the names, locations, and other pertinent information for all high and moderate (significant) hazard dams in the planning area. For those shaded light-gray, the most recent inspection reports were obtained from the Iowa Department of Natural Resources. Inspection reports were not available for the un-shaded dams. The Vulnerability Analysis section provides additional information about these dams based on data that was extracted from the inspection reports.

Table 3.24. High and Significant Hazard Dams in the Polk County Planning Area

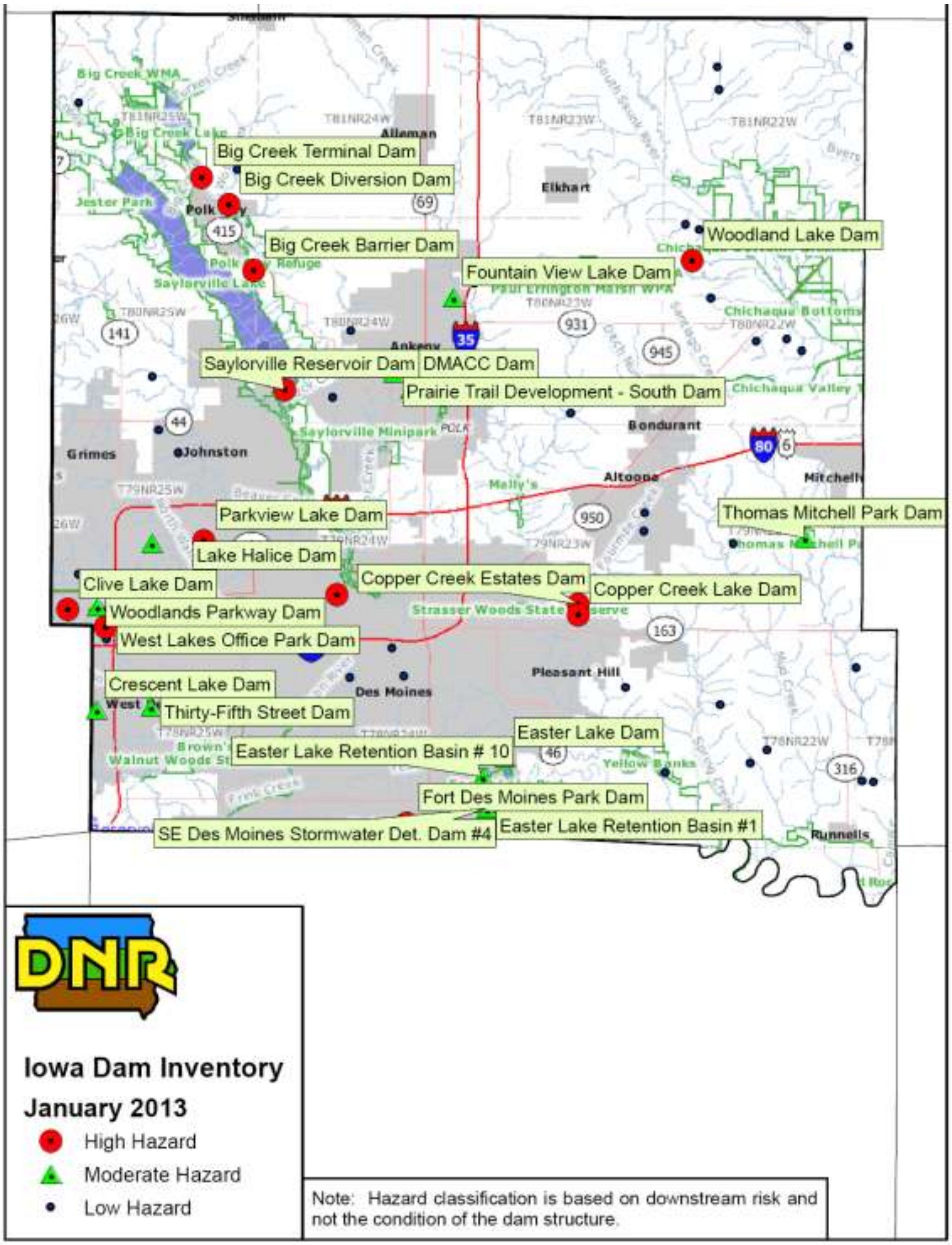
Dam Name	Hazard Class	EAP	Dam Height (Ft)	Maximum Storage (Acre-Ft)	Normal Storage (Acre-Ft)	Last Inspection Date By DNR	River	Nearest Downstream City	Distance To Nearest City (Miles)	Dam Owner
Big Creek Barrier Dam	H	Y	88	99,999	74,000	N/A	Des Moines River	Polk City	2	U.S. Army Corps Of Engineers
Big Creek Diversion Dam	H	Y	84	35,500	15,600	N/A	Big Creek	Polk City	2	U.S. Army Corps Of Engineers
Big Creek Terminal Dam	H	Y	124	35,500	15,600	N/A	Big Creek	Saylorville Reservoir	2	U.S. Army Corps Of Engineers
Clive Lake Dam	H	NR	37	1,253	274	9/29/2011	Tr- Walnut Creek	Clive	0	Country Club Owners Association
Copper Creek Estates Dam	H	NR	21	24	15	10/11/2011	Tr-Little Four Mile Creek	Pleasant Hill	0	D.W. Homes, Inc.
Copper Creek Lake Dam	H	NR	31	103	46	10/7/2011	Tr- Four Mile Creek	Pleasant Hill	0	Copper Creek Golf Course, L.C.
Easter Lake Stormwater Retention Basin – Site 9	H	NR	24	168	23	8/7/2012	Tr- Yeader Creek	Des Moines	0	City Of Des Moines
Fort Des Moines Park Dam	H	NR	49	240	120	10/7/2011	Tr-North River	Des Moines	0	Polk Co Conservation Board
Parkview Lake Dam	H	NR	21	95	15	10/7/2011	Karen Acres Creek	Urbandale	0	City Of Urbandale
Saylorville Reservoir Dam	H	Y	126	99,999	74,000		Des Moines River	Des Moines	5	U.S. Army Corps Of Engineers
Twenty-Sixth Street Stormwater Detention Basin	H	NR	43	242	97	8/13/2012	Closes Creek	Des Moines	0	City Of Des Moines
West Lakes Office Park Dam	H	NR	41	267	85	9/29/2011	Tr-Walnut Creek	West Des Moines	0	Farm Bureau Life Insurance Co.
Woodland Lake Dam	H	NR	43	723	421	10/7/2011	Tr-Skunk River	Colfax (Jasper Co.)	15	Woodland Lake Estates Homeowners Assn.
Crescent Lake Dam	S	NR	0	27	15		Tr- Jordan Creek	West Des Moines	0	Ladco Development
DMACC Dam	S	NR	37	306	88	9/18/2012	Tr- Saylor Cr.	Ankeny	0	Iowa Dept. Of Transportation
Easter Lake Dam	S	NR	43	6,200	3,200	8/7/2012	Yeader Creek	Des Moines	0	Polk Co Conservation Board
Easter Lake Retention Basin # 10	S	NR	22	23	10	6/17/2010	Tr- Yeader Creek	Des Moines	0	City Of Des Moines

Dam Name	Hazard Class	EAP	Dam Height (Ft)	Maximum Storage (Acre-Ft)	Normal Storage (Acre-Ft)	Last Inspection Date By DNR	River	Nearest Downstream City	Distance To Nearest City (Miles)	Dam Owner
Easter Lake Retention Basin #1	S	NR	18	20	6	6/17/2010	Tr-Yeader Creek	Des Moines	0	City Of Des Moines
Fountain View Lake Dam	S	NR	8	115	78		Tr- Four Mile Creek	Ankeny	0	Fountain View Estates Homeowners Assn.
Lake Halice Dam	S	NR	27	120	75	8/13/2012	Tr- North Walnut Cr.	Urbandale	0	Lake Halice Lot Owners Assn.
Prairie Trail Development – North Dam	S	NR	22	105	44		Tr- Saylor Creek	Ankeny	0	City Of Ankeny And Dra Properties
Prairie Trail Development – South Dam	S	NR	31	114	46		Tr- Saylor Creek	Ankeny	0	City Of Ankeny & Dra Properties
Se Des Moines Stormwater Det. Dam #3	S	NR	34	185	30	6/17/2010	Tr- Yeader Creek	Des Moines	0	City Of Des Moines
Se Des Moines Stormwater Det. Dam #4	S	NR	26	95	20	6/17/2010	Tr- Yeader Creek	Des Moines	0	City Of Des Moines
Thirty-Fifth Street Dam	S	NR	23	95	25	11/29/2005	Tr-Jordan Creek	West Des Moines	0	City Of West Des Moines
Thomas Mitchell Park Dam	S	NR	27	75	25	10/28/2010	Tr-Camp Creek	Red Rock Reservoir	25	Polk Co Conservation Board
Thunder Bay Lake Dam	S	NR	19	119	60		Tr-Four Mike Creek	Altoona	0	Prairie Crossing Investments, Inc.
Ward Business Park Dam	S	NR	17	25	9		Tr- North Walnut Creek	Urbandale	0	Wbd, Inc.
Woodlands Parkway Dam	S	NR	0	48	23	9/1/2009	Tr-Walnut Creek	Clive	1	Woodlands Parkway, Llc C/O Grant Correll

Source: Iowa Department of Natural Resources; H = High, S = Significant; NR= Not Required; N/A = Not Available; EAP = Emergency Action Plan

Figure 3.37 provides the locations of high, significant, and low hazard dams in the planning area.

Figure 3.37. Dam Locations in Polk County



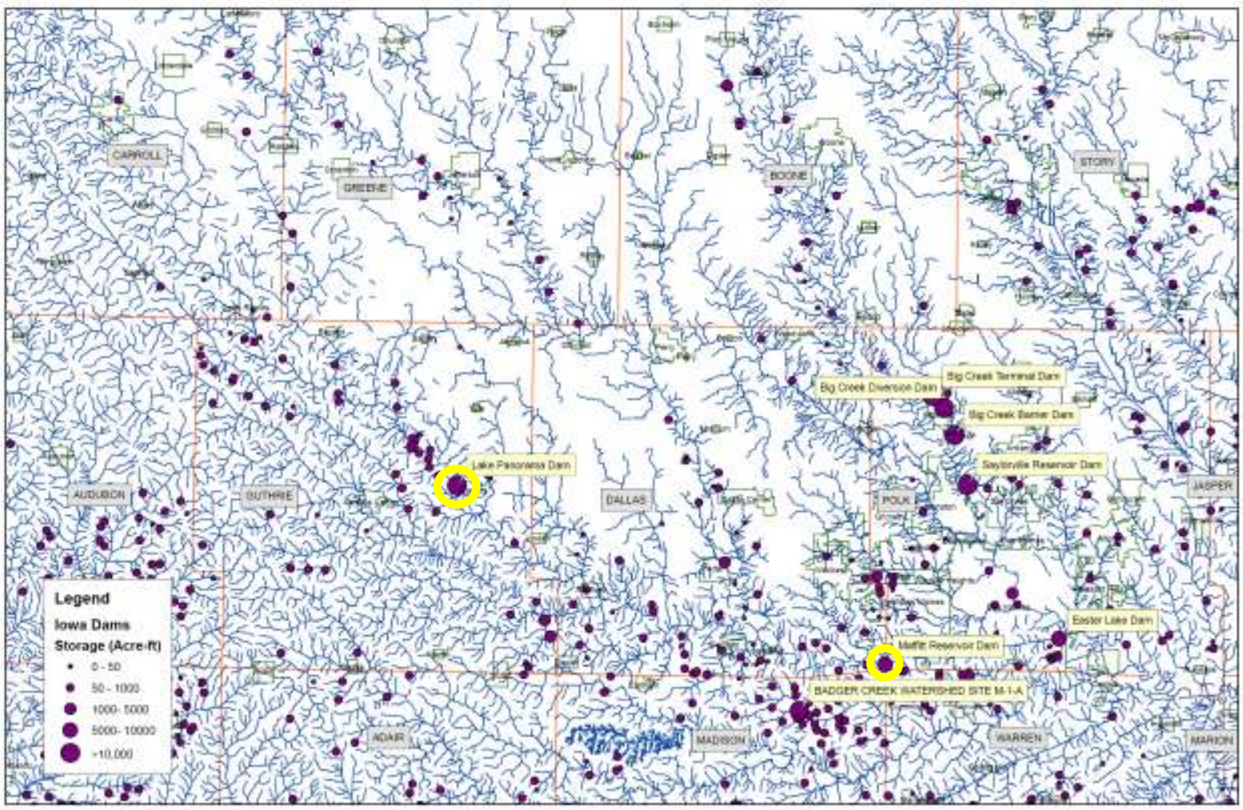
Source: Iowa Department of Natural Resources

Upstream Dams Outside the Planning Area

The Iowa Department of Natural Resources was consulted to comment on dams located outside of Polk County that would impact Polk County in the unlikely event of failure. Due to the limited size of upstream dams, the DNR review of upstream dams did not reveal any that would cause significant damages in Polk Count in the event of a dam failure. However, there are two dams that might cause some damages as a result of flooding in Polk County. These are Maffit Reservoir in Dallas County and Lake Panorama in Guthrie County (identified by bellow circles in map).

Table 3.3 provides the locations of these dams relative to Polk County. The size of the dot in the figure is relative to the storage size.

Figure 3.38. Upstream Dams Outside Polk County



Source: Iowa Department of Natural Resources

Previous Occurrences

To determine previous occurrences of dam failure within Polk County, the 2009 Polk County Hazard Mitigation Plan, the Iowa State Hazard Mitigation Plan, and the Stanford University's National Performance of Dams Program (**http://npdp.stanford.edu/**) were reviewed for historical dam failures. No record of dam failure within Polk County boundaries was found.

Although no record of dam failure within Polk County was found, there was concern during the very wet period of 1993 that water might overtop Saylorville Reservoir. With the outfall flowing at full capacity and water flowing out of the spillway, the reservoir did not overtop the dam.

Probability of Future Occurrence

There is an overall low probability of dam failures in Polk County. There is a rigorous routine inspection and regular maintenance schedule for all state regulated dams. USACE is responsible for the inspection and maintenance of their four dams. Recent inspection reports were requested from Iowa DNR for all high hazard dams regulated by the State. According to these inspection reports, all state-regulated high hazard dams in the County have been inspected in the last two years. The findings of the inspection reports, including downstream development are discussed in greater detail in the vulnerability section that follows.

Probability Score: 1—Unlikely

Vulnerability

Overview

Dam failure is typically an additional or secondary impact of another disaster such as flooding or earthquake. The impacts to the planning area and its municipalities from a dam failure would be similar in some cases to those associated with flood events (see the flood hazard vulnerability analysis and discussion). Based on the hazard class definitions, failure of any of the high hazard dams could result in a serious threat of loss of human life, serious damage to residential, industrial or commercial areas, important public utilities, public buildings, or major transportation facilities.

Catastrophic failure of high hazard dams has the potential to result in greater destruction due to the potential speed of onset and greater depth, extent, and velocity of flooding. Another difference is that dam failures could flood areas outside of mapped flood hazards.

State-Regulated Dams

For each of the state-regulated high-hazard dams indicated in **Table 3.24** the information provided by the Iowa Department of Natural Resources, including the most recent inspection reports have been reviewed to determine the specific jurisdictions, approximate number of people and types of property that may be vulnerable in the event of dam failure. More detailed spatial analysis was not possible since inundation maps are not available.

This analysis revealed that the following jurisdictions are vulnerable to the unlikely failure of high hazard dams.

- Clive
- Colfax (in Jasper County)
- Des Moines
- Pleasant Hill
- Polk City
- Urbandale

- West Des Moines

Additionally, the following communities are vulnerable to dam failure of significant hazard dams:

- Altoona
- Ankeny
- Clive
- Des Moines
- Urbandale
- West Des Moines

To determine the potential magnitude of dam failure of the high and significant hazard dams, several factors were evaluated: Dam Hazard Class, Proximity to populations, and Volume of Dam. **Table 3.25** summarizes the estimated potential magnitude for the state-regulated high and significant hazard dams that could impact the planning area in the event of overtopping or failure. Those dams with gray shading also have an available recent inspection report completed by the Iowa Department of Natural Resources and are discussed separately in the section entitled Potential Losses to Existing Development.

Table 3.25. Potential Magnitude of Failure of Federal/State-regulated Dams

Dam Name	Hazard Class	Maximum Storage (Acre-Ft)	River	Nearest Downstream City	Distance To Nearest City (Miles)	Potential Magnitude in the Event of Failure
Big Creek Barrier Dam-Federal	H	99,999	Des Moines River	Polk City	2	Catastrophic
Big Creek Diversion Dam-Federal	H	35,500	Big Creek	Polk City	2	Catastrophic
Big Creek Terminal Dam-Federal	H	35,500	Big Creek	Saylorville Reservoir	2	Catastrophic
Clive Lake Dam	H	1,253	Tr- Walnut Creek	Clive	0	Critical
Copper Creek Estates Dam	H	24	Tr-Little Four Mile Creek	Pleasant Hill	0	Critical
Copper Creek Lake Dam	H	103	Tr- Four Mile Creek	Pleasant Hill	0	Critical
Easter Lake Stormwater Retention Basin – Site 9	H	168	Tr- Yeader Creek	Des Moines	0	Critical
Fort Des Moines Park Dam	H	240	Tr-North River	Des Moines	0	Critical
Parkview Lake Dam	H	95	Karen Acres Creek	Urbandale	0	Critical
Saylorville Reservoir Dam-Federal	H	99,999	Des Moines River	Des Moines	5	Critical
Twenty-Sixth Street Stormwater Detention Basin	H	242	Closes Creek	Des Moines	0	Critical
West Lakes Office Park Dam	H	267	Tr-Walnut Creek	West Des Moines	0	Critical
Woodland Lake Dam	H	723	Tr-Skunk River	Colfax	15	Critical
Crescent Lake Dam	S	27	Tr- Jordan Creek	West Des Moines	0	Limited
Dmacc Dam	S	306	Tr- Saylor Cr.	Ankeny	0	Limited
Easter Lake Dam	S	6,200	Yeader Creek	Des Moines	0	Critical
Easter Lake Retention Basin # 10	S	23	Tr- Yeader Creek	Des Moines	0	Limited
Easter Lake Retention Basin #1	S	20	Tr-Yeader Creek	Des Moines	0	Limited
Fountain View Lake Dam	S	115	Tr- Four Mile Creek	Ankeny	0	Limited
Lake Halice Dam	S	120	Tr- North Walnut Cr.	Urbandale	0	Limited

Dam Name	Hazard Class	Maximum Storage (Acre-Ft)	River	Nearest Downstream City	Distance To Nearest City (Miles)	Potential Magnitude in the Event of Failure
Prairie Trail Development – North Dam	S	105	Tr- Saylor Creek	Ankeny	0	Limited
Prairie Trail Development – South Dam	S	114	Tr- Saylor Creek	Ankeny	0	Limited
Se Des Moines Stormwater Det. Dam #3	S	185	Tr- Yeader Creek	Des Moines	0	Limited
Se Des Moines Stormwater Det. Dam #4	S	95	Tr- Yeader Creek	Des Moines	0	Limited
Thirty-Fifth Street Dam	S	95	Tr-Jordan Creek	West Des Moines	0	Limited
Thomas Mitchell Park Dam	S	75	Tr-Camp Creek	Red Rock Reservoir	25	Limited
Thunder Bay Lake Dam	S	119	Tr-Four Mike Creek	Altoona	0	Limited
Ward Business Park Dam	S	25	Tr- North Walnut Creek	Urbandale	0	
Woodlands Parkway Dam	S	48	Tr-Walnut Creek	Clive	1	Limited

Source: Iowa Department of Natural Resources

Federal Dams

Inundation maps were provided for the federal dams in the planning area. From the inundation data for a Probable Maximum Flood including failure of the dam, it was determined that the following jurisdictions are vulnerable to the unlikely failure of federal dams:

- Unincorporated Polk County
- Ankeny
- Carlisle
- Des Moines
- Johnston
- Pleasant Hill
- Runnells
- Urbandale
- West Des Moines

Magnitude/Severity Score: 2—Limited

Potential Losses to Existing Development

Potential losses to existing development were determined for all high hazard dams in the planning area in one of two ways, depending on available data.

1) State-regulated Dams

To estimate potential losses to existing development as a result of dam failure of state-regulated high hazard dams, hazard information regarding potential downstream impacts in the event of failure was extracted from the hazard classification review in available inspection reports. Inspection reports were available for all but one state regulated dam, West Lakes Office Park Dam

Table 3.26 provides the information on assets downstream of dam structures obtained from the hazard classification review comments contained in the inspection reports:

Table 3.26. Assets Downstream of State-regulated High Hazard Dam Structures

Dam Name	Hazard Class	River	Nearest Downstream City	Distance To Nearest City (Miles)	Inspection Date/Rating	Assets Downstream
Clive Lake Dam	H	Tr- Walnut Creek	Clive	0	9/29/2011 Satisfactory	Urban development/ public and private property
Copper Creek Estates Dam	H	Tr-Little Four Mile Creek	Pleasant Hill	0	10/11/2011 Satisfactory	Housing Development
Copper Creek Lake Dam	H	Tr- Four Mile Creek	Pleasant Hill	0	10/12/2011 Satisfactory	Not Indicated
Easter Lake Stormwater Retention Basin – Site 9	H	Tr- Yeader Creek	Des Moines	0	8/7/2012 Satisfactory	Existing residential structures and probable development of additional residential structures.
Fort Des Moines Park Dam	H	Tr-North River	Des Moines	0	10/7/2011 Satisfactory	SE 5th Street (heavily traveled)/ A few residential structures
Parkview Lake Dam	H	Karen Acres Creek	Urbandale	0	10/7/2011 Satisfactory	Extensive urban development
Twenty-Sixth Street Stormwater Detention Basin	H	Closes Creek	Des Moines	0	8/13/2012 Satisfactory	Houses, apartment buildings, and commercial buildings
Woodland Lake Dam	H	Tr-Skunk River	Colfax	15	10/7/2011 Fair	Residential Structures

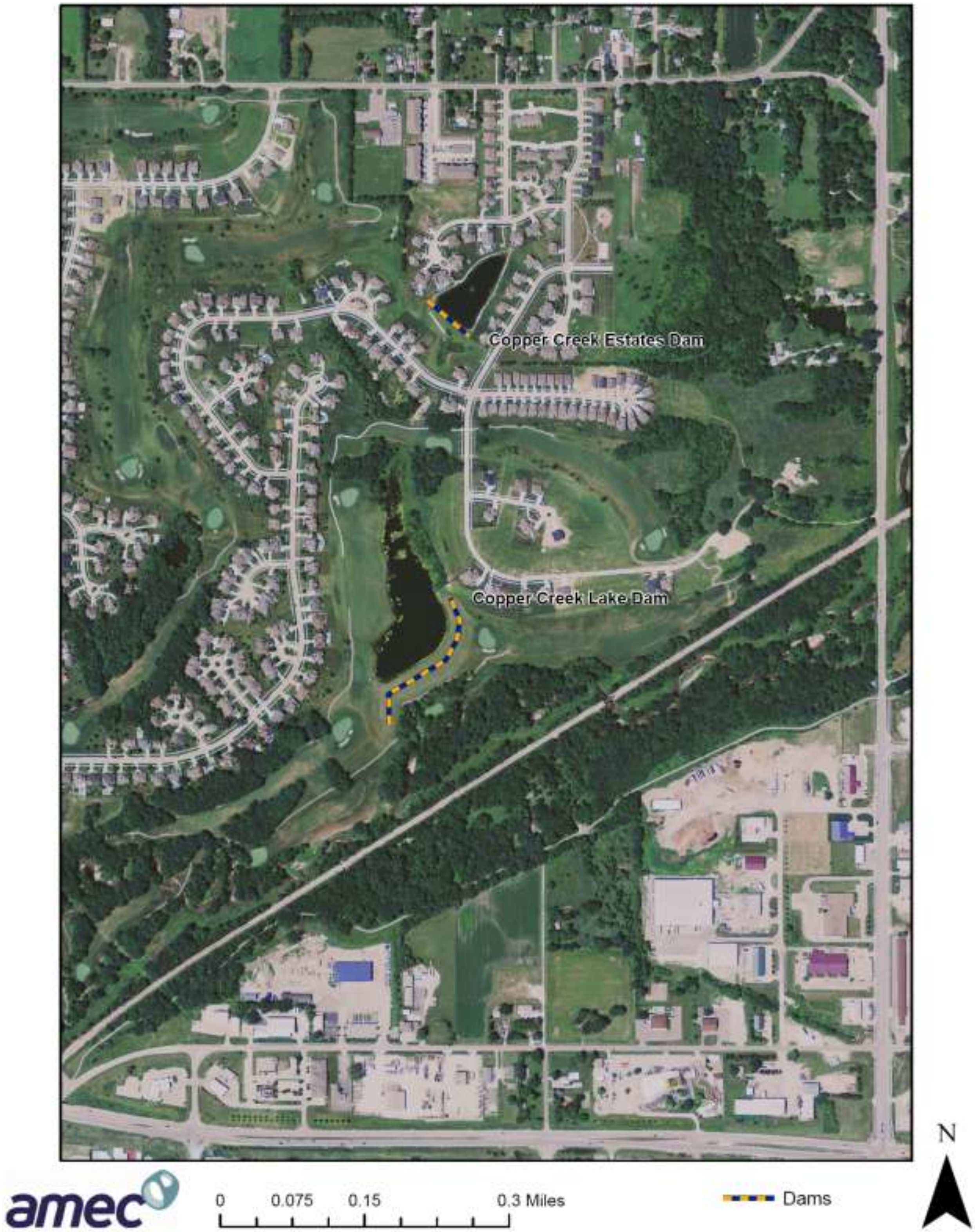
Source: Iowa Department of Natural Resources

Data limitations for state-regulated dams prevent additional development of quantitative loss estimates since specific inundation maps are not available to determine specific structures, values, and expected water depth. If inundation maps become available prior to the next update of this plan, additional quantitative loss estimates can be developed. **Figure 3.39** through **Figure 3.45** provide aerial imagery of the state-regulated high hazard dams in Polk County to provide contextual information regarding downstream development.

Figure 3.39. Clive Lake Dam

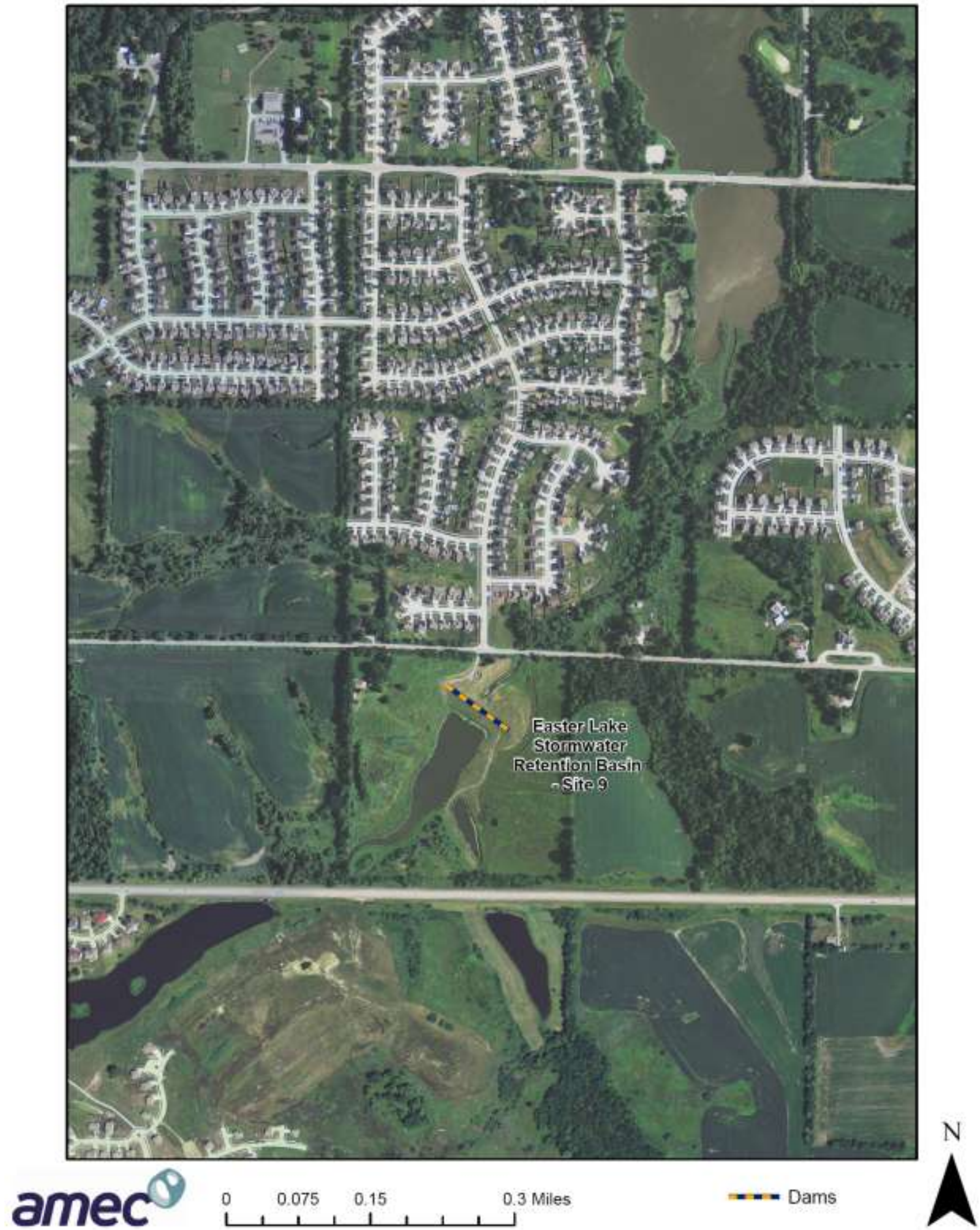
Source: Map compiled by AMEC; Dam Locations from Iowa Department of Natural Resources; Aerial Imagery from USDA

Figure 3.40. Copper Creek Estates Dam and Copper Creek Lake Dam



Source: Map compiled by AMEC; Dam Locations from Iowa Department of Natural Resources; Aerial Imagery from USDA

Figure 3.41. Easter Lake Stormwater Retention Basin-Site 9

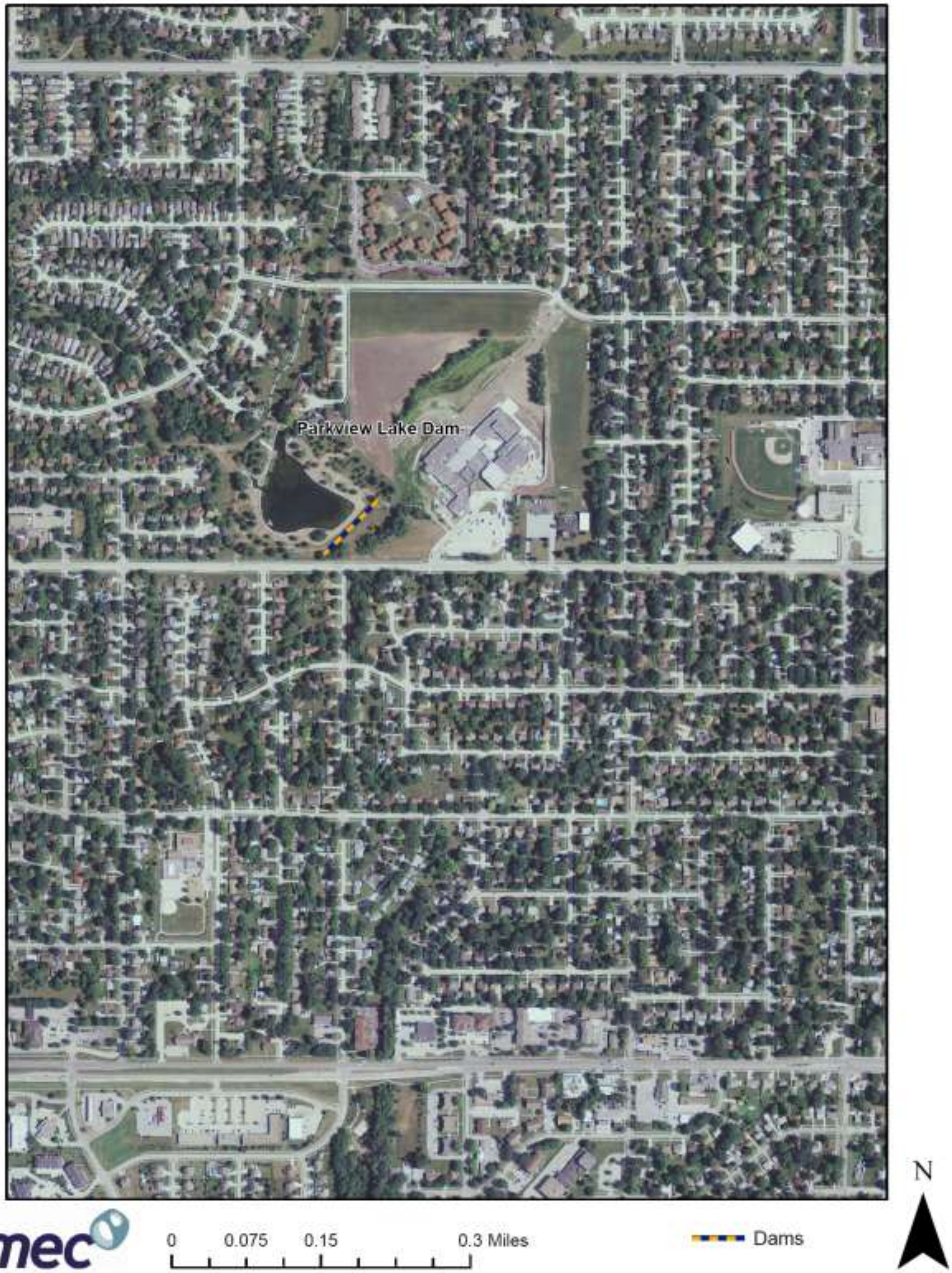


Source: Map compiled by AMEC; Dam Locations from Iowa Department of Natural Resources; Aerial Imagery from USDA

Figure 3.42. Fort Des Moines Park Dam

Source: Map compiled by AMEC; Dam Locations from Iowa Department of Natural Resources; Aerial Imagery from USDA

Figure 3.43. Parkview Lake Dam

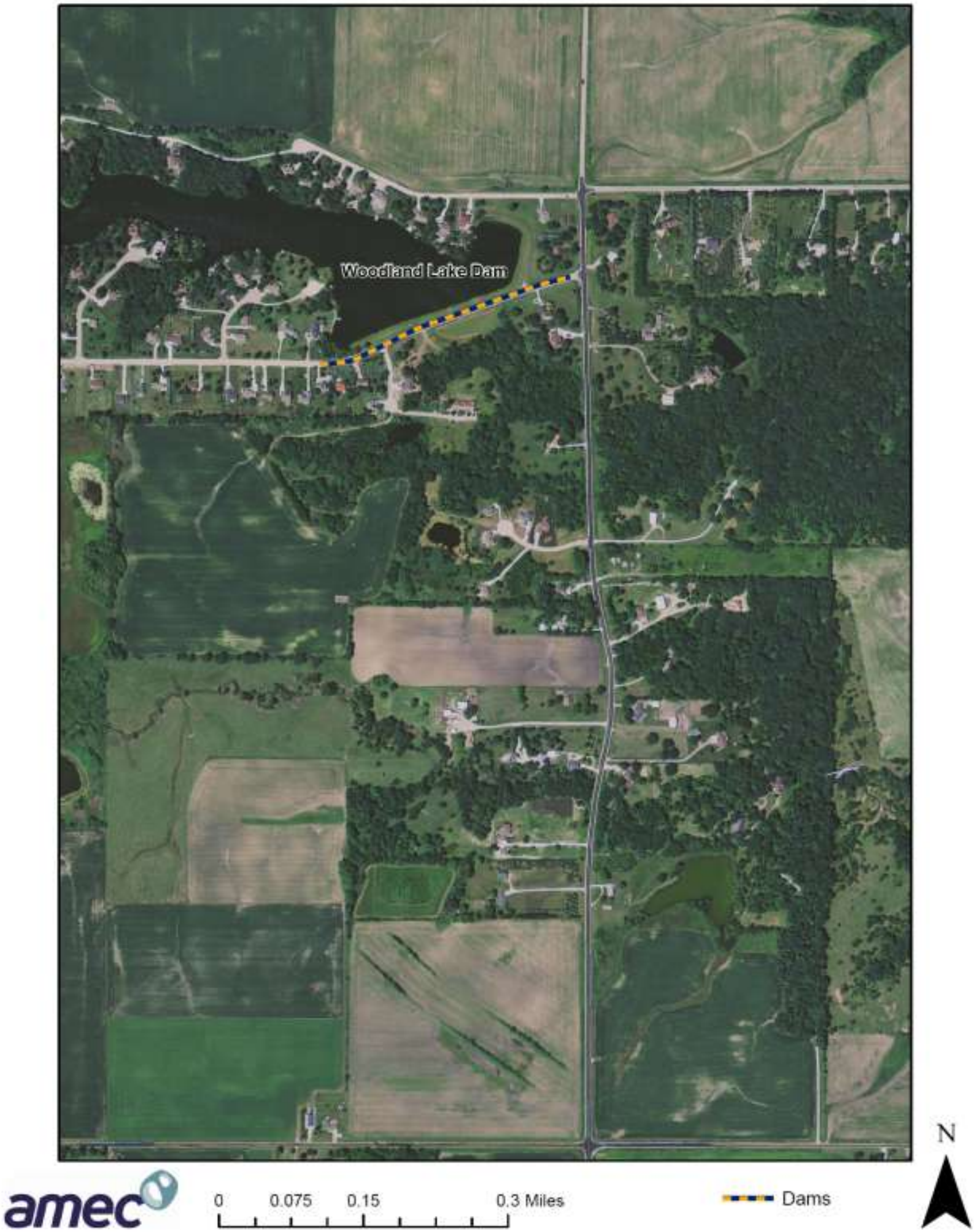


Source: Map compiled by AMEC; Dam Locations from Iowa Department of Natural Resources; Aerial Imagery from USDA

Figure 3.44. Twenty-sixth Street Stormwater Detention Basin

Source: Map compiled by AMEC; Dam Locations from Iowa Department of Natural Resources; Aerial Imagery from USDA

Figure 3.45. Woodland Lake Dam



Source: Map compiled by AMEC; Dam Locations from Iowa Department of Natural Resources; Aerial Imagery from USDA

2) Federal Dams

Two major reservoirs that serve as flood protection devices are located in Polk County: Big Creek Lake on Big Creek and Saylorville Reservoir on the Des Moines River. There are four federal dams associated with these reservoirs, three for Big Creek Lake and one for Saylorville Reservoir. Failure of these dams would impact jurisdictions in the planning area.

In 2013, the USACE Rock Island District provided updated GIS inundation scenarios for the Saylorville project. Since all four federal dams are part of one project, the inundation map is inclusive of all dam structures. For purposes of determining vulnerability and loss estimates, the inundation scenario for Probable Maximum Flood-Failure was chosen for the analysis. To determine specific potential losses as a result of this type of failure, the inundation layer was overlaid on current parcel and building data from the Des Moines GIS Department to provide details on the types, numbers, and values of structures at risk. To estimate the population impacted, the number of residential buildings in each jurisdiction was multiplied by the average household size for that jurisdiction, according to the 2010 census. A noted data limitation is related to multi-family buildings that exist in the inundation area. This methodology does not take these into account. Therefore, the population at risk is likely underestimated. Additionally, it was noted that several parcels have buildings indicated on the building layer, but there is no associated value on the parcel layer. This is most apparent in the “agricultural” property type.

Table 3.27 provides the number and types of buildings that would be impacted by this dam failure scenario as well as the estimated population at risk. **Table 3.28** that follows provides the building values in the inundation area. **Figure 3.46** provides a map of the dam inundation area as a result of this failure scenario.

A specific dollar loss estimate has not been generated as part of this analysis due to data limitations. Losses, both in terms of human life and building damages, would be expected to be greater in those inundation areas closest to the dam structure due to limited time to respond as well as higher velocity of flows. Some buildings would be a total loss, while others further downstream might sustain losses in a range of 10 to 20 percent of value.

Table 3.27. Building Count and Estimated Population in Saylorville/Big Creek Lake Inundation Path-Probable Maximum Flood-Failure

Jurisdiction	Residential	Commercial	Government	School	Industrial	Agricultural	Total	Avg. Household Size	Est. Population at Risk
Alleman	0	0	0	0	0	0	0	2.86	0
Altoona	0	0	0	0	0	0	0	2.64	0
Ankeny	2	0	0	0	0	0	2	2.58	5
Bondurant	0	0	0	0	0	0	0	2.83	0
Carlisle*	68	14	4	0	8	23	117	2.57	175
Clive (Dallas)	0	0	0	0	0	0	0	2.68	0
Clive (Polk)	0	0	0	0	0	0	0	2.68	0
Des Moines (Polk)	11,809	1,716	735	27	463	27	14,777	2.43	28,696
Des Moines (Warren)	0	3	0	0	0	1	4	2.43	0
Elkhart	0	0	0	0	0	0	0	2.67	0
Granger*	0	0	0	0	0	0	0	2.59	0
Grimes (Dallas)	0	0	0	0	0	0	0	2.65	0
Grimes (Polk)	0	0	0	0	0	0	0	2.65	0
Johnston	1,907	593	275	32	23	30	2,860	2.67	5,092
Mitchellville	0	0	0	0	0	0	0	2.53	0
Mitchellville (Jasper)	0	0	0	0	0	0	0	2.53	0
Norwalk*	0	0	0	0	0	0	0	2.70	0
Pleasant Hill	87	481	13	0	20	7	608	2.57	224
Polk City	0	0	0	0	0	0	0	2.73	0
Polk County Unincorporated	2,590	618	133	0	49	611	4,001	2.48	6,423
Runnells	21	2	16	0	0	4	43	2.83	59
Sheldahl*	0	0	0	0	0	0	0	2.57	0
Urbandale (Dallas)	0	0	0	0	0	0	0	2.52	0
Urbandale (Polk)	231	11	8	0	0	0	250	2.52	582
West Des Moines (Dallas)	0	0	0	0	0	0	0	2.32	0
West Des Moines (Madison)	0	0	0	0	0	0	0	2.32	0
West Des Moines (Polk)	7	12	20	0	0	4	43	2.32	16
West Des Moines (Warren)	0	0	0	0	0	0	0	2.32	0
Windsor Heights	0	0	0	0	0	0	0	2.24	0
Total	**16,722**	**3,450**	**1,204**	**59**	**563**	**707**	**22,705**		**41,272**

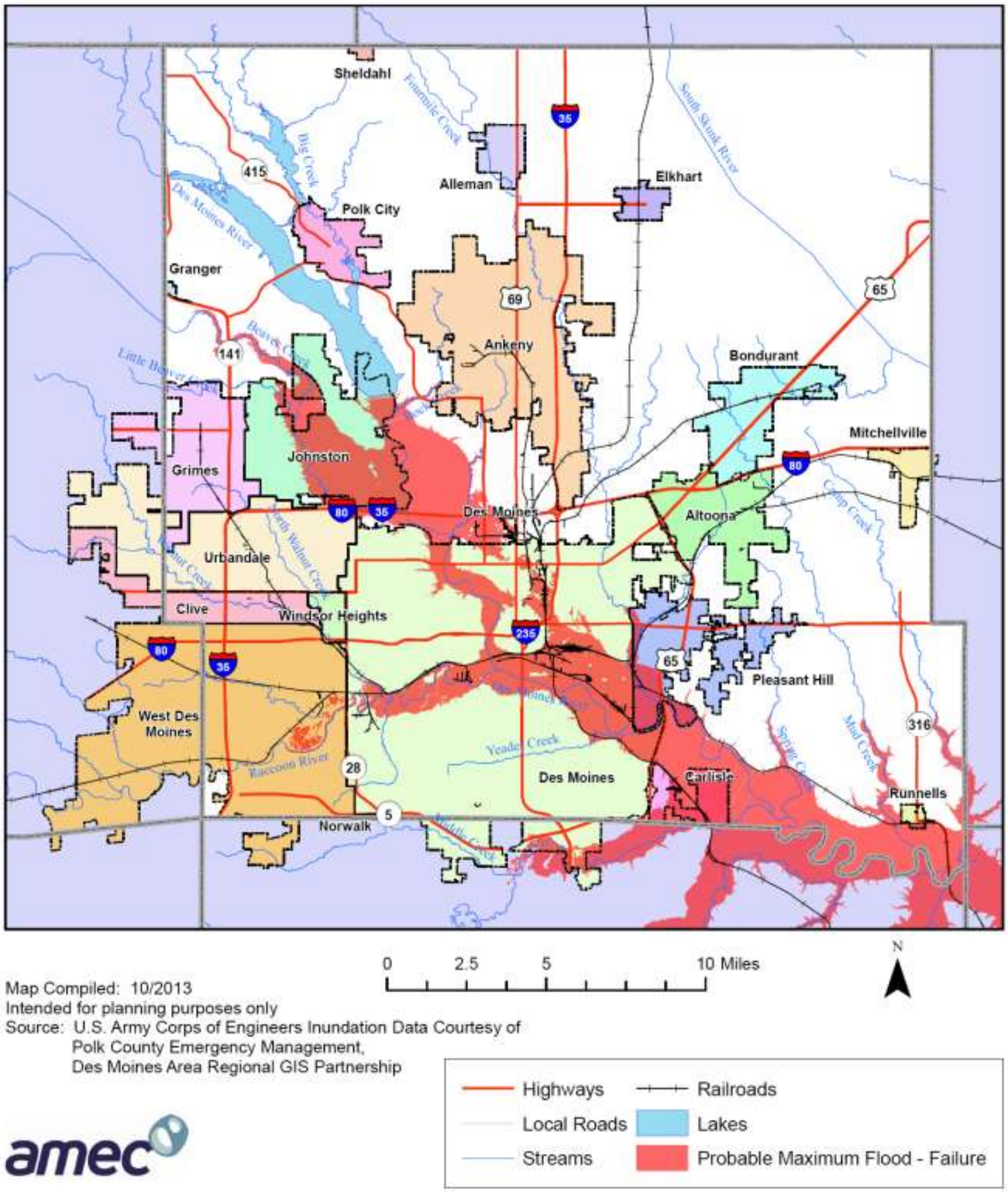
Source: Inundation layer from US Army Corps of Engineers Saylorville Dam Emergency Plan courtesy of Des Moines GIS Department; Parcel data from Des Moines GIS Department, Analysis by AMEC; Note: Commercial Category also includes those buildings in the parcel data indicated as “Header”, “Utility”, and “Unknown””; Average Household size is from the U.S. Census Bureau, 2010 Decennial Census; * Data is for the portion of these cities that is in Polk County only

Table 3.28. Building Values in Saylorville/Big Creek Lake Inundation Path—Probable Maximum Flood-Failure

Jurisdiction	Residential	Commercial	Government	School	Industrial	Agricultural	Total
Alleman	$0	$0	$0	$0	$0	$0	$0
Altoona	$0	$0	$0	$0	$0	$0	$0
Ankeny	$765,500	$0	$0	$0	$0	$0	$765,500
Bondurant	$0	$0	$0	$0	$0	$0	$0
Carlisle*	$2,888,800	$4,742,000	$0	$0	$4,822,000	$343,300	$12,796,100
Clive (Dallas)	$0	$0	$0	$0	$0	$0	$0
Clive (Polk)	$0	$0	$0	$0	$0	$0	$0
Des Moines (Polk)	$467,372,100	$535,544,310	$27,520,350	$2,646,000	$99,859,400	$3,100	$1,132,945,260
Des Moines (Warren)	$0	$0	$0	$0	$0	$0	$0
Elkhart	$0	$0	$0	$0	$0	$0	$0
Granger*	$0	$0	$0	$0	$0	$0	$0
Grimes (Dallas)	$0	$0	$0	$0	$0	$0	$0
Grimes (Polk)	$0	$0	$0	$0	$0	$0	$0
Johnston	$270,840,950	$226,566,060	$2,760,350	$7,401,990	$1,275,000	$301,800	$509,146,150
Mitchellville	$0	$0	$0	$0	$0	$0	$0
Mitchellville (Jasper)	$0	$0	$0	$0	$0	$0	$0
Norwalk*	$0	$0	$0	$0	$0	$0	$0
Pleasant Hill	$4,999,100	$10,696,600	$0	$0	$3,921,500	$0	$19,617,200
Polk City	$0	$0	$0	$0	$0	$0	$0
Polk County Unincorporated	$109,120,300	$43,371,000	$684,420	$0	$19,490,500	$8,073,700	$180,739,920
Runnells	$566,800	$0	$0	$0	$0	$44,000	$610,800
Sheldahl	$0	$0	$0	$0	$0	$0	$0
Urbandale (Dallas)	$0	$0	$0	$0	$0	$0	$0
Urbandale (Polk)	$28,262,600	$15,330,100	$0	$0	$0	$0	$43,592,700
West Des Moines (Dallas)	$0	$0	$0	$0	$0	$0	$0
West Des Moines (Madison)	$0	$0	$0	$0	$0	$0	$0
West Des Moines (Polk)	$816,600	$173,100	$0	$0	$0	$0	$989,700
West Des Moines (Warren)	$0	$0	$0	$0	$0	$0	$0
Windsor Heights	$0	$0	$0	$0	$0	$0	$0
Total	**$885,632,750**	**$836,423,170**	**$30,965,120**	**$10,047,990**	**$129,368,400**	**$8,765,900**	**$1,901,203,330**

Source: Inundation layer from US Army Corps of Engineers Saylorville Dam Emergency Plan courtesy of Polk County Emergency Management; Parcel data from Des Moines GIS Department, Analysis by AMEC; Note: Commercial Category also includes those buildings in the parcel data indicated as “Header”, “Utility”, and “Unknown””; Average Household size is from the U.S. Census Bureau, 2010 Decennial Census; * Data is for the portion of these cities that is in Polk County only

Figure 3.46. Saylorville Dam Inundation Area, Probable Maximum Flood-Failure



Future Development

Future development located downstream from dams in floodplains or inundation zones would increase vulnerability to this hazard. Of those jurisdictions vulnerable to dam inundation hazard, the following have had an increase in housing units in the last 10 years suggesting the potential for future development.

Table 3.29. Jurisdictions Vulnerable to Dam Failure with Increasing Development Trend, 2000-2010

Jurisdiction	Type of Dam	Housing Units 2010	Housing Units 2000	2000-2010 # Change	2000-2010 % change
Polk County	High Hazard Federal	182,262	156,447	25,815	16.5%
Altoona	Significant	5,702	3,959	1,743	44.0%
Ankeny	Significant	18,339	10,882	7,457	68.5%
Clive	High Hazard Federal	6,077	4,902	1,175	24.0%
Des Moines	High Hazard Federal	89,052	85,067	3,985	4.7%
Johnston	Federal	6,618	3,406	3,212	94.3%
Pleasant Hill	High Hazard Federal	3,587	1,966	1,621	82.5%
Polk City	High Hazard	1,276	842	434	51.5%
Urbandale	High Hazard Federal	16,319	11,869	4,450	37.5%
West Des Moines	High Hazard Federal	26,219	20,815	5,404	26.0%
Windsor Heights	Federal	2,289	2,222	67	3.0%

Source: U.S. Bureau of the Census, Decennial Census; Population Statistics are for entire incorporated areas as reported by the U.S. Census bureau

Dam Failure Hazard Summary by Jurisdiction

The magnitude determinations discussed in the vulnerability overview sections were factored into the following hazard summary table to show how this hazard varies by jurisdiction. The Dam Failure hazard is considered Not Applicable (N/A) for jurisdictions that are not in the path of federal, high or significant hazard dams. For Des Moines Water Works, the analysis of the critical facility inventory revealed some facilities are in the inundation path of the probably maximum flood failure scenario. Therefore, the magnitude for this jurisdiction was determined to be a “3”.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	1	3	4	4	2.35	Moderate
Cities						
City of Alleman	N/A	N/A	N/A	N/A	N/A	N/A
City of Altoona	1	2	4	4	2.05	Moderate
City of Ankeny	1	3	4	4	2.35	Moderate
City of Bondurant	N/A	N/A	N/A	N/A	N/A	N/A
City of Clive	1	3	4	4	2.35	Moderate
City of Des Moines	1	3	4	4	2.35	Moderate
City of Elkhart	N/A	N/A	N/A	N/A	N/A	N/A
City of Grimes	N/A	N/A	N/A	N/A	N/A	N/A
City of Johnston	1	3	4	4	2.35	Moderate
City of Mitchellville	N/A	N/A	N/A	N/A	N/A	N/A
City of Pleasant Hill	1	3	4	4	2.35	Moderate
City of Polk City	1	3	4	4	2.35	Moderate
City of Runnells	1	3	4	4	2.35	Moderate
City of Urbandale	1	3	4	4	2.35	Moderate
City of West Des Moines	1	3	4	4	2.35	Moderate
City of Windsor Heights	N/A	N/A	N/A	N/A	N/A	N/A
Des Moines Water Works	1	3	4	4	2.35	Moderate
School Districts						
Ankeny, 261	1	3	4	4	2.35	Moderate
Bondurant-Farrar, 720	N/A	N/A	N/A	N/A	N/A	N/A
Dallas Center-Grimes, 1576	N/A	N/A	N/A	N/A	N/A	N/A
Des Moines Independent, 1737	1	3	4	4	2.35	Moderate
Johnston, 3231	1	3	4	4	2.35	Moderate
North Polk, 4779	N/A	N/A	N/A	N/A	N/A	N/A
Saydel, 5805	1	3	4	4	2.35	Moderate
Southeast Polk, 6101	1	3	4	4	2.35	Moderate
Urbandale, 6579	1	3	4	4	2.35	Moderate
West Des Moines	1	3	4	4	2.35	Moderate

3.4.3 Drought

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
3	2	1	4	2.50	Moderate

Profile

Hazard Description
Drought is generally defined as a condition of moisture levels significantly below normal for an extended period of time over a large area that adversely affects plants, animal life, and humans. There are four types of drought conditions relevant to Iowa:

Meteorological drought is defined on the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. A meteorological drought must be considered as region-specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.

Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (e.g., streamflow, reservoir and lake levels, ground water). The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are usually out of phase with or lag the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, streamflow, and ground water and reservoir levels. As a result, these impacts are out of phase with impacts in other economic sectors.

Agricultural drought focus is on soil moisture deficiencies, differences between actual and potential evaporation, reduced ground water or reservoir levels, and so forth. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil.

Socioeconomic drought refers to when physical water shortage begins to affect people.

The four different definitions all have significance in Iowa. A meteorological drought is the easiest to determine based on rainfall data and is an easier drought to monitor from rain gauges and reports. A hydrological drought means that stream and river levels are low, which also has an impact for surface water and ground water irrigators. In addition, in-stream discharges that fall below a pre-required level also place the State in regulatory difficulty with U.S. Fish and Wildlife and with neighboring states over cross-border flowage rights. An agricultural drought represents difficulty for Iowa's agricultural-based economy and is also relatively easy to monitor based on crop viabilities for different regions.

The National Drought Mitigation Center (NDMC) located at the University of Nebraska in Lincoln provides a clearinghouse for information on the effects of drought, based on reports from media, observers and other sources. NDMC's website is found at http://www.drought.unl.edu/. Specific drought impacts by county are recorded at http://droughtreporter.unl.edu/.

The NDMC categorizes impacts of drought as economic, environmental, or social. Many economic impacts occur in agriculture and related sectors, including forestry and fisheries, because of the reliance of these sectors on surface and subsurface water supplies. In addition to obvious losses in yields in both crop and livestock production, drought is associated with increases in insect infestations, plant disease and wind erosion. Droughts also bring increased problems with insects and disease to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk. Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected.

Although drought is not predictable, long-range outlooks may indicate an increased chance of drought, which can serve as a warning. A drought period can last for months, years, or even decades. It is rarely a direct cause of death, though the associated heat, dust and stress can all contribute to increased mortality.

Warning Time Score: 1—24+ Hours

Duration Score: 4—more than 1 week

Geographic Location/Extent

The entire planning area in Polk County is at risk to drought and 66 percent of the surface land in the county is for agriculture purposes. The conversion of farmland to development is occurring and Polk is becoming more "metropolitan" in nature.

According to the High Plains Regional Climate Center, the planning area received an average of 30.10 inches of rainfall per year from 4/1/1948 to 3/31/2013. In average years, this represents enough rainfall to prevent drought; however, it is the result of successive years of below-average rainfall that cause drought impacts in the planning area.

Previous Occurrences

Drought occurs periodically in Iowa with the most severe in historical times occurring in the 1930's. Other major droughts, usually characterized by deficient rainfall combined with unusually high summer temperatures, occurred in 1886, 1893-1894, 1901, 1954-1956, 1976–1977, 1988–1989, 1999, 2000, 2003, 2005, 2006, 2011-2012. Although droughts are not the spectacular weather events that floods, blizzards or tornadoes can be, historically they produce more economic damage to the State than all other weather events combined.

According to the National Drought Mitigation Center's Drought Impact Reporter, during the 10-year period from July 2004 thru July 2013, Polk County was included in 235 listed drought impacts. 122 of these impacts reported affect the entire State of Iowa. The following are the categories and reported number of impacts. Note: some impacts have been assigned to more than one category:

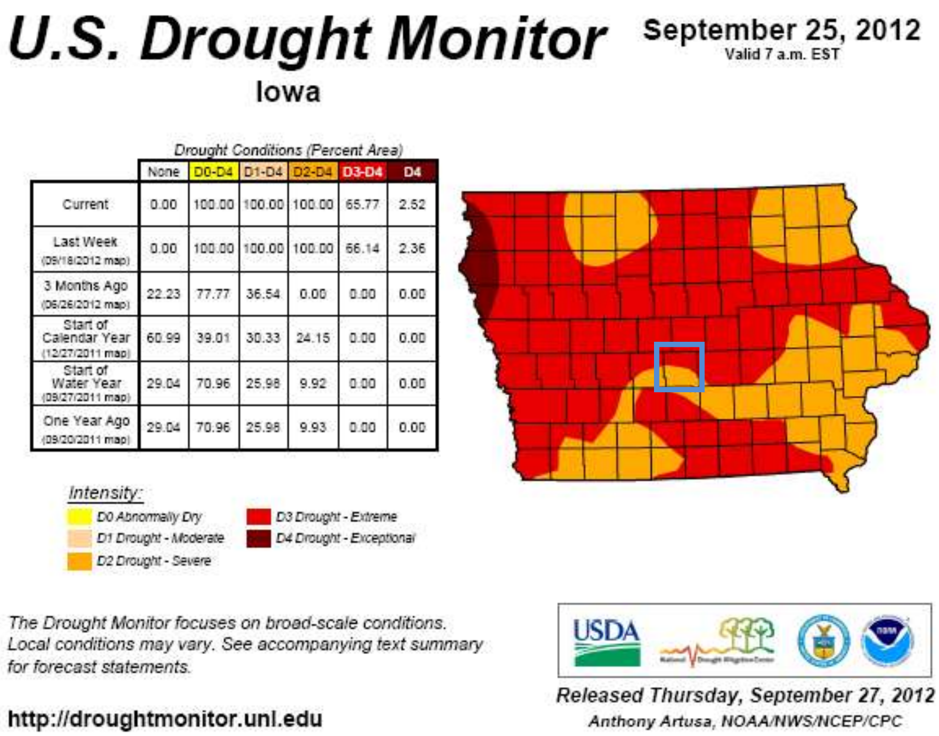
- Agriculture – 132
- Business & Industry – 23

- Energy – 5
- Fire – 17
- Plant & Wildlife – 30
- Relief, Response & Restrictions – 59
- Society & Public Health – 29
- Tourism & Recreation – 6
- Water Supply & Quality – 62

Impacts of recent drought periods in Iowa that affected Polk County are provided below. Unless otherwise indicated, these impacts are from the Drought Impact Reporter.

- **May 23, 2013—**The Des Moines Water Works, serving approximately 500,000 people, asked metro area customers, both residential and commercial, to use Wise Water Best Practices. The drought conditions from 2012 caused a large nitrate concentration to be found in the Raccoon and Des Moines Rivers and thus Des Moines Water Works could not pull water from either river.
- **November 11, 2012—** Drought drove corn prices to record highs this year. As a result, Ethanol producers in the U.S. lost $0.36 per gallon produced compared to sales the year before.
- **October 31, 2012—**The drought trimmed hay production by a third to a half in most parts of the State. Many cattlemen began feeding hay much earlier than usual because pastures did not grow back well.
- **October 12, 2012—**Iowa State University agriculture experts advised farmers to test forages for quality this fall because variable nutrient levels and high nitrate levels can occur in forages grown during drought.
- **September 25, 2012—Figure 3.47** shows the severity of the statewide drought conditions. Polk County was in Severe and Extreme Drought conditions.

Figure 3.47. U.S. Drought Monitor Map of Iowa on September 25, 2012



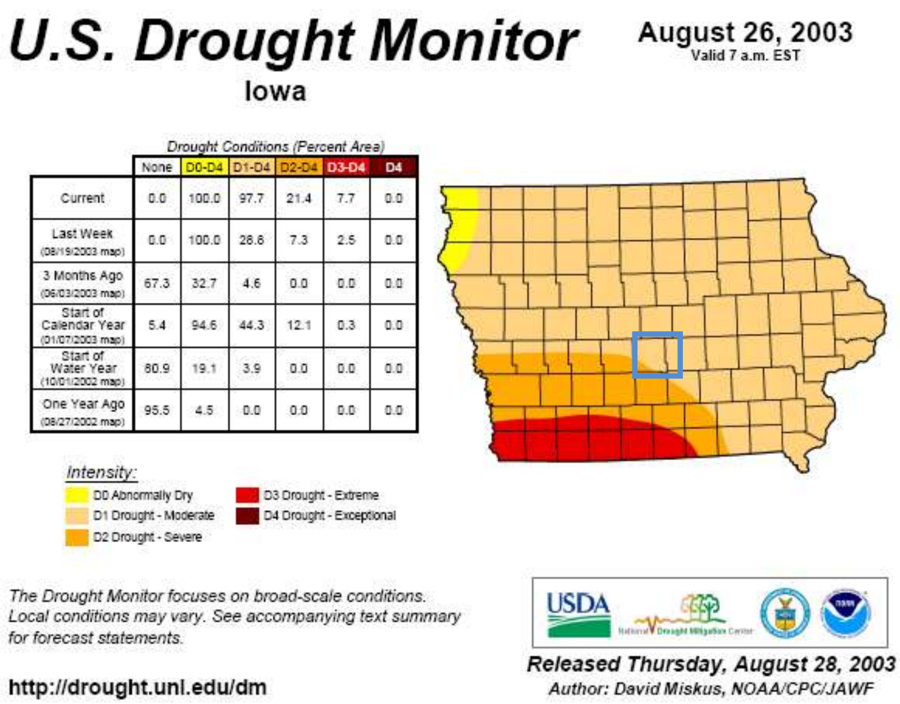
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	100.00	65.77	2.52
Last Week (09/18/2012 map)	0.00	100.00	100.00	100.00	66.14	2.36
3 Months Ago (06/26/2012 map)	22.23	77.77	36.54	0.00	0.00	0.00
Start of Calendar Year (12/27/2011 map)	60.99	39.01	30.33	24.15	0.00	0.00
Start of Water Year (09/27/2011 map)	29.04	70.96	25.98	9.92	0.00	0.00
One Year Ago (09/20/2011 map)	29.04	70.96	25.98	9.93	0.00	0.00

Note: Blue square outlines Polk County.

- **July 26, 2012**—The Governor issued a disaster emergency proclamation that allowed for the suspension of state laws and regulations affecting the transportation of hay and straw. In the statement, it says, “the drought has destroyed or depleted sources of these products that are necessary for livestock production and feed.”
- **July 17, 2012**—Iowa foresters said that trees across the State were dropping their leaves early, due to the drought, while smaller trees may not be able to survive. Also the Iowa Department of Natural Resources documented massive fish kills as streams dwindled and heat decreased the water’s oxygen content.
- **July 1-30, 2012**—Very warm and dry weather that began in the spring continued into the summer. Rainfall was in short supply across the State. Much of the State recorded less than 50 percent of normal rainfall for July. Rapid deterioration of the corn and soybean crop took place with several periods of temperatures in excess of 100 degrees. By the end of July, officials estimated that 32 percent of the corn yield had been lost to the drought. At the current price, the loss total was in excess of $4.5 billion state-wide.
- **2012—**Governor Branstad created a website dedicated to the Iowa Drought 2012, https://governor.iowa.gov/drought/ as a resource for all Iowans. This year’s drought damages surpassed that of 1988.
- **January 1, 2011 to March 31, 2012**—Drought in 2011 led ranchers to sell cattle leading to the lowest cattle inventory in the U.S. since 1952, according to the U.S. Department of Agriculture. Beef and dairy farmers owned 90.77 million head of cattle on January 1, 2012, which were 2.1 percent fewer cattle than in January 2011. Drought forced many ranchers in the South to sell their livestock because it was more economical to sell than to feed them.

- **August 2, 2011 to December 13, 2011**—The U.S. Drought Monitor reported the drought conditions as Abnormally Dry in August, Moderate Drought in November and Abnormally Dry in December for Polk County.
- **September 15, 2006 to October 20, 2006**—Agriculture Secretary Mike Johanns lengthened the time allowed for emergency livestock grazing on land in the Conservation Reserve Program (CRP) in 30 states including Iowa for farmers and livestock owners who were affected by drought.
- **July 31, 2006**—The statewide average precipitation for the May through July period was only 8.28 inches or 4.83 inches less than normal. This ranks 2006 as 8th driest among 134 years of record for this time period with only 1988 being drier in the most recent 70 years.
- **October 5, 2005**—In southeastern Iowa, some elevators turned farmers away with loads of corn. Some corn has also been rejected by processors, because of aflatoxin. Aflatoxin is a naturally occurring toxin and it is caused by a mold that grows in corn damaged by insects or heat stress.
- **June, July & August 2003**—This was the driest summer since 1991 with only a total of 9.87 inches of rain or 3.20 inches less than normal. The dry conditions caused deterioration on corn and soybean production. **Figure 3.48** shows the U.S. Drought Monitor report with Polk County having Moderate to Severe Drought conditions.

Figure 3.48. U.S. Drought Monitor Map of Iowa on August 26, 2003



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.0	100.0	97.7	21.4	7.7	0.0
Last Week (08/19/2003 map)	0.0	100.0	28.6	7.3	2.5	0.0
3 Months Ago (06/03/2003 map)	67.3	32.7	4.6	0.0	0.0	0.0
Start of Calendar Year (01/07/2003 map)	5.4	94.6	44.3	12.1	0.3	0.0
Start of Water Year (10/01/2002 map)	80.9	19.1	3.9	0.0	0.0	0.0
One Year Ago (08/27/2002 map)	95.5	4.5	0.0	0.0	0.0	0.0

Note: Blue square outlines Polk County.

- **August & September 2000**—According to NCDC, crops were stressed with the warm temperatures and lack of rainfall. Livestock deaths occurred because of the daytime heat and warm overnight temperatures.

- **July 20-30, 1999**—According to NCDC the hot and dry conditions hindered the pollination process. Crop losses over the south third of the State were near 20 percent.

Table 3.30 provides the NCDC monthly recorded low precipitation in Des Moines, Iowa from 1971 to 2000 according to the NOAA Regional Climate Center, (http://www.hprcc.unl.edu).

Table 3.30. NCDC Monthly Recorded Lowest Precipitation and the Year Occurred, 1948-2012 from Des Moines, IA Airport Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Lowest Year
Lowest Precip.(in)	0.04	0.13	0.17	0.23	1.23	1.02	0.04	0.25	0.41	0.03	0.03	0.00	17.07
Yr. Lowest Occurred	1997	1957	1994	1985	1949	1992	1975	1984	1950	1952	1969	2002	1956

Source: http://www.hprcc.unl.edu/data/historical/index.php?state=ia&action=select_state&submit=Select+State

According to the USDA's Risk Management Agency, payments for insured crop losses in Polk County as a result of drought conditions occurred in all ten years from 2003-2012 and totaled $4,817,019 (see **Table 3.31**). With the extensive drought conditions during the year of 2012, 58 percent of the 10-year crop losses came from 2012 alone.

Table 3.31. Crop Insurance Claims Paid From Drought, 2003-2012

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2003	Corn	Drought	$113,182
2003	Hybrid Corn Seed	Drought	$8,446
2003	Soybeans	Drought	$1,299,468
2004	Corn	Drought	$234
2005	Corn	Drought	$21,831
2005	Hybrid Corn Seed	Drought	$5,390
2005	Soybeans	Drought	$36,019
2006	Corn	Drought	$50,152
2006	Soybeans	Drought	$78,331
2007	Corn	Drought	$53,228
2007	Soybeans	Drought	$25,047
2008	Corn	Drought	$29,927
2008	Soybeans	Drought	$14,105
2009	Corn	Drought	$666
2010	Soybeans	Drought	$3,759
2011	Corn	Drought	$210,214
2011	Soybeans	Drought	$51,884
2012	Oats	Drought	$462
2012	Corn	Drought	$70,185
2012	Corn	Drought	$2,205,812
2012	Corn	Drought	$168,295
2012	Fresh Market Sweet Corn	Drought	$5,578
2012	Hybrid Corn Seed	Drought	$113,374
2012	Soybeans	Drought	$2,733
2012	Soybeans	Drought	$247,192

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2012	Soybeans	Drought	$1,506
Total			**$4,817,019**

Source: USDA Risk Management Agency Crop Insurance Payment FOIA Request; USDA Risk Management Agency Iowa Crop Insurance Profile, http://www.rma.usda.gov/pubs/2012/stateprofiles/iowa11.pdf

Probability of Future Occurrence

NOAA's National Climatic Data Center uses the U.S. Palmer Drought Indices and the Standardized Precipitation Index to monitor and predict drought conditions. Lack of precipitation for a given area is the primary contributor to drought conditions. Since precipitation levels cannot be predicted in the long term, the following indices can be used to determine the probability of future occurrences of drought.

The following are the indices:

- **Palmer Z Index** monitors short-term monthly moisture conditions when depart from normal,
- **Palmer Drought Severity Index** measures the duration and intensity of the long-term (meteorological) drought patterns,
- **Palmer Hydrological Drought Index** measures long-term (hydrological) drought and wet conditions reflecting groundwater and reservoir levels.
- **Standardized Precipitation Index** is a probability index that considers only precipitation. This is important to farmers to estimate soil moisture.

In the past 30 years, there have been nine years of recorded damages from drought conditions in Polk County resulting in a probability rating of 30 percent. The Polk County Hazard Mitigation Planning Team believes that the current trend of warmer climate conditions will continue and that the probability rating is "Likely"

Probability Score: 3—Likely

Vulnerability

Overview

Polk County jurisdictions are impacted by drought because it is an expensive weather disaster; it reduces agricultural productivity and causes a strain on urban water supplies. In Polk County, farmers bear the most direct stress from drought as wells may run dry; crops wilt and die, and forage for livestock becomes scarce and costly.

Polk County has 738 farms in the County that cover 249,427 acres of land. This translates to 66 percent of the surface land in the County being used for agriculture. Therefore, the planning area has a high exposure to this hazard. Aside from agricultural impacts, other losses related to drought include increased costs of fire suppression and damage to roads and structural foundations due to the shrink dynamic of expansive soils during excessively dry conditions. Drought also presents hazards to public health in extreme cases, where drinking water production cannot keep up with demand. Water wells become less productive during drought and a failure of remaining productive wells (due to power outage, etc.) can cause public drinking water supplies to become compromised.

According to the 2013 Iowa Hazard Mitigation Plan, of the 8 hazards for which date was available to estimate annualized losses, drought ranked 2nd with $424 million in annualized losses based on data spanning an 18-year period. Although losses associated with this hazard can be very high, particularly associated with agriculture; crop insurance coverage mitigates the adverse economic impacts somewhat. According to the 2012 USDA Crop Insurance Profile for the State of Iowa, 88 percent of insurable crops are insured. Considering the planning area's capabilities to withstand a portion of the impacts associated with drought, the magnitude was determined to be "Limited".

Magnitude Score: 2—Limited

Potential Losses to Existing Development

Areas associated with agricultural use are vulnerable to drought conditions which could result in a decrease in crop production or a decrease in available grazing area for livestock. Drought has no real effect on houses and buildings. The impacts would be minimal in terms of landscaping. Rationing water supplies would most likely be the worst case scenario impact.

According to the ten year period from USDA's Risk Management Agency, the amount of claims paid for crop damage as a result of drought in Polk County was $4,817,019. According to the 2012 Iowa Crop Insurance Profile from USDA's Risk Management Agency, 88 percent of the insurable crops in Iowa are insured with USDA Crop Insurance. To factor in estimated losses to insurable crops that are not insured, the 88 percent crop insurance coverage was factored in to provide an adjusted estimate of losses. According to this calculation, estimated annualized losses were $547,388(see **Table 3.32**).

Considering the value of crops from the 2007 Census of Agriculture as baseline crop exposure, the estimated annual losses from drought was determined minimal compared to the value of the insurable crops.

Table 3.32. Estimated Insurable Annual Crops Lost Resulting From Drought

10-Year Drought Insurance Paid	Adjusted 10-Year Drought Losses (considering 88% insured)	Estimated Annualized Losses	2007 Value of Crops
$4,817,019	$5,473,885	$547,388	$105,403,000

Source: Crop value is from USDA 2007 Census of Agriculture; Crop Insurance Paid is from the USDA's Risk Management Agency for 2003-2012.; Crop Insurance Coverage is from USDAs 2012 State Crop Insurance Profile for Iowa
Note: This includes insurable crops that are insured

Future Development

Increases in acreage planted with crops would increase the exposure to drought-related agricultural losses. In addition, increases in population add additional strain on water supply systems to meet the growing demand for treated water.

Drought Hazard Summary by Jurisdiction

The magnitude determinations discussed in the vulnerability overview sections were factored into the following hazard summary table to show how this hazard varies by jurisdiction. As discussed in the drought previous occurrences and vulnerability sections, the majority of the damages from drought are to crops and other agriculture-related activities. In the cities, the drought conditions would be the same, but the magnitude would be less with lawns and local gardens affected, and leading to expansive soil problems around foundations. The magnitude score is lower in the cities and school districts. Des Moines Water Works did not indicate any specific concerns related to water supply during drought conditions, therefore, their ranking levels were determined to be consistent with the levels for the cities.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	3	2	1	4	2.50	Moderate
Cities						
City of Alleman	3	1	1	4	2.20	Moderate
City of Altoona	3	1	1	4	2.20	Moderate
City of Ankeny	3	1	1	4	2.20	Moderate
City of Bondurant	3	1	1	4	2.20	Moderate
City of Clive	3	1	1	4	2.20	Moderate
City of Des Moines	3	1	1	4	2.20	Moderate
City of Elkhart	3	1	1	4	2.20	Moderate
City of Grimes	3	1	1	4	2.20	Moderate
City of Johnston	3	1	1	4	2.20	Moderate
City of Mitchellville	3	1	1	4	2.20	Moderate
City of Pleasant Hill	3	1	1	4	2.20	Moderate
City of Polk City	3	1	1	4	2.20	Moderate
City of Runnells	3	1	1	4	2.20	Moderate
City of Urbandale	3	1	1	4	2.20	Moderate
City of West Des Moines	3	1	1	4	2.20	Moderate
City of Windsor Heights	3	1	1	4	2.20	Moderate
Des Moines Water Works	3	1	1	4	2.20	Moderate
School Districts						
Ankeny, 261	3	1	1	4	2.20	Moderate
Bondurant-Farrar, 720	3	1	1	4	2.20	Moderate
Dallas Center-Grimes, 1576	3	1	1	4	2.20	Moderate
Des Moines Independent, 1737	3	1	1	4	2.20	Moderate
Johnston, 3231	3	1	1	4	2.20	Moderate
North Polk, 4779	3	1	1	4	2.20	Moderate
Saydel, 5805	3	1	1	4	2.20	Moderate
Southeast Polk, 6101	3	1	1	4	2.20	Moderate
Urbandale, 6579	3	1	1	4	2.20	Moderate
West Des Moines	3	1	1	4	2.20	Moderate

3.4.4 Earthquakes

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
1	1	4	1	1.45	Low

Profile

Hazard Description

An earthquake is a sudden motion or trembling that is caused by a release of energy accumulated within or along the edge of Earth's tectonic plates. Earthquakes occur primarily along fault zones, tears in the Earth's crust, along which stresses build until one side of the fault slips, generating compressive and shear energy that produces the shaking and damage to the built environment. Heaviest damage generally occurs nearest the epicenter which is that point on the Earth's surface directly above the point of fault movement. The composition of geologic materials between these points is a major factor in transmitting the energy to buildings and other structures on the Earth's surface.

Warning Time Score: 4—less than 6 hours

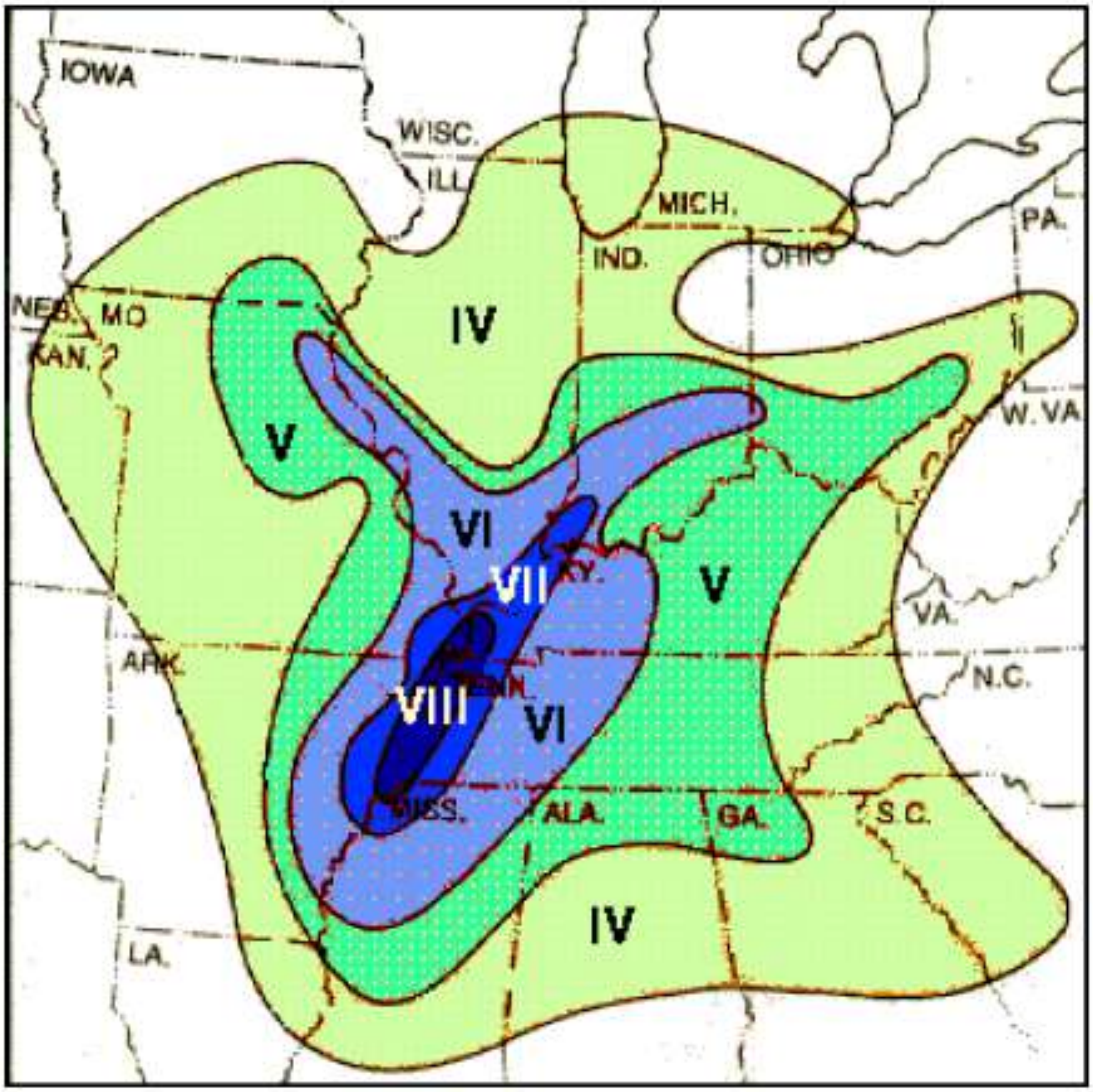
Duration Score: 1—less than 6 hours

Geographic Location/Extent

While geologists often refer to the Midwest as the "stable midcontinent," because of its lack of major crustal movements, there are two regions of active seismicity, the Nemaha Ridge and the New Madrid Fault Zone. The Nemaha Ridge in Kansas and Nebraska, associated with the Humboldt Fault, is characterized by numerous small earthquakes that release stresses before they build to dangerous levels. The fault is not considered a threat to Iowa. The New Madrid Fault Zone, on the other hand, has greater destructive potential. It is located along the valley of the Mississippi River, from its confluence with the Ohio River southward, and includes portions of Illinois, Kentucky, Tennessee, Missouri, Arkansas, and Mississippi. The Earth's crust in the midcontinent is older, and therefore thicker, cooler, and more brittle than that in California for example. Consequently, earthquake shock waves travel faster and farther in the Midwest, making quakes here potentially more damaging than similar sized events in other geologic settings.

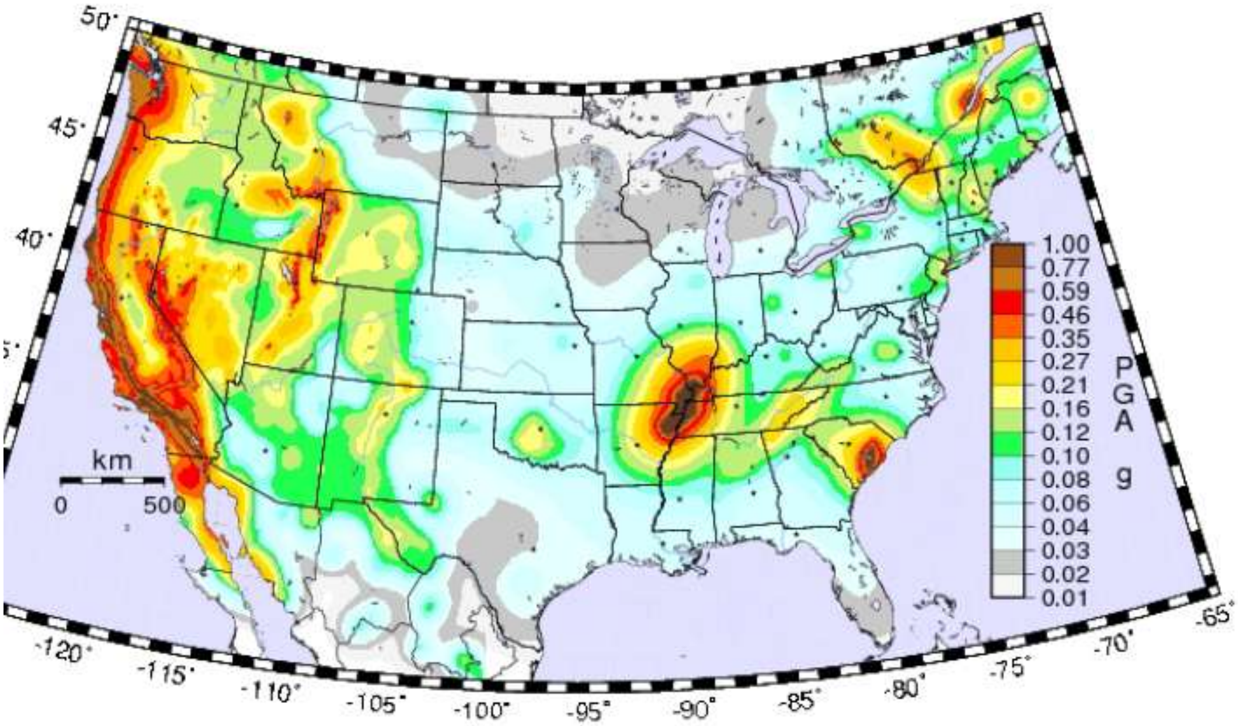
Iowa counties are located in low risk zones as a whole. The southeastern part of the state of Iowa is more at risk to earthquake effects from the New Madrid Fault Zone. **Figure 3.49** shows the estimated effects of a 6.5 Richter magnitude earthquake scenario along the New Madrid Fault Zone. It suggests that Iowans in four southeast counties could experience trembling buildings, some broken dishes and cracked windows, movement and falling of small unstable objects, abrupt openings or closing doors, and liquids spilling from open containers. About 29 other counties, from Page to Polk to Muscatine, could experience vibrations similar to the passing of a heavy truck, rattling of dishes and windows, creaking of walls, and swinging of suspended objects. These effects will vary considerably with differences in local geology and construction techniques. **Figure 3.50** shows the Seismic Hazard Map for the U.S. showing the peak ground acceleration of 10 percent in a 50 year timeframe.

Figure 3.49. 6.5 Richter Magnitude Earthquake Scenario, New Madrid Fault Zone



Source: http://www.igsb.uiowa.edu/Browse/quakes/quakes.htm

Figure 3.50. United States Seismic Hazard Map



Source: United States Geological Survey, http://earthquake.usgs.gov/hazards/products/conterminous/2008/maps/

The extent or severity of earthquakes is generally measured in two ways: 1) Magnitude Measurement utilizes the Richter Magnitude Scale and 2) Severity Measurement utilizes the Modified Mercalli Intensity Scale.

Richter Magnitude Scale

The Richter Magnitude Scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for the variation in the distance between the various seismographs and the epicenter of the earthquakes. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Modified Mercalli Intensity Scale

The effect of an earthquake on the Earth's surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and finally - total destruction. Although numerous *intensity scales* have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli (MM) Intensity Scale. It was developed in 1931 by the American seismologists Harry Wood and Frank Neumann. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced.

The **lower** numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The **higher** numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above.

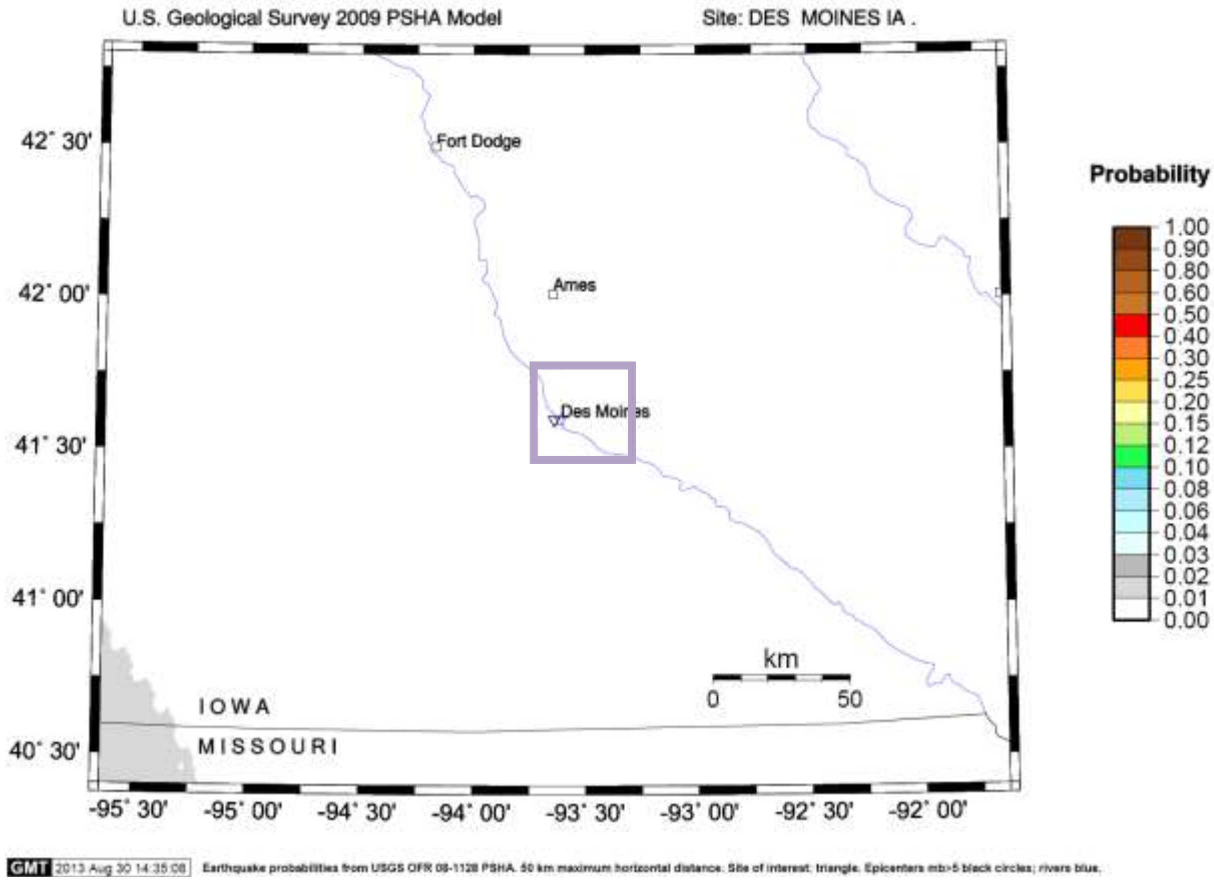
Previous Occurrences

Iowa has experienced little effects from only a few earthquakes in the past 175 years. The epicenters of 13 earthquakes have been located in the State with the majority along the Mississippi River. The strongest earthquake in Iowa occurred in Davenport in 1934 and resulted in only slight damage. There have been no epicenters in Polk County and no earthquake damages recorded in the County (Source: State of Iowa Hazard Mitigation Plan, 2010).

Probability of Future Occurrence

Figure 3.51 demonstrates the probability of an earthquake with a magnitude greater than 5.0 in the Polk County in a 100 year time period. The purple square shows the approximate Polk County boundary. As shown in this graphic, the probability of a 5.0 Magnitude or greater earthquake in the next 100 years is 0.00 percent. The probability converts to an estimated maximum recurrence interval of 5,000 years. The probability of a significant earthquake in any given year is unlikely.

Figure 3.51. Probability of Magnitude 5.0 or greater within 100 Years – Polk County



Source: United States Geological Survey, https://geohazards.usgs.gov/eqprob/2009/index.php; Note: Purple square is approximate location of Polk County, IA

<u>Probability Score</u>: 1—Unlikely

Vulnerability

Overview

As discussed under the probability section, the probability of a 5.0 Magnitude or greater earthquake in the next 100 years is 0.00 percent. Although a damaging event is unlikely, the potential impacts could be costly in the more urban areas of the County. Most structures in Polk County are not built to withstand earthquake shading, but because of the relatively low magnitude of a possible quake, property damage would likely be very minor damage.

The main impacts to Polk County from a New Madrid Earthquake would be related to incoming evacuees from areas more heavily damaged by the event. This could result in a shortage of short-term lodging, such as hotel rooms and extended stay establishments. Depending on the magnitude of the earthquake, shelters may be designated in Polk County as evacuee shelter locations. If this occurred, assistance would be coordinated through the Emergency

Management Assistance Compact (EMAC) between the State of Iowa and State governments of impacted areas.

<u>Magnitude Score:</u> 1—Negligible

Potential Losses to Existing Development

FEMA's loss estimation software, HAZUS was utilized to analyze a worst-case, probabilistic, 2,500 year, 6.7 magnitude scenario event. The HAZUS Earthquake module reports earthquake damage by census tract. As a result, it is not possible to separate the resulting damage amounts by incorporated area, as the census tract boundaries are not the same as the incorporated area boundaries. **Table 3.33** below provides the results of the HAZUS analysis for Polk County as well as the census tracts included or overlapping in those incorporated areas that are part of the Des Moines-West Des Moines Metropolitan Statistical Areas (MSA) that extend into adjacent counties (Dallas, Warren, and Madison). This analysis estimates that the total direct structural damage would be just over $15.5 Million. The combined building, contents and related economic losses calculated to be nearly $244 Million.

Table 3.33. Polk County, Iowa and Des Moines-West Des Moines Metropolitan Statistical Area (MSA) Estimated Economic Losses-2,500 Year 6.7 Magnitude Earthquake Event (In Millions of Dollars)

	Structural Damage	Non-structural Damage	Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Loss	Rental Income Loss	Total Loss
Polk	$13,566	$22,886	$5,606	$406	0.12	$152,845	$4,804	$6,489	$20,548	$227,151
Dallas*	$1,519	$2,671	$629	$8	0.11	$3,961	$180	$251	$626	$9,844
Warren*	$302	$432	$95	$0	0.10	$4,895	$0	$0	$440	$6,164
Madison*	$151	$254	$60	$4	0.11	$87	$25	$40	$39	$657
Total	$15,538	$26,243	$6,391	$418	0.11	$161,788	$5,009	$6,780	$21,652	$243,817

Source: HAZUS-MH 2.1, August 2013; *Includes only those portions of the West Des Moines-Des Moines Metropolitan Area that extend into adjacent counties.

Table 3.34 provides the anticipated numbers of buildings by type and damage category that would result according to the HAZUS analysis. The estimated building types and counts are from the HAZUS damage outputs utilizing census block data.

Table 3.34. Expected Building Damage by Building Type--2,500 Year 6.7 Magnitude Earthquake Event

	None	Slight	Moderate	Extensive	Complete	Total
Dallas County Portion of MSA						
Religion	24	1	0	0	0	25
Single Family	11,115	188	34	5	0	11,343
Industrial	137	6	3	0	0	146
Other Residential	2,161	61	18	2	0	2,243
Commercial	289	13	5	1	0	307
Education	17	1	0	0	0	18
Agriculture	362	17	7	1	0	387
Government	9	0	0	0	0	9
Dallas County Portion of MSA Total	**14,114**	**287**	**67**	**9**	**0**	**14,478**
Madison County Portion of MSA						
Religion	17	1	0	0	0	18
Agriculture	74	4	2	0	0	79
Other Residential	853	29	9	1	0	892
Industrial	70	3	1	0	0	75
Single Family	1,615	29	5	1	0	1,650
Education	2	0	0	0	0	2
Commercial	131	6	2	0	0	140
Government	5	0	0	0	0	5
Madison County Portion of MSA Total	**2,767**	**72**	**19**	**2**	**0**	**2,861**
Polk County						
Government	256	10	4	0	0	270
Industrial	2,979	136	50	7	0	3,173
Other Residential	20,524	766	254	20	2	21,565
Single Family	114,915	1,945	354	48	4	117,266
Religion	453	20	8	1	0	481
Commercial	4,910	222	78	11	1	5,222
Agriculture	3,989	187	75	11	1	4,263
Education	282	13	5	1	0	301
Polk County Total	**148,308**	**3,299**	**828**	**99**	**8**	**152,541**
Warren County Portion of MSA						
Education	1	0	0	0	0	1
Agriculture	453	23	9	1	0	487
Government	2	0	0	0	0	2
Industrial	79	4	2	0	0	85
Single Family	4,150	75	14	2	0	4,241
Other Residential	364	24	9	0	0	397
Religion	0	0	0	0	0	0
Commercial	54	3	1	0	0	58
Warren County Portion of MSA Total	**5,103**	**129**	**35**	**3**	**0**	**5,271**
Combined Total	**170,292**	**3,787**	**949**	**113**	**8**	**175,151**

Source: HAZUS-MH 2.1, August 2013.

Future Development

Overall the planning area has a low vulnerability to earthquake risk. Future development is not expected to increase the risk other than contributing to the overall exposure of what could become damaged as a result of an unlikely event.

Earthquake Hazard Summary by Jurisdiction

The following hazard summary table shows that this hazard does not significantly vary by jurisdiction. Although damage amounts would be higher in the more urban areas, damage ratios would be relatively the same.

Jurisdiction	**Probability**	**Magnitude**	**Warning Time**	**Duration**	**Score**	**Level**
Polk County	1	1	4	1	1.45	Low
Cities						
City of Alleman	1	1	4	1	1.45	Low
City of Altoona	1	1	4	1	1.45	Low
City of Ankeny	1	1	4	1	1.45	Low
City of Bondurant	1	1	4	1	1.45	Low
City of Clive	1	1	4	1	1.45	Low
City of Des Moines	1	1	4	1	1.45	Low
City of Elkhart	1	1	4	1	1.45	Low
City of Grimes	1	1	4	1	1.45	Low
City of Johnston	1	1	4	1	1.45	Low
City of Mitchellville	1	1	4	1	1.45	Low
City of Pleasant Hill	1	1	4	1	1.45	Low
City of Polk City	1	1	4	1	1.45	Low
City of Runnells	1	1	4	1	1.45	Low
City of Urbandale	1	1	4	1	1.45	Low
City of West Des Moines	1	1	4	1	1.45	Low
City of Windsor Heights	1	1	4	1	1.45	Low
Des Moines Water Works	1	1	4	1	1.45	Low
School Districts						
Ankeny, 261	1	1	4	1	1.45	Low
Bondurant-Farrar, 720	1	1	4	1	1.45	Low
Dallas Center-Grimes, 1576	1	1	4	1	1.45	Low
Des Moines Independent, 1737	1	1	4	1	1.45	Low
Johnston, 3231	1	1	4	1	1.45	Low
North Polk, 4779	1	1	4	1	1.45	Low
Saydel, 5805	1	1	4	1	1.45	Low
Southeast Polk, 6101	1	1	4	1	1.45	Low
Urbandale, 6579	1	1	4	1	1.45	Low
West Des Moines	1	1	4	1	1.45	Low

3.4.5 Expansive Soils

Hazard Score Calculation					
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**	**Level**
2	1	1	1	1.45	Low

Profile

Hazard Description

A relatively widespread geologic hazard for Iowa is the presence of soils that expand and shrink in relation to their water content. Expansive soils can cause physical damage to building foundations, roadways, and other components of the infrastructure when clay soils swell and shrink due to changes in moisture content. For Iowa, the vulnerability to this hazard most frequently is associated with soils shrinking during periods of drought.

Warning Time Score: 1—24 + hours

The warning time for expansive soils is consistent with other geologic hazards that occur slowly overtime.

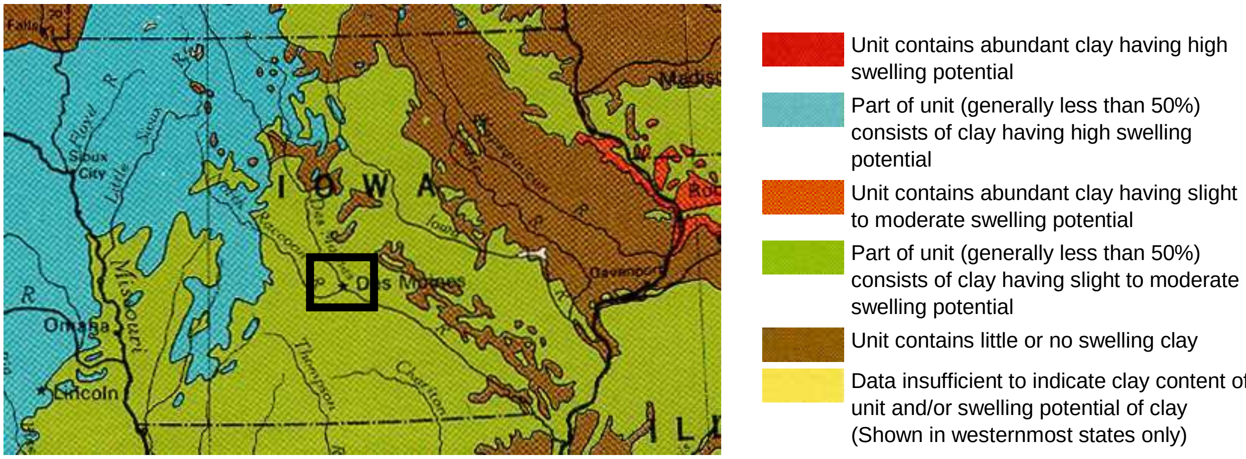
Duration Score: 1—Less than 6 hours

The duration of response to this hazard is limited in the State of Iowa. Although prolonged periods of drought are a primary indicator of risk followed by forecasted periods of precipitation, the response to expansive soils in Iowa is limited and is in large part coupled with response to flash flooding and river flooding.

Geographic Location/Extent

Figure 3.52 shows a map of the swelling potential of soils in Iowa. Polk County is located in areas with little or no swelling clay (brown shading) and areas where part of the soil unit (generally less than 50 percent) consists of clay having slight to moderate swelling potential (green shading). This hazard affects all participating jurisdictions.

Figure 3.52. U.S. Geological Survey Swelling Clays Map of Iowa



Source: U.S. Geological Survey approximate location of Polk County is black square

Previous Occurrences

Streets and parking lots throughout the County are damaged every year by the effects of expansive soils as well as underground water lines that are damaged as the soil expands and contracts at varying levels along a water line. The frequency of damage from expansive soils can be associated with the cycles of drought and heavy rainfall, which reflect changes in moisture content. Damages occur with isolated incidents and affected property owners, local governments, and businesses generally make any necessary repairs.

The Urbandale School District reported significant damages to Jensen Elementary as a result of exterior wall movement that occurred due to expansive soils. The damage became noticeable in 2010 and gradually became worse. Soil movement at this site caused cracking of mortar joints in CMU walls, some damaged CMU block, floor slap shifting and heaving, and window and door problems. This problem resulted in the District closing a classroom for approximately two weeks. The students had to be moved to another area while helical pilings and structural repairs were made. The cost of repairs was over $140,000.

Probability of Future Occurrence

Although there will continue to be some damage to paved areas and foundations in Polk County due to swelling soils, it is unlikely that these damages will become greater in the future unless new development occurs in areas where the hazard is more severe. Certain buildings and construction practices could be put in place to lessen these impacts. The HMPC determined that damage to assets in the planning area has a 1 in 5 chance of occurring in any given year.

<u>Probability Score:</u> 2—Occasional

<u>Vulnerability</u>

Overview

The HMPC has determined that while the entire planning area is vulnerable to some structural damage as a result of shrinking and expanding soils, there is no data available to determine damage estimates for this hazard. In most cases, individual property owners, local governments, and businesses pay for repairs to damages caused by this hazard. The HMPC felt that underground utility lines such as water and sewer pipes may be at risk to damages associated with expansive soils. However, there is no data to support damages and costs associated with this hazard at this time.

Magnitude Score: 1—Negligible

Potential Losses to Existing Development

Existing development will continue to be vulnerable to expansive soils.

Future Development

Additional future development in the planning area will also be vulnerable to this hazard.

Expansive Soils Hazard Summary by Jurisdiction

The following hazard summary table shows that this hazard does not vary by jurisdiction.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	2	1	1	1	1.45	Low
Cities						
City of Alleman	2	1	1	1	1.45	Low
City of Altoona	2	1	1	1	1.45	Low
City of Ankeny	2	1	1	1	1.45	Low
City of Bondurant	2	1	1	1	1.45	Low
City of Clive	2	1	1	1	1.45	Low
City of Des Moines	2	1	1	1	1.45	Low
City of Elkhart	2	1	1	1	1.45	Low
City of Grimes	2	1	1	1	1.45	Low
City of Johnston	2	1	1	1	1.45	Low
City of Mitchellville	2	1	1	1	1.45	Low
City of Pleasant Hill	2	1	1	1	1.45	Low
City of Polk City	2	1	1	1	1.45	Low
City of Runnells	2	1	1	1	1.45	Low
City of Urbandale	2	1	1	1	1.45	Low
City of West Des Moines	2	1	1	1	1.45	Low
City of Windsor Heights	2	1	1	1	1.45	Low
Des Moines Water Works	2	1	1	1	1.45	Low
School Districts						
Ankeny, 261	2	1	1	1	1.45	Low
Bondurant-Farrar, 720	2	1	1	1	1.45	Low
Dallas Center-Grimes, 1576	2	1	1	1	1.45	Low
Des Moines Independent, 1737	2	1	1	1	1.45	Low
Johnston, 3231	2	1	1	1	1.45	Low
North Polk, 4779	2	1	1	1	1.45	Low
Saydel, 5805	2	1	1	1	1.45	Low
Southeast Polk, 6101	2	1	1	1	1.45	Low
Urbandale, 6579	2	1	1	1	1.45	Low
Wes Des Moines	2	1	1	1	1.45	Low

3.4.6 Extreme Heat

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
2	2	1	3	1.95	Low

Profile

Hazard Description

Extreme temperature events, both hot and cold, can have severe impacts on human health and mortality, natural ecosystems, agriculture and other economic sectors. The remainder of this section profiles extreme heat. Extreme cold events are profiled in combination with Winter Storm in **Section 3.4.20.** According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Ambient air temperature is one component of heat conditions, with relative humidity being the other. The relationship of these factors creates what is known as the apparent temperature. The Heat Index chart shown in **Figure 3.53** uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions.

Figure 3.53. Heat Index (HI) Chart

Temperature (°F)

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

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution   Extreme Caution   Danger   Extreme Danger

Source: National Weather Service (NWS)

Note: Exposure to direct sun can increase Heat Index values by as much as 15°F. The shaded zone above 105°F corresponds to a HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

From 1988-2011, there were 3,496 fatalities in the U.S. attributed to summer heat. This translates to an annual average of 146 deaths. According to the National Weather Service, among natural hazards, no other natural disaster—not lightning, hurricanes, tornadoes, floods, or earthquakes—takes a greater toll.

Those at greatest risk for heat-related illness include infants and children up to five years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. However, even young and healthy individuals are susceptible if they participate in strenuous physical activities during hot weather. In agricultural areas, the exposure of farm workers, as well as livestock, to extreme temperatures is a major concern.

Table 3.35 lists typical symptoms and health impacts of exposure to extreme heat.

Table 3.35. Typical Health Impacts of Extreme Heat

Heat Index (HI)	Disorder
80-90° F (HI)	Fatigue possible with prolonged exposure and/or physical activity
90-105° F (HI)	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105-130° F (HI)	Heatstroke/sunstroke highly likely with continued exposure

Source: National Weather Service Heat Index Program, www.weather.gov/os/heat/index.shtml

The National Weather Service has a system in place to initiate alert procedures (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for issuing excessive heat alerts is when the maximum daytime Heat Index is expected to equal or exceed 105 degrees Fahrenheit (°F) and the night time minimum Heat Index is 80°F or above for two or more consecutive days. A heat advisory is issued when temperatures reach 105 degrees and a warning is issued at 115 degrees.

<u>Warning Time Score</u>: 1—More than 24 hours warning time

<u>Duration Score</u>: 3—Less than one week

Geographic Location/Extent

The entire planning area is subject to extreme heat and all participating jurisdictions are affected.

Previous Occurrences

According to information obtained from the National Climatic Data Center (NCDC) and the National Weather Service in Des Moines, Iowa there have been 3 heat-related watches 8 heat-related warnings and 26 heat-related advisories between 2005 and August 2013.

<u>Heat-Related Warnings</u>

June 2009; August 2010; July 2011 (several) August 2011; July 2012(several); August 2013

<u>Heat-Related Watches</u>

August 2010; June 2011; July 2012

Heat-Related Advisories

July 2005(several); August 2006; August 2007(several); August 2008; June 2009(several); August 2009; July 2010(several); August 2010(several); June 2011; July 2011(several) June 2012(several) July 2012(several); July 2013(several) August 2013(several)

The HMPC also reviewed high temperature data from the National Weather Service COOP station at Des Moines, Iowa (Polk County) from the Iowa Environmental Mesonet, Iowa State University Department of Agronomy (http://mesonet.agron.iastate.edu/request/coop/fe.phtml). The website contains records of high temperature by date.

The planning committee identified 81 days that had temperatures above 100 degrees Fahrenheit. Years when temperatures exceeded 100 during an event were 1954, 1955, 1956, 1957, 1966, 1974 1977, 1983, 1984 1987, 1988, 2003 and 2012. The highest recorded temperature in Des Moines, Iowa during this time period (Polk County) was 108 degrees Fahrenheit which was reached in August 1983.

Research revealed that the average monthly temperatures at the Des Moines, Iowa Station for the months of June, July, and August, are 82, 86, and 84 degrees Fahrenheit, respectively. Based on these average monthly temperatures, the heat events that were 10 degrees or more above the average monthly temperature for June, July, and August, were considered. To further review historical occurrences of extreme heat events, the data for temperatures 10 degrees or more above normal were further analyzed to determine how many events last three days or more. **Table 3.36** below provides the number of times during the 63 year period of record for each month (June, July, and August) when the temperature was 10 degrees or more above normal for 3 or more consecutive days. Based on 54 events during June, July, and August during the 63 year period, this translates to an 86 percent chance likelihood of extreme heat events occurring in the planning area.

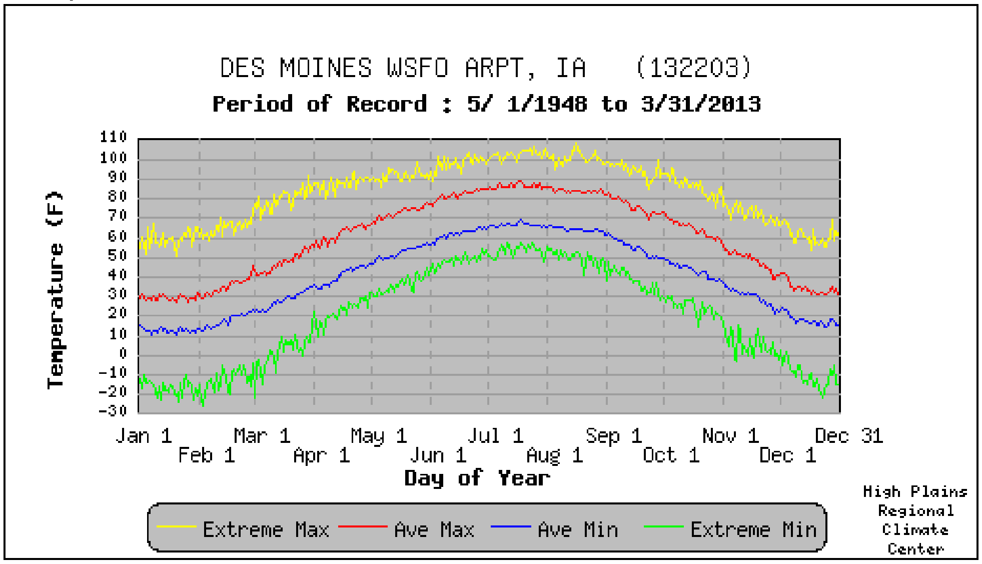
Table 3.36. Number of Events in June, July, and August with Temperature 10 Degrees or More Above Normal Lasting for 3 or more Consecutive Days (Jan. 1, 1950 to December 1, 2012)

Month	# of Events
June	16
July	21
August	17
Total	54

Source: Iowa State University Department of Agronomy, http://mesonet.agron.iastate.edu/request/coop/fe.phtml

Figure 3.54 provides the daily temperature averages and extremes for the Des Moines, Iowa weather station for the period of record from 1948 to 2013.

Figure 3.54. Daily Temperatures Averages and Extremes, Des Moines, Iowa (1948 – 2013)



- Extreme Max. is the maximum of all daily maximum temperatures recorded for the day of the year.
- Ave. Max. is the average of all daily maximum temperatures recorded for the day of the year.
- Ave. Min. is the average of all daily minimum temperatures recorded for the day of the year.
- Extreme Min. is the minimum of all daily minimum temperatures recorded for the day of the year.

Source: High Plains Regional Climate Summary, http://www.hprcc.unl.edu/data/historical/index.php?state=ia&action=select_state&submit=Select+State

According to the USDA's Risk Management Agency, insured payments in Polk County for damages to crops as a result of heat and hot wind from 2003-2012 totaled $6,547. **Table 3.37** shows the insurable crop insurance claims paid in Polk County as a result of heat and hot wind.

Table 3.37. Claims Paid in Polk County for Crop Loss as a Result of Heat (2003-2012)

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid ($)
2003	Soybeans	Heat	$2558
2006	Corn	Heat	$5,276
2008	Corn	Hot Wind	3,820
2009	Oats	Hot Wind	742
2011	Oats	Heat	$895
2011	Corn	Hot Wind	3,820
2011	Corn	Heat	$319
2001	Hybrid Corn Seed	Heat	$22,206
2011	Soybeans	Heat	$6,365
2012	Oats	Heat	$462
2012	Soybeans	Heat	$241
2012	Corn	Heat	$20,217
Total:			**$67,547**

Source: Crop value is from USDA 2007 Census of Agriculture; Crop Insurance Paid is from the USDA's Risk Management Agency for 2003-2012; Note: This includes insurable crops that are insured

Probability of Future Occurrence

Based on historical data from the NWS COOP station at Des Moines, Iowa there were 54 extreme heat events during June, July, and August during the 63 year period from 1950 to 2012. This translates to an 86 percent chance probability of an extreme heat event occurring in the planning area in any given year. Most of these extreme heat events last for less than a week and then temperatures change and become milder. Although extreme heat events, by definition, occur almost every year for a short timeframe, the HMPC determined that damaging events occur less often and determined that the Probability Score for this hazard should be occasional, with a 10 to 20 percent likelihood of a damaging extreme heat event in any given year.

Probability Score: 2—Occasional

Vulnerability

Overview

Those at greatest risk for heat-related illness and deaths include infants and children up to five years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. Since 1996 there have been two reported heat related deaths in Polk County according to the Polk County Health Department. To determine jurisdictions within the planning area with populations that may be more vulnerable to extreme heat, demographic data was obtained from the 2010 Census on numbers of people in each jurisdiction under age 5 and over age 65 as seen in **Table 3.38.** Data was not available for overweight individuals and those on certain medications.

Overall, Iowa is already older than the country as a whole. About 15 percent of its population is over 65, compared with 13 percent nationally. Polk County, however, is slightly younger than the U.S. as a whole, with 11 percent of the population over 65.
The aging of the population has profound implications for the health-care system, because, seniors, as a group, have the greatest health-care needs. They assume the bulk of health care costs today, particularly in institutional (hospital, nursing home and other residential) care.

The participating jurisdictions with the highest numbers of children under 5 and adults 65 and over in descending order are: Des Moines, West Des Moines and Ankeny.

Magnitude Score: 2—Limited

Table 3.38. Polk County Population Under Age 5 and Over Age 65, 2010 Census Data

Jurisdiction	Population Under 5 yrs	Population 65 yrs and over
*Polk County	32,816	46,545
City of Alleman	19	32
City of Altoona	1,240	1,316
City of Ankeny	4, 204	3,795
City of Bondurant	427	97
City of Carlisle	277	475

Jurisdiction	Population Under 5 yrs	Population 65 yrs and over
*City of Clive	1,107	1,541
*City of Des Moines	16,152	22,318
City of Elkhart	89	52
City of Granger	36	123
*City of Grimes	817	471
City of Johnston	1,239	1.712
*City of Mitchellville	121	230
City of Norwalk	612	512
City of Pleasant Hill	736	989
City of Polk City	328	264
City of Runnels	51	54
City of Sheldahl	25	44
*City of Urbandale	2,778	4,664
*City of West Des Moines	3,995	6,028
City of Windsor Heights	289	870

Source: U.S. Census Bureau, (*) includes entire population of each city or county

Estimated Losses to Existing Development

According to USDA Risk Management Agency, losses to insurable crops during the 10-year time period from 2003 to 2013 were $67,547. According to the 2012 Iowa Crop Insurance Profile Report issued by the USDA Risk management Agency, 88 percent of Iowa insurable crops were insured. Crop insurance payments have been extrapolated to estimate losses to all insurable crops. Using this methodology, during this time frame, the annualized estimated crop losses were $76,758. This translates to an annual average of $7,675 in estimated losses as a result of extreme heat.

Extreme heat can also cause a strain on electricity delivery infrastructure which can be overloaded during peak use of electricity to power air conditioning during extreme heat events. Another type of infrastructure damage that can occur as a result of extreme heat is road damage. When asphalt is exposed to prolonged extreme heat, it can cause buckling of asphalt-paved roads, driveways, and parking lots.

Future Development

Population growth can result in increases in the age-groups that are most vulnerable to extreme heat. Of the three participating jurisdictions that have the highest concentrations of populations vulnerable to extreme heat, Ankeny has had the most growth between 2000 and 2010 with 68 percent. West Des Moines grew 21 percent and Des Moines grew 2.4 percent. Population growth also increases the strain on electricity infrastructure and more homes are built and serviced with electricity to accommodate the growing population.

Extreme Heat Hazard Summary by Jurisdiction

Extreme heat is a regional hazard and impacts all jurisdictions in the planning area.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	2	2	1	3	1.95	Low
Cities						
City of Alleman	2	2	1	3	1.95	Low
City of Altoona	2	2	1	3	1.95	Low
City of Ankeny	2	2	1	3	1.95	Low
City of Bondurant	2	2	1	3	1.95	Low
City of Clive	2	2	1	3	1.95	Low
City of Des Moines	2	2	1	3	1.95	Low
City of Elkhart	2	2	1	3	1.95	Low
City of Grimes	2	2	1	3	1.95	Low
City of Johnston	2	2	1	3	1.95	Low
City of Mitchellville	2	2	1	3	1.95	Low
City of Pleasant Hill	2	2	1	3	1.95	Low
City of Polk City	2	2	1	3	1.95	Low
City of Runnells	2	2	1	3	1.95	Low
City of Urbandale	2	2	1	3	1.95	Low
City of West Des Moines	2	2	1	3	1.95	Low
City of Windsor Heights	2	2	1	3	1.95	Low
Des Moines Water Works	2	2	1	3	1.95	Low
School Districts						
Ankeny, 261	2	2	1	3	1.95	Low
Bondurant-Farrar, 720	2	2	1	3	1.95	Low
Dallas Center-Grimes, 1576	2	2	1	3	1.95	Low
Des Moines Independent, 1737	2	2	1	3	1.95	Low
Johnston, 3231	2	2	1	3	1.95	Low
North Polk, 4779	2	2	1	3	1.95	Low
Saydel, 5805	2	2	1	3	1.95	Low
Southeast Polk, 6101	2	2	1	3	1.95	Low
Urbandale, 6579	2	2	1	3	1.95	Low
Wes Des Moines	2	2	1	3	1.95	Low

3.4.7 Flash Flooding

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	3	2	1	3.10	High

Profile

Hazard Description

A flash flood is an event that occurs when water levels rise at an extremely fast rate as a result of intense rainfall over a brief period, sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil or impermeable surfaces.

Ice jam flooding is a form of flash flooding that occurs when ice breaks up in moving waterways, and then stacks on itself where channels narrow. This creates a natural dam, often causing flooding within minutes of the dam formation.

Riverine Flooding is discussed separately in **Section 3.4.13** and flooding caused by dam failure or levee failure is discussed in **Section 3.4.1** and **Section 3.4.8** respectively.

Most flash flooding is caused by slow-moving thunderstorms or thunderstorms repeatedly moving over the same area. Flash flooding is an extremely dangerous form of flooding which can reach full peak in only a few minutes and allows little or no time for protective measures to be taken by those in its path. Flash flood waters move at very fast speeds and can move boulders, tear out trees, scour channels, destroy buildings, and obliterate bridges. Flash flooding often results in higher loss of life, both human and animal, than slower developing river and stream flooding.

In some cases, flooding may not be directly attributable to a river, stream, or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations–areas that are often not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow

In certain areas, aging storm sewer systems are not designed to carry the capacity currently needed to handle the increased storm runoff. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns. This combined with rainfall trends and rainfall extremes all demonstrate the high probability, yet generally unpredictable nature of flash flooding in the planning area.

Although flash floods are somewhat unpredictable, there are factors that can point to the likelihood of flash floods occurring. Weather surveillance radar is being used to improve monitoring capabilities of intense rainfall. This, along with knowledge of the watershed characteristics, modeling techniques, monitoring, and advanced warning systems increases the warning time for flash floods.

Warning Time Score: 2—12-24 hours warning time. This refers to the period of time prior to the event with heightened awareness that a flash flood could occur, not the issuance of a "flash flood warning" by the National Weather Service.

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

Flash flooding occurs in those locations of the in the planning area that are low-lying and/or do not have adequate drainage to carry away the amount of water that falls during intense rainfall events. According to NCDC, the following jurisdictions have a history of flash flooding events: unincorporated county, City of Altoona, City of Ankeny, City of Des Moines, City of Elkhart, City of Grimes, City of Mitchellville, City of Pleasant Hill, City of Runnells, City of Urbandale, City of West Des Moines, and the City of Windsor Heights. There were four reported flash flood events at the Des Moines International Airport. The jurisdictions with the most previous flash flood events are the City of Des Moines and the unincorporated county.

Table 3.39 provides the number of flash flood events by location for 66 flash flood events recorded in NCDC for the 17.3 year period.

Table 3.39. NCDC Flash Flood Events by Location, 1996-April 2013

Location	# of Events
Unincorporated County	13
-Unincorporated County (unspecified)	
-Unincorporated County (Hastier area)-1	
-Unincorporated County (Lovington area)-5	
-Unincorporated County (North Portion)-2	
-Unincorporated County (Santiago area)-2	
-Unincorporated County (Swanwood area)-1	
Altoona	1
Ankeny	8
-Ankeny (unspecified) -6	
-Ankeny (Oralabor area)-1	
-Ankeny (Saylorville area)-1	
Des Moines	19
-Des Moines (unspecified)-18	
-Des Moines (Avon area)-1	
Elkhart	1
Grimes	3
Mitchellville	1
Pleasant Hill-Youngstown area	1
Polk City	2
Runnells	1
Urbandale	7
-Urbandale (unspecified)-6	
-Urbandale(Rider area)-1	
West Des Moines	4
-West Des Moines (unspecified)-3	
-West Des Moines (Clover Hills area)-1	
Windsor Hgts	1
Des Moines International Airport	4
Countywide	1
Total	**66**

Specific areas reported to be prone to flash flooding and/or included in descriptions of previous impacts are provided by jurisdiction below:

<u>Unincorporated County:</u> Swanwood Area—Delaware Ave. north of Oralabor Rd.; Vandalia Rd. and SE 42nd Street; Lovington Area—Intersection of Beaver Drive and Valdez Drive and Merle Hay Road;

<u>Altoona</u>: NE 9th Street; NE 38th at 24th Street near the 6th Ave SE intersection

<u>Ankeny</u>: Oralabor Area—1st Street near HyVee and High School; Intersection of Crestmoor Place and Northeast 6th Street; 400 Block of Delaware Avenue; Intersection of SE 4th and Trilein; Intersection of West 1st Street and SW State Street; Intersection of North Ankeny Boulevard; Highway 415; flash flooding caused roadway failure along NW Inrindale Drive in 2010.

Flash flooding of Rock Creek and Four Mile Creek cause damages/disruptions within the City of Ankeny. Westwind area residences have experienced erosion of yards due to high and fast water flow. Emergency action has been necessary to keep one home from collapsing into the ravine. The City has invested funds in mitigating the impacts of flash flooding in the Westwind Development.

<u>Des Moines</u>: Lovington Area—Aurora and 30th Street; 22nd and Logan; 55th and Beaver Drive; Martin Luther King and Delaware; Court Avenue; Keo Way; US Highway 6; intersection at 63rd and Hickman Road; Douglas near Merle Hay Road; 47th and 48th Streets between Hickman and Beaver Crest; Hickman and Merle Hay Road; Martin Luther King near Douglas and Euclid Avenue.

Subsequent to the reported flash flooding, significant improvements including a new storm sewer and pump station have reduced the flash food risk on Court Avenue in the City of Des Moines.

<u>Grimes:</u> South 19th Street between Little Beaver and Highway 141; James Road, 7th Street Place.

<u>Mitchellville</u>: I-80 east of the east mix master

<u>Pleasant Hill/Youngstown area</u>: 4300 block of Fairview near Dean Avenue/ 65 ramp at Vandalia Road south of Pleasant Hill

<u>Polk City</u>: Highway 17 and 122nd Avenue near the Des Moines River Bridge

<u>Runnells</u>: Low lying gravel roads between Runnells and Highway 163

<u>Urbandale</u>: Intersection of 86th and I-80; Northwest Urbandale Drive and Meredith Drive; Douglas Avenue and Aurora.

West Des Moines: Intersection of Grand and 61st Street; George Flagg Parkway and southwest 30th Street near the Raccoon River; Garden Road near Waterworks Park; Valley West Drive and Westown Parkway

Windsor Heights: NW 75th Street, 76th Street, Marilyn Drive, 6900 block of School Street, Colby Park, and Hunter Circle

Des Moines International Airport: Highway 5 and Highway 28; Fleur Drive south of Army Post Road

The National Weather Service has various flash flooding products that are issued to the public to provide information regarding upcoming and current flash flood threats (see **Table 3.40**).

Table 3.40. National Weather Service Flash Flooding Products

Product	What It Means	You Should…
Hazardous Weather Outlook	Will there be any threat of flash flooding in the next several days?	If there is a threat of flash flooding, check back later for updated forecasts and possible watches and warnings. Latest Hazardous Weather Outlook
Flash Flood Watch	There is a threat of flash flooding within the next 48 hours, either as a result of heavy rain, ice jams, or the threat of a dam break.	Monitor weather conditions closely, especially if you live in an area prone to flash flooding.
Flash Flood Warning	There is an immediate threat for flash flooding in the warned area, especially in low-lying and poor drainage areas. These warnings are updated frequently with Flash Flood Statements.	If you live in an area susceptible to flash flooding, be prepared to evacuate and head to higher ground. Be very cautious when driving in the warned area, especially at night or while it is still raining. You may not be able to see a flooded road until it is too late!
A *Flash Flood Emergency* may be declared when a severe threat to human life and catastrophic damage from a flash flood is imminent or ongoing. The declaration of a *Flash Flood Emergency* would typically be found in either a Flash Flood Warning or Flash Flood Statement. People are strongly encouraged to avoid the geographic area of concern in a *Flash Flood Emergency*. The *Flash Flood Emergency* wording is used very rarely and is reserved for exceptionally rare and hazardous events.		
Areal Flood Warning	The threat of flash flooding is over, but there is still significant standing water in the affected area.	Areal flood warnings will typically list locations and roads impacted by the flooding. Try to avoid these locations until the water has receded.

Source: National Weather Service, website accessed 8/26/2013 http://www.crh.noaa.gov/dmx/?n=preparefloodproducts

Previous Occurrences

Table 3.41 provides details regarding the flash-flood related products issued for Polk County by the National Weather Service office in Des Moines.

Table 3.41. Flash Flood-Related National Weather Service Watches, Warnings & Advisories Issued for Polk County, Iowa (November 2005 – August 2013)

Phenomena	Significance	# of times Issued
Flash Flood	Watch	60
Flash Flood	Warning	61
Flood	Warning	140
Areal Flood	Advisory	18
Areal Flood	Warning	15
Areal Flood	Watch	7

Source: National Weather Service, Des Moines

As discussed in the Description section, flash flooding can be caused by intense rainfall over a brief period. **Table 3.42** provides the top 30 rainfall events at the Des Moines Airport Weather Station from August 1, 1952 to August 1, 2013 (60 years).

Table 3.42. Top 30 Rainfall Events, Des Moines Airport Weather Station, 1952 to 2013

Date	Precipitation (inches)
8/27/1975	6.18
6/9/2011	4.53
7/24/1997	4.45
9/12/1961	4.42
6/16/1990	4.23
8/26/1977	4.18
6/5/2008	4.15
4/28/1974	3.80
5/9/1996	3.65
11/3/2003	3.55
7/6/1998	3.47
8/25/1987	3.45
4/14/2012	3.43
6/29/1986	3.32
7/17/1996	3.30
9/25/1993	3.29
8/13/1986	3.23
5/22/2004	3.21
7/3/1981	3.18
8/29/1993	3.16
4/17/2013	3.14
6/8/1974	3.11
6/29/1959	3.10
9/28/1973	3.06
7/2/1958	2.92
7/1/1973	2.89
8/31/1977	2.80
5/31/1954	2.76
8/26/1954	2.74
5/4/2003	2.73

Source: Iowa State University Department of Agronomy http://mesonet.agron.iastate.edu/request/coop/fe.phtml

Information from the National Climatic Data Center was obtained from 1996 to April 2013 to determine previous occurrences for flash flood in the planning area. **Table 3.43** provides a summary of the NCDC data.

Table 3.43. NCDC Polk County, Iowa Flash Flood Events Summary, 1996 to April 2013

Year	# of Events	# of Deaths	# of Injuries	Property Damages	Crop Damages
2012	2	0	0	$50,000	$0
2011	1	0	0	$250,000	$0
2010	26	1	4	$2,806,000	$75,000
2008	19	0	0	$327,000	$0
2007	2	0	0	$300,000	$300,000
2004	6	0	0	$400,000	$60,000
2003	2	0	0	$200,000	$0
2002	1	0	0	$150,000	$15,000
2001	1	0	0	$150,000	$10,000
1998	2	0	0	$1,150,000	$40,000
1997	3	1	0	$330,000	$20,000
1996	1	0	0	$300,000	$50,000
Total	**66**	**1**	**4**	**$6,413,000**	**$570,000**

Source: NCDC, data accessed 8/26/2013

Of the 66 events described in the NCDC data, three were ice jam events; one in 2010, one in 2008, and one in 1997. Descriptions of these and other notable flash flood events are provided below in reverse chronological order:

- **June 2012**—The City of Grimes reported 12 inches of rain in 3 days that caused basement flooding, bank erosion and minor storm sewer blow outs.
- **April 14, 2012**—Street flooding reported with one to two feet in Ankeny near the HyVee and High School by 1st Street as well as 18 inches of water flowing across Delaware Ave., north of Oralabor Rd.
- **June 9, 2011**—Four Feet of water covered Vandalia Rd. and SE 42nd Street.
- **FEMA-DR-1930-IA—***Severe Storms, Flooding, and Tornadoes, Declared July 29, 2010; Incident Period June 1 to August 31, 2010*. The flash flooding associated with this event transitioned in to widespread riverine flooding. Therefore, this event is also discussed in **Section 3.4.13**, River Flooding. The details described below for Polk County occurred from August 4-11. Three vehicles, containing 11 people were swept into the waters of Mud Creek near Altoona in Polk County. One fatality occurred and four were injured. Evacuations took place from 3324 Hubble Ave. at an apartment complex to 3560 Douglas Avenue near a trailer Park in east Des Moines. Interstate 35 was covered by water at mile post 97 and several cars spun out in the flood waters. In Ankeny 4 to 5 inches of water covered the intersection of Crestmoor Place and Northeast 6th Street, water was 2 feet deep on Delaware Avenue in the 400 block, 18 inches of running water went across the intersection of SE 4th and Trilein; intersection of West 1st Street and SW State Street was impassable; and North Ankeny Boulevard and NE 9th Street was closed due to 16-18 inches of water. The basement walls of a house in the Avon Lakes area collapsed due to the heavy rains. In Grimes, water from the flooded creek flowed over James Road and inundated a few houses along the creek on 7th Street Place, extending to the 1800 block and 6 to 8 inches of water flowed out of a corn field and across South 19th Street between Little Beaver and Highway 141. In Des Moines, four feet of water covered the street at Aurora and 30th Street. In the Pleasant Hill/Youngstown area, flooding in the 4300 block of Fairview near Dean Avenue washed away railroad tracks and caused a derailment. In West Des Moines, water was over the road at Grand and 61st Street. In Urbandale, water

flooded over the intersections of 86th and I-80, Northwest Urbandale Drive and Meredith Drive, and Douglas Avenue and Aurora Avenue. In Windsor Heights, four basement apartments and three houses were inundated with water on NW 75th Street due to the fast rising waters from North Walnut Creek. In the unincorporated county, Merle Hay had 2 feet of water over the road and the intersection was flooded at Beaver Drive and Valdez Drive.

- **June 12, 2010**—Highway 415 was closed due to water running over the road.
- **May 12, 2010**—Highway 65 ramp at Vandalia Road south of Pleasant Hill was impassable due to high water and NE 38th at 24th Street near the 6th Ave SE intersection was washed out in Ankeny.
- **March 10, 2010**—An ice jam upstream of the Fleur Drive gauge caused water to rise rapidly, impacting George Flagg Parkway and southwest 30th Street near the Raccoon River.
- **December 27, 2008**—An ice jam on the Raccoon River caused water levels in the Des Moines area to rise 7 feet in less than 3 hours caused water to back up over George Flagg Parkway and Garden Road near Waterworks Park. Water backed up through the storm drains and flooded some businesses on Garden Road.
- **June 25-26, 2008**—In Des Moines, six to eight inches of water covered the road at 22nd and Logan, water was over the road at 55th and Beaver Drive, and nine inches of water was over a 300 foot area of Martin Luther King and Delaware, causing a vehicle to stall, 2.5 feet of water covered the intersection at 63rd and Hickman Road and water flowed over Douglas near Merle Hay Road; Near Mitchellville, four inches of water covered the interstate east of the east mix master. In West Des Moines, Valley West Drive and Westown Parkway had two and one half feet of water depth that drowned out a police squad car. In Polk City, water covered the road on Highway 17 and 122nd Avenue near the Des Moines River Bridge.
- **June 12, 2008**—Court Avenue was flooded with manhole covers being described as geysers.
- **June 6, 2008**—In Des Moines, flash flooding brought debris onto the road on Keo Way and waist high water covered the road near 47th and 48th Streets between Hickman and Beaver Crest. At the Des Moines International Airport, five feet of water was reported over Highway 5 and Highway 28 with multiple cars stalled and Fleur Drive south of Army Post Road had cars stalled with 8 to 9 inches of water on the road.
- **June 3, 2008**—Flash flooding was reported at Hickman and Merle Hay Road and on Martin Luther King near Douglas and Euclid Avenues.
- **June 16, 2004**—Heavy rainfall in Des Moines caused flash flooding with water flowing over 2 feet deep over US Highway 6.
- **November 3, 2003**—Heavy rains caused water over several intersections in the Des Moines metro area. In Altoona, the heavy rains resulted in some basements flooding.
- **May 4, 2003**—Flash flooding caused water over roads and highways as well as flooded basements in the metro area.
- **June 12, 2002**—Flash flooding to Flash flooding took place in southern Polk County, especially in Des Moines and areas east and south. Rainfall rates were in the 2 to 3 inch per hour range. The city of Des Moines was hard hit with flooded streets. There were numerous reports of stalled vehicles with water two to three feet deep in the streets. East of Des Moines in the Runnells area, low lying gravel roads between Runnells and highway

163 were barricaded as they went under water. Damage occurred to some of the county gravel roads as well as numerous houses by basement flooding.

- **June 18, 1998—**In Des Moines, a state of emergency was declared as water of 6 feet or greater in depth choked many of the city intersections. Hundreds of cars were stalled in the streets and many basements were flooded. Between the high winds and water, electricity was knocked out to 15,000 homes in Des Moines during the height of the storm. Damage estimates were in the hundreds of thousands of dollars in all of the flash flood counties, and over one million dollars in Polk County, where the Governor declared a state disaster. A disaster declaration was also made for Dallas County. Reports indicated that in the Des Moines metropolitan area, up to 10,000 homes had water in the basement. The city of Des Moines reported that infrastructure losses alone around $1 million.
- **July 24, 1997**—Heavy rains mentioned above in the urban and small stream flooding caused flash flooding in Polk County, specifically in Des Moines. Walnut Creek rose quickly above flood stage. Serious flooding occurred in low areas of the city with rush hour traffic snarled by closed roads that were under water.
- **February 19 and 20, 1997—**Ice jams occurred along the lower reaches of the Raccoon River. On the 19th, a fatality occurred due to an ice jam suddenly breaking. The water released from the jam swept a car off the road on the west side of Des Moines, drowning the occupant. On the 20th, a major ice jam, 12 miles in length, began at the 63rd street bridge in West Des Moines. The river went slightly above flood stage there before it broke free. The ice flowed down the river where it once again became jammed near the mouth of the river. It caused a rapid rise in the river level to nearly 2 feet above flood stage. Roads along the river were closed by the high water and ice. Heavy equipment was brought in to move the large chunks of ice off the roads before they could be opened.

The US Army Corps of Engineers, Cold Regions Research and Engineering Laboratory (CRREL) maintains a database of historic ice jams. **Table 3.44** lists the number of ice jams by water year (October – September with the water year being that of the end of the period). During the 20 year period from September 1993 to August 2013, there were a total of 18 recorded ice jam events in Polk County, Iowa. Note that additional ice jams may have occurred but were not observed or recorded in the ice jam database.

Table 3.44. Polk County, Iowa Ice Jams (Sept. 1993 to August 2013)

City	River	Jam Date	Water Year	Gage Number
Des Moines	Raccoon River	2/17/2011	2011	
Des Moines	Raccoon River	3/10/2010	2010	5484900
Des Moines	Raccoon River	12/28/2008	2009	5484900
Des Moines	Raccoon River	12/27/2008	2009	5484900
Norwalk	North River	12/27/2008	2009	5486000
Norwalk	North River	12/27/2008	2009	5486000
Des Moines	Raccoon River	12/10/2007	2008	5484650
Saylorville	Des Moines River	1/23/2005	2005	5481650
Des Moines	Des Moines River	1/23/2005	2005	5485500
Runnells	Des Moines River	1/23/2005	2005	5487500
Des Moines	Des Moines River	1/23/2005	2005	5482000
Des Moines	Walnut Creek	12/24/2004	2005	5484800
Des Moines	Raccoon River	3/15/2001	2001	5484650
Des Moines	Raccoon River	2/21/1997	1997	5484650

Norwalk	North River	2/20/1997	1997	5486000
Des Moines	Raccoon River	2/1/1996	1996	Not Reported
Des Moines	Raccoon River	¾/1993	1993	Not Reported
Des Moines	Raccoon River	¾/1993	1993	Not Reported

Source: US Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, website accessed 8/28/2013; http://www.crrel.usace.army.mil/

Probability of Future Occurrence

The frequency of past events is used to gauge the likelihood of future occurrences. The events from NCDC that occurred on the same day were combined to determine the total number of flash flooding events in the planning area. There were 28 separate days when flash flooding was reported somewhere in the planning area during the period from 1996 to April 2013 (17.3 years). This translates to flash flooding somewhere in the planning area approximately 1.6 times in any given year.

Probability Score: 4—Highly Likely

Vulnerability

Vulnerability Overview

Water over low-lying roads and bridges are the most frequent types of impacts associated with flash flooding that has occurred in the planning area. This can cause wash out of bridge abutments and erosion/scour damage on roads. There is potential for loss of life if motorists drive into moving water. However, public education campaigns have helped to educate citizens about not driving through moving water. Building damage is generally limited to water in basements where rain is too intense for drainage systems and natural drainage to carry water away from the structure. In addition, when combined storm/sanitary sewer systems are overloaded, this can result in sewer back-up. Generally, flash-flooding is short in duration and government services and business operations are not impacted.

Based on historical occurrences available from the City as well as NCDC, the City of Des Moines is particularly vulnerable to flash flooding as there were 19 occurrences during the 17.3-year period. The Unincorporated County had the next highest number of flash flooding occurrences with 14 during the same 17.3-year period.

Magnitude Score: 3—Critical. The magnitude was determined to be critical mainly due to the potential for loss of life with this hazard. During the 17.3 year period from 1996 to April 2013, there were two deaths in the planning area attributed to flash flooding.

Potential Losses to Existing Development

When roads and bridges are inundated by water, damage often occurs as the water scours materials around bridge abutments and gravel roads. The water can also cause erosion undermining road beds. In some instances, steep slopes that are saturated with water may cause mud or rock slides onto roadways. These damages can cause costly repairs for state, county, and city road/bridge maintenance departments. When sewer back-up occurs, this can result in costly clean-up for home and business owners as well as present a health hazard.

Based on loss estimates reported by NCDC, property losses averaged $253,800 per year over the 17.3-year period from 1996 to April 2013 and crop losses averaged $32,948 over the same period.

Future Development

In planning future development, jurisdictions in the planning area should avoid development in low-lying areas near rivers and streams or where interior drainage systems are not adequate to provide drainage during heavy rainfall events. Future development should also take into consideration the impact of additional impervious surfaces to water run-off and drainage capabilities during heavy rainfall events.

Flash Flood Hazard Summary by Jurisdiction

For the jurisdictions indicated in previous flash flood events reported to NCDC, or mentioned in the episode narrative, the magnitude was determined to be "critical" (3) and the probability "highly likely" (4). For the remaining jurisdictions, the probability was determined to be "occasional" (2) and the magnitude was determined to be "negligible" (1) due to the small number of reported flash flooding events or no flash flooding events reported for these areas. For the school districts, the levels of the cities served by the school district were applied. For Des Moines Water Works, the primary flooding threat is river flooding. However, flash flooding would impact the utility to some degree as a result of road closures that might impede travel for service vehicles.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	4	3	2	1	3.10	High
Cities						
City of Alleman	4	1	2	1	3.10	High
City of Altoona	4	3	2	1	3.10	High
City of Ankeny	4	3	2	1	3.10	High
City of Bondurant	2	1	2	1	1.60	Low
City of Clive	2	1	2	1	1.60	Low
City of Des Moines	4	3	2	1	3.10	High
City of Elkhart	4	3	2	1	3.10	High
City of Grimes	4	3	2	1	3.10	High
City of Johnston	2	1	2	1	1.60	Low
City of Mitchellville	4	3	2	1	3.10	High
City of Pleasant Hill	4	3	2	1	3.10	High
City of Polk City	4	3	2	1	3.10	High
City of Runnels	4	3	2	1	3.10	High
City of Urbandale	4	3	2	1	3.10	High
City of West Des Moines	4	3	2	1	3.10	High
City of Windsor Heights	4	3	2	1	3.10	High
Des Moines Water Works	2	1	2	1	1.60	Low
School Districts						
Ankeny, 261	4	3	2	1	3.10	High
Bondurant-Farrar, 720	2	1	2	1	1.60	Low
Dallas Center-Grimes, 1576	4	3	2	1	3.10	High
Des Moines Independent, 1737	4	3	2	1	3.10	High
Johnston, 3231	2	1	2	1	1.60	Low
North Polk, 4779	4	3	2	1	3.10	High
Saydel, 5805	4	3	2	1	3.10	High
Southeast Polk, 6101	4	3	2	1	3.10	High
Urbandale, 6579	4	3	2	1	3.10	High
West Des Moines	4	3	2	1	3.10	High

3.4.8 Grass or Wildland Fire

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	1	1	1	2.35	Moderate

Profile

Hazard Description

Iowa's urban/rural interface (areas where development occurs within or immediately adjacent to wildland, near fire-prone trees, brush, and/or other vegetation), is growing as metro areas expand into natural forest, prairies and agricultural areas that are in permanent vegetative cover through the Conservation Reserve Program (CRP). The State has the largest number of CRP contracts in the nation, totaling over 1.5 million acres. Most of this land is planted in cool and warm season grass plantings, tree plantings and riparian buffer strips. There is an additional 230,000 acres in federal ownership and conservation easements. The threat of wildland fire in the urban interface is greater now than it has been in more than a century and the problem is compounded by homeowners formerly from urban areas that do not understand that firefighting services and response times generally taken for granted in the cities are not equally available in more rural areas.

Wildfires are frequently associated with lightning and drought conditions, as dry conditions make vegetation more flammable. As new development encroaches into the wildland/urban interface more and more structures and people are at risk. On occasion, ranchers and farmers intentionally set fire to vegetation to restore soil nutrients or alter the existing vegetation growth. Also, individuals in rural areas frequently burn trash, leaves and other vegetation debris. These fires have the potential to get out of control and turn into wildfires.

The risk of wildfires is a real threat to landowners across the State. The National Weather Service monitors the conditions supportive of wildfires in the State on a daily basis so that wildfires can be predicted, if not prevented.

The risk factors considered are:

- High temperature
- High wind speed
- Fuel moisture (greenness of vegetation)
- Low humidity
- Little or no cloud cover

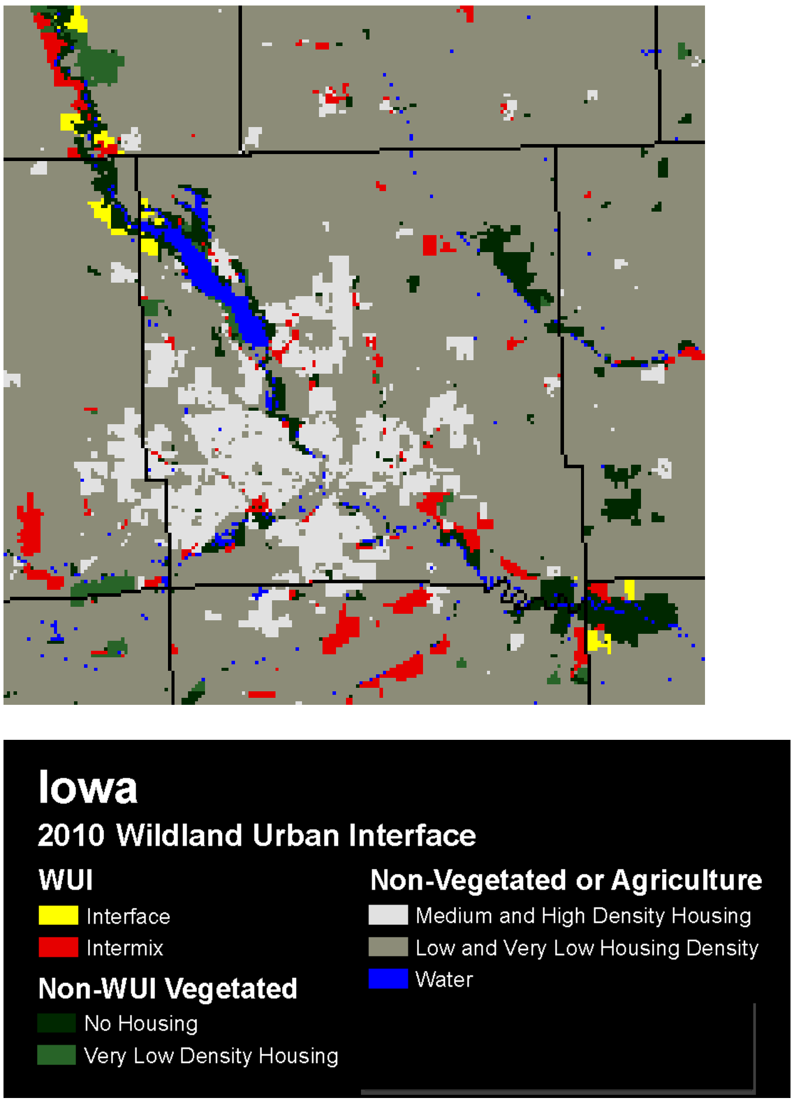
Warning Time Score: 1—More than 24 hours warning time. Although individual wildland/grass fires can ignite with very little warning, the warning time for the hazard condition is generally more than 24 hours.

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

Wildland/Grass fires are most likely to occur in the Wildland Urban Interface (WUI). This is the area where houses meet or intermingle with undeveloped wildland vegetation. Within the WUI, there are two specific areas identified: 1) Interface and 2) Intermix. The interface areas are those areas that abut wildland vegetation and the Intermix areas are those areas that intermingle with wildland areas. As can be seen in **Figure 3.55**, Polk County has very few areas of WUI Interface and WUI Intermix. The WUI Interface areas are limited to the unincorporated areas in the very northwest corner of the County along the northern portion of Saylorville Lake. The WUI Intermix areas are slightly more prevalent, sprinkled throughout the County.

Figure 3.55. Polk County Wildland Urban Interface, 2010



Source: SILVIS Lab, Department of Forest Ecology and management, University of Wisconsin-Madison; WUI 2010, http://silvis.forest.wisc.edu/maps/wui/state10

Previous Occurrences

Data was obtained from two sources to provide information on previous occurrences of grass/wildland fires in the planning area; 1) the Iowa Department of Public Safety, State Fire Marshal Division and 2) the Iowa Department of Natural Resources, Forestry Bureau.

Fire Marshal Division Data

Through the National Fire Incident Reporting System (NFIRS), the Iowa State Fire Marshal Office collects and reports fire incidents throughout the State. NFIRS is a repository of statistical data reported by participating fire departments. Although this is the best available statistical data for grass and wildland fires, there are some data limitations. Several of the fire departments in Polk County (Clive, Des Moines, Grimes, Mitchellville, Urbandale, and West Des Moines) have jurisdictional boundaries that extend into areas outside Polk County and NFIRS includes data on all reported fires, even those outside Polk County. In addition, there are also some fire departments that are based in neighboring counties and have jurisdictional boundaries that extend into Polk County (Madrid, Slater, Maxwell, Granger, Carlisle, Northern Warren, and Norwalk Fire Departments). The fires reported by those fire departments are not included in the data retrieved for Polk County.

To report previous events of grass or wildland fires in the planning area, statistics were gathered from Fire Departments based in Polk County for 2010-2012 for three categories: 1) Forest, Woods, or Wildland Fires, 2) Brush or Brush and Grass Mixture Fires, and 3) Grass Fires. **Table 3.45** provides the details of the number of fires in each of these categories by year and fire department. The first column provides the number of total reports received for each year. This column demonstrates that some fire departments do not report to the system. Therefore, there are likely additional fires that occur, but are not reported. In addition, some of the reporting fire departments fire district boundaries extend outside of Polk County. For these fire departments, some of the reported fires may have occurred in adjacent counties (see **Figure 3.56**).

During this 3-year period, the total number of reported wildland/grass fires was 598, for an annual average of 199 fires. The data included associated property and contents losses, where available. In 2012, property and contents losses totaled $6,605. In 2011 and 2010, there were no reported property or contents losses as a result of wildland/grass fires.

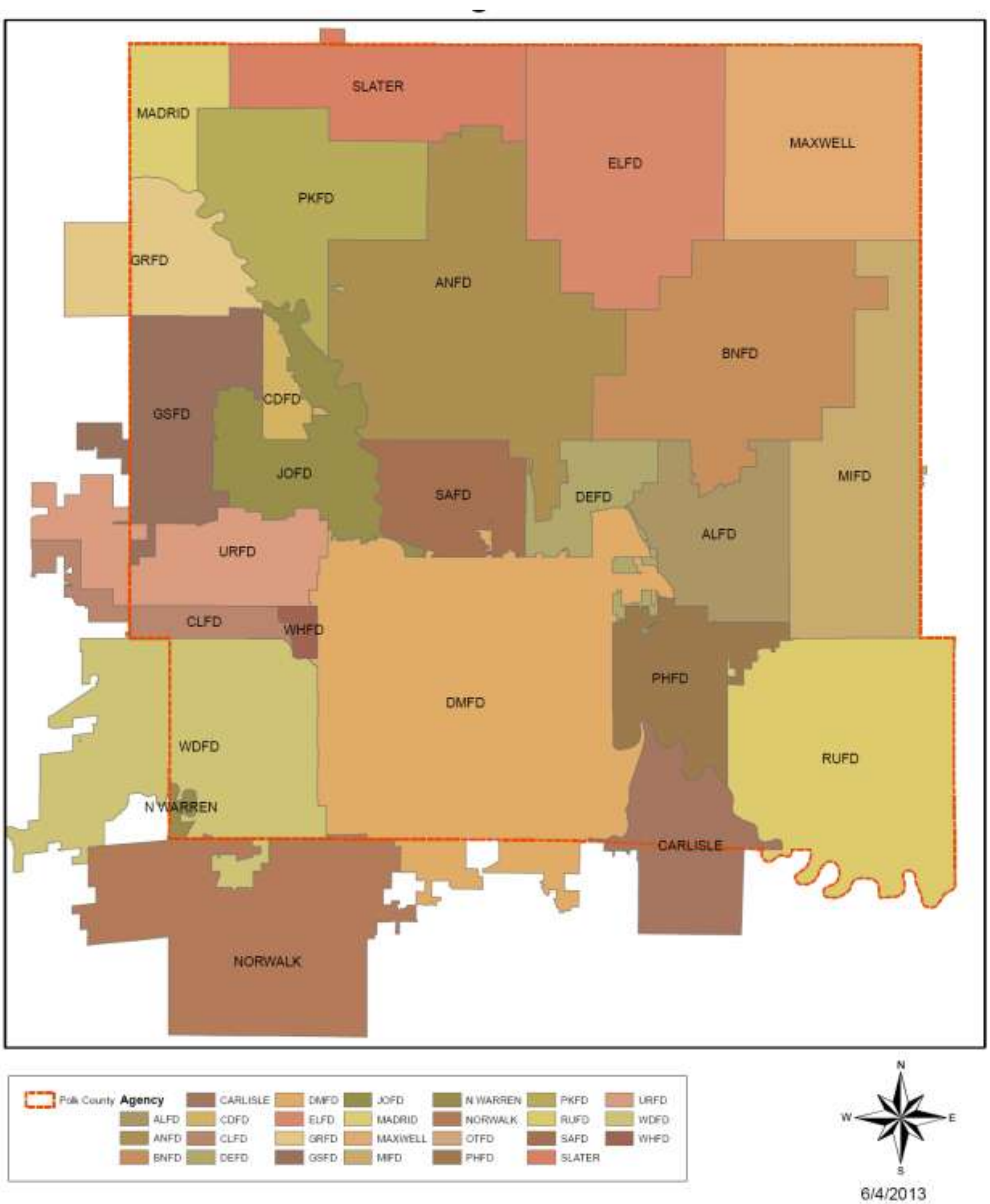
Table 3.45. Polk County Grass and Wildland Fires Reported to the Iowa Fire Marshal Division Office 2010-2012

Fire Department	Total Fire Reports Received	Forest, Woods, or Wildland Fires	Brush or Brush-and-Grass Mixture Fires	Grass Fires	Total All Categories of Wildland/Grass Fires
2012					
132nd FW Fire Department	0	0	0	0	**0**
Altoona Fire Department	1,699	0	5	6	**11**
Ankeny Fire Department	3,304	1	11	8	**20**
Bondurant Fire Department	323	0	1	2	**3**
Camp Dodge Fire Department	34	0	0	2	**2**
Clive Fire Department	1,046	0	0	5	**5**
Delaware Twp Fire Department	432	0	7	5	**12**
Des Moines Fire Department	20,164	15	40	48	**103**
Elkhart Fire Department	87	0	4	1	**5**
Grimes Fire Department	740	0	7	5	**12**
Johnston Fire Department	1,099	1	7	3	**11**
Mitchellville Fire Department	0	0	0	0	**0**
Pleasant Hill Fire Department	829	1	4	5	**10**
Polk City Fire Department	363	0	2	3	**5**
Runnells Fire Department	0	0	0	0	**0**
Saylor Twp Fire Department	735	0	2	2	**4**
Urbandale Fire Department	2,605	0	2	8	**10**
West Des Moines Fire Department	2,467	7	27	14	**48**
Windsor Heights Fire Department	0	0	0	0	**0**
2012 Total	**35,927**	**25**	**119**	**117**	**261**
2011					
132nd FW Fire Department	0	0	0	0	**0**
Altoona Fire Department	1,593	1	6	10	**17**
Ankeny Fire Department	2,430	0	5	8	**13**
Bondurant Fire Department	0	0	0	0	**0**
Camp Dodge Fire Department	0	0	0	0	**0**
Clive Fire Department	1,355	2	3	1	**6**
Delaware Twp Fire Department	322	2	7	2	**11**
Des Moines Fire Department	19,748	7	53	32	**92**
Elkhart Fire Department	102	0	2	5	**7**
Grimes Fire Department	498	1	2	3	**6**
Johnston Fire Department	1,154	0	11	2	**13**
Mitchellville Fire Department	0	0	0	0	**0**
Pleasant Hill Fire Department	738	1	4	3	**8**
Polk City Fire Department	154	0	1	0	**1**
Runnells Fire Department	166	0	1	21	**22**
Saylor Twp Fire Department	802	0	0	1	**1**
Urbandale Fire Department	2,489	2	5	6	**13**
West Des Moines Fire Department	2,593	1	20	8	**29**
Windsor Heights Fire Department	0	0	0	0	**0**
2011 Total	**34,144**	**17**	**120**	**102**	**239**
2010					
132nd FW Fire Department	0	0	0	0	**0**
Altoona Fire Department	1,417	0	2	4	**6**
Ankeny Fire Department	2,339	0	2	4	**6**
Bondurant Fire Department	0	0	0	0	**0**
Camp Dodge Fire Department	1	0	0	0	**0**
Clive Fire Department	2	0	0	0	**0**
Delaware Twp Fire Department	29	0	0	0	**0**
Des Moines Fire Department	15,516	2	29	12	**43**
Elkhart Fire Department	73	0	0	1	**1**

Fire Department	Total Fire Reports Received	Forest, Woods, or Wildland Fires	Brush or Brush-and-Grass Mixture Fires	Grass Fires	Total All Categories of Wildland/Grass Fires
Grimes Fire Department	555	0	6	2	**8**
Johnston Fire Department	933	0	7	0	**7**
Mitchellville Fire Department	0	0	0	0	**0**
Pleasant Hill Fire Department	862	0	2	0	**2**
Polk City Fire Department	91	0	0	1	**1**
Runnells Fire Department	0	0	0	0	**0**
Saylor Twp Fire Department	647	0	0	2	**2**
Urbandale Fire Department	2,179	0	5	0	**5**
West Des Moines Fire Department	2,307	3	8	4	**15**
Windsor Heights Fire Department	462	0	1	1	**2**
2010 Total	**27,413**	**5**	**62**	**31**	**98**

Source: Iowa Department of Public Safety, State Fire Marshal Division

Figure 3.56. Polk County Fire Agencies



Source: Polk County Emergency Management

Department of Natural Resources Forestry Bureau Data

The Iowa Department of Natural Resources Forestry Bureau also receives reports from participating fire departments of grass and wildland fires. This data was reported in this plan since it provides insight into the most frequent causes of reported grass and wildland fires as well as the acreage burned. According to this data source, there were 142 reported wildland or grass fires in Polk County from 2005-June 2013 (8.5 yrs). In total, these fires burned 5,770 acres. Of the 142 total fires, 101 were controlled/prescribed burns burning 5,364 acres and 41 were caused by natural and other accidental causes and burned 403 acres**. Table 3.46** provides the number of acres burned each year from 2005-June 2013 by cause.

Table 3.46. Acreage Burned by Grass or Wildland Fires by Cause, 2005-June 2013

Year	Lightning	Campfire	Smoking	Debris Burning	Arson	Equip Use	Railroads	Children	Misc	Controlled Burns
2005	0.00	0.00	0.00	3.00	86.00	0.00	0.00	1.00	174.00	262.00
2006	0.00	0.00	0.20	9.00	1.00	1.00	0.00	0.00	3.00	591.00
2007	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	17.00	402.49
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	517.13
2009	0.00	0.00	0.00	1.50	0.00	0.00	0.00	1.00	2.50	509.28
2010	0.00	0.00	0.00	0.00	0.00	14.00	0.00	0.00	0.00	150.18
2011	0.00	0.00	0.00	63.00	0.00	0.00	0.00	0.00	24.05	1,957.00
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	362.27
2013*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	613.00
Total	0.00	0.00	0.20	77.50	87.00	15.00	0.00	2.00	224.55	5,364.35

Source: Iowa Department of Natural Resources Forestry Bureau, 2013; *Partial Year January to June

Probability of Future Occurrence

Available data documents at least 199 wildland/grass fires per year in the planning area.

Probability Score: 4—Highly Likely

Vulnerability

Overview

Since most of Polk County is comprised of urban land use, most fires that are constituted as wildland/grass fires fall into the category of grass fire. According to the data from the Fire Marshal Division, of all wildland grass fires reported in the three year period, 92 percent were brush or brush/grass, and grass fires. The urban fire departments in the County are equipped to handle complex structure fires. As such, these smaller-scale brush/grass fires are well within the existing firefighting capabilities and are generally extinguished before much damage occurs. Areas that are most vulnerable to wildfire are agricultural areas where land is burned, rural areas where trash and debris are burned, and the wildland-urban interface areas. The portion of the planning area that is most vulnerable is that portion of the unincorporated county in the northwest corner of the County along Saylorville Lake. In this Wildland Urban Interface area, wildland fire fuels are in close proximity to built structures and could potentially cause extensive damage in this area if a fire occurred, especially during dry/drought conditions. To demonstrate how vulnerability to this hazard varies by jurisdiction, the 2010 spatial data indicating acreage of Wildland Urban Interface/Intermix areas from the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison was compared against the corporate boundary layer for the planning area. **Table 3.47** provides the results of this analysis. As the table indicates the only jurisdiction with Wildland Urban Interface acreage is unincorporated Polk County. The unincorporated County also has the most Wildland Urban Intermix acreage with 3,861 acres followed by the City of Des Moines and Pleasant Hill.

Table 3.47. Wildland Urban Interface/Intermix Acreage by Jurisdiction

Jurisdiction	Intermix (Acreage)	Interface (Acreage)
Alleman	0	0
Altoona	9	0
Ankeny	696	0
Bondurant	0	0
Carlisle*	0	0
Clive (Dallas)	57	0
Clive (Polk)	91	0
Des Moines (Polk)	1,412	0
Des Moines (Warren)	72	0
Elkhart	0	0
Granger*	0	0
Grimes (Dallas)	0	0
Grimes (Polk)	82	0
Johnston	270	0
Mitchellville	34	0
Mitchellville (Jasper)	25	0
Norwalk*	0	0
Pleasant Hill	1,086	0
Polk City	163	0
Polk County Unincorporated	3,881	1,207
Runnells	0	0
Sheldahl*	20	0

Jurisdiction	Intermix (Acreage)	Interface (Acreage)
Urbandale (Dallas)	10	0
Urbandale (Polk)	25	0
West Des Moines (Dallas)	57	0
West Des Moines (Madison)	0	0
West Des Moines (Polk)	339	0
West Des Moines (Warren)	0	0
Windsor Heights	0	0
Total	**8,329**	**1,207**

Source: SILVIS Lab, Department of Forest Ecology and management, University of Wisconsin-Madison; Corporate Boundary layer from the Des Moines Area Regional GIS Partnership; * Data is for the portion of these cities that is in Polk County only

Potential Losses to Existing Development

Wildfires can be responsible for extensive damage to crops, the environment and occasionally residential or business facilities. Homes built in rural areas are more vulnerable since they are in closer proximity to land that is burned and homeowners are more likely to burn trash and debris in rural locations. The vulnerability of structures in rural areas is exacerbated due to the lack of hydrants in these areas for firefighting and the distance required for firefighting vehicles and personnel to travel to respond. Potential losses to crops and rangeland are additional concerns.

Utilizing the data available from the Fire Marshal Division, there was an annual average of 199 grass and wildland fires, causing an annual average of $2,201 in property damages during the three-year period. It is noted that during the three-year period, $6,605 in damages occurred in 1 year with no damages occurring the other two years. This indicates that the damages incurred can be highly variable and therefore difficult to estimate.

To estimate future losses in terms of acreage burned, the data from the Department of Natural Resources Forestry Bureau was analyzed. During the 8.5-year period from 2005-2013, there were 41 accidental or natural-caused fires that burned 403 acres. If grass and wildland fires continue at a similar rate, the average annual acreage burned would be 47 acres per year.

<u>Magnitude Score</u>: 1—Negligible

Future Development

Future development in the wildland-urban interface/intermix areas would increase vulnerability to this hazard.

Grass or Wildland Fires Hazard Summary by Jurisdiction

The unincorporated portions of Polk County are more vulnerable to wildland/grass fires as a result of the WUI near the northern end of Saylorville Lake and more homes built in rural areas in closer proximity to land/trash/debris that is burned. Therefore, the magnitude for Polk County was determined to be a 2. For the remaining communities, probability levels were determined as follows: 1,000 or more acres intermix = 4; 300-999 acres intermix = 3; 100-299 acres intermix = 2; and less than 100 acres intermix = 1. Wildland/Grass fires can occur in city limits. However, this generally occurs less often and the magnitude is generally lower due to proximity to firefighting services. There is less potential for wildland/grass fires impacting schools and Des Moines Water Works facilities due to general locations away from Wildland Urban Interface Areas. If a wildland/grass fire were to occur near school buildings, the magnitude would be lower due to close proximity to firefighting services.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	4	2	1	1	2.65	Moderate
Cities						
City of Alleman	1	1	1	1	1.00	Low
City of Altoona	1	1	1	1	1.00	Low
City of Ankeny	3	1	1	1	1.90	Low
City of Bondurant	1	1	1	1	1.00	Low
City of Clive	1	1	1	1	1.00	Low
City of Des Moines	4	1	1	1	2.35	Moderate
City of Elkhart	1	1	1	1	1.00	Low
City of Grimes	1	1	1	1	1.00	Low
City of Johnston	2	1	1	1	1.45	Low
City of Mitchellville	1	1	1	1	1.00	Low
City of Pleasant Hill	4	1	1	1	2.35	Moderate
City of Polk City	2	1	1	1	1.45	Low
City of Runnells	1	1	1	1	1.00	Low
City of Urbandale	1	1	1	1	1.00	Low
City of West Des Moines	3	1	1	1	1.90	Low
City of Windsor Heights	1	1	1	1	1.00	Low
Des Moines Water Works	1	1	1	1	1.00	Low
School Districts						
Ankeny, 261	1	1	1	1	1.00	Low
Bondurant-Farrar, 720	1	1	1	1	1.00	Low
Dallas Center-Grimes, 1576	1	1	1	1	1.00	Low
Des Moines Independent, 1737	1	1	1	1	1.00	Low
Johnston, 3231	1	1	1	1	1.00	Low
North Polk, 4779	1	1	1	1	1.00	Low
Saydel, 5805	1	1	1	1	1.00	Low
Southeast Polk, 6101	1	1	1	1	1.00	Low
Urbandale, 6579	1	1	1	1	1.00	Low
West Des Moines	1	1	1	1	1.00	Low

3.4.9 Hazardous Materials Incident

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	2	4	1	3.10	High

Profile

Hazard Description

A hazardous substance is one that may cause damage to persons, property, or the environment when released to soil, water, or air. Chemicals are manufactured and used in increasing types and quantities. Each year over 1,000 new synthetic chemicals are introduced and as many as 500,000 products pose physical or health hazards and can be defined as "hazardous chemicals". Hazardous substances are categorized as toxic, corrosive, flammable, irritant, or explosive. Hazardous material incidents generally affect a localized area.

Fixed Hazardous Materials Incident

A fixed hazardous materials incident is the accidental release of chemical substances or mixtures during production or handling at a fixed facility.

Transportation Hazardous Materials Incident

A transportation hazardous materials incident is the accidental release of chemical substances or mixtures during transport. Transportation Hazardous Materials Incidents in Polk County can occur during rail transport or highway transport. Accidents involving rail shipments of hazardous materials typically fall into four general categories: track deterioration, equipment failures, human error, and other causes. Highway accidents involving hazardous materials pose a great potential for public exposures. Both nearby populations and motorists can be impacted and become exposed by accidents and releases. Generally speaking, the volume of hazardous materials transported is greater in rail transport than highway transport due to the higher capacity in rail cars.

Pipeline Incident

A pipeline transportation incident occurs when a break in a pipeline creates the potential for an explosion or leak of a dangerous substance (oil, gas, etc.) possibly requiring evacuation. An underground pipeline incident can be caused by environmental disruption, accidental damage, or sabotage. Incidents can range from a small, slow leak to a large rupture where an explosion is possible. Inspection and maintenance of the pipeline system along with marked gas line locations and an early warning and response procedure can lessen the risk to those near the pipelines.

Warning Time Score: 4—Less than six hours warning time

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

This section provides geographic locations within Polk County impacted by each type of potential hazardous materials incident.

Fixed Hazardous Materials Incident

According to the Iowa Department of Natural Resources, as of August 2013, there were 311 sites in Polk County that because of the volume or toxicity of the materials on site were designated as Tier II Facilities under the Superfund Amendments and Reauthorization Act. Of these 311 facilities, 158 reported materials on site that are considered to be "Extremely Hazardous Substances" (EHS).

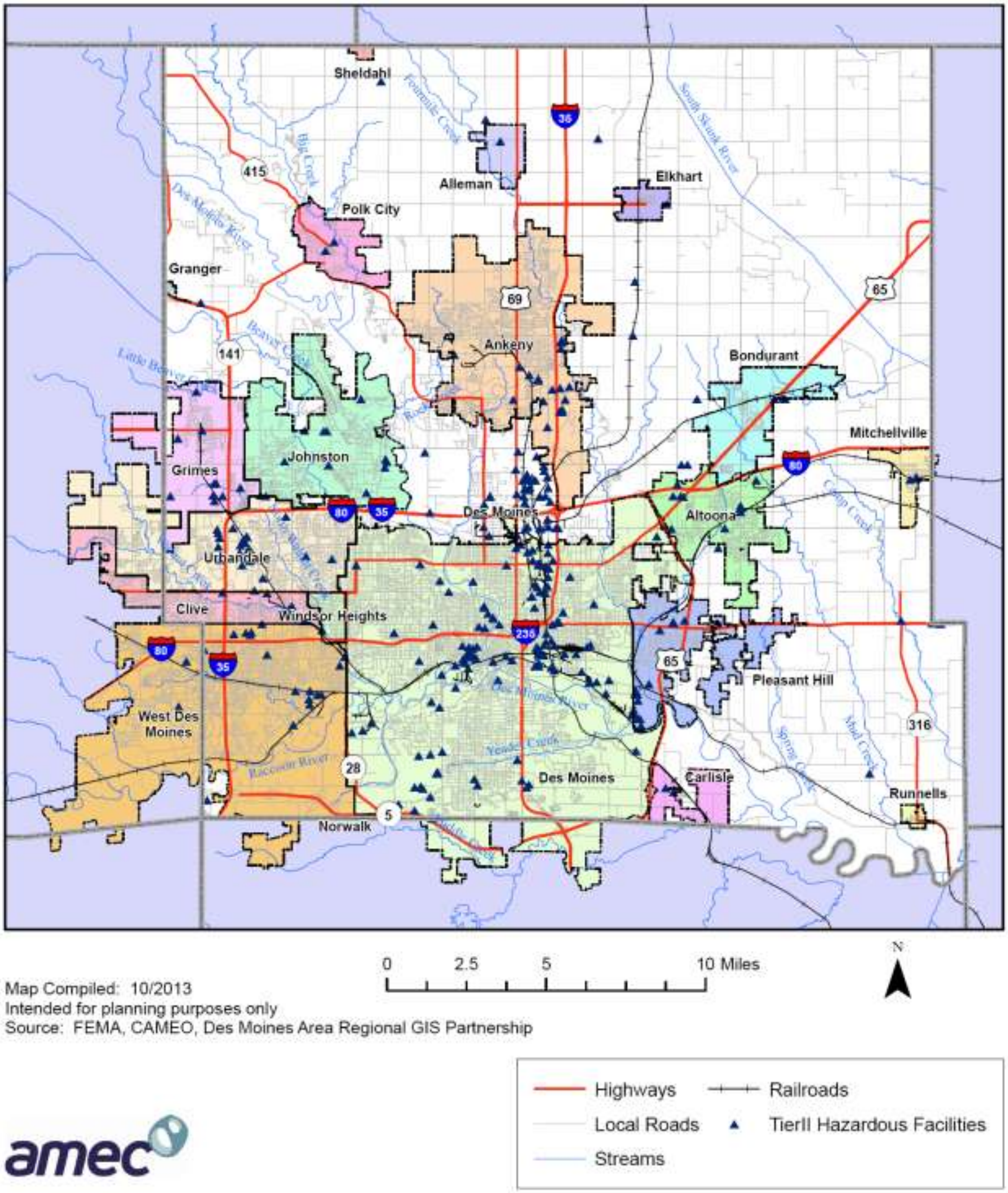
Table 3.48 provides the number of Tier II Facilities, as well as the number with EHS for each jurisdiction in the planning area. The locations of the facilities were overlaid with the corporate boundaries provided by the Des Moines Area Regional GIS Partnership to determine the number of facilities in each jurisdiction. **Figure 3.57** that follows is a map showing the locations of Tier II Facilities.

Table 3.48. Number of Tier II Facilities and EHS Facilities by Jurisdiction

Jurisdiction	Tier II Facilities	EHS Facilities
Alleman	1	1
Altoona	10	5
Ankeny	19	14
Bondurant	3	2
Carlisle*	2	2
Clive (Dallas)	0	0
Clive (Polk)	6	1
Des Moines (Polk)	122	56
Des Moines (Warren)	0	0
Elkhart	1	0
Granger*	0	0
Grimes (Dallas)	0	0
Grimes (Polk)	10	3
Johnston	13	8
Mitchellville	3	3
Mitchellville (Jasper)	0	0
Norwalk*	0	0
Pleasant Hill	15	7
Polk City	2	2
Polk County Unincorporated	61	30
Runnells	0	0
Sheldahl*	0	0
Urbandale (Dallas)	0	0
Urbandale (Polk)	24	15
West Des Moines (Dallas)	2	2
West Des Moines (Madison)	0	0
West Des Moines (Polk)	16	6
West Des Moines (Warren)	0	0
Windsor Heights	1	1
Total	**311**	**158**

Source: Iowa Department of Natural Resources, Des Moines Area Regional GIS Partnership; * Data is for the portion of these cities that is in Polk County only

Figure 3.57. Tier II Facilities in Polk County



Transportation Hazardous Materials Incident

In 2000, the Des Moines Area Metropolitan Organization (MPO) completed the *Goods Movement in the Des Moines Metropolitan Area* study. Then in 2006, the MPO completed an update to this study titled the *2006 Update Report of the Goods Movement in Central Iowa and in the Des Moines Metro Area.* Much of the statistical data in this section is sourced from the 2000 study and 2006 update report.

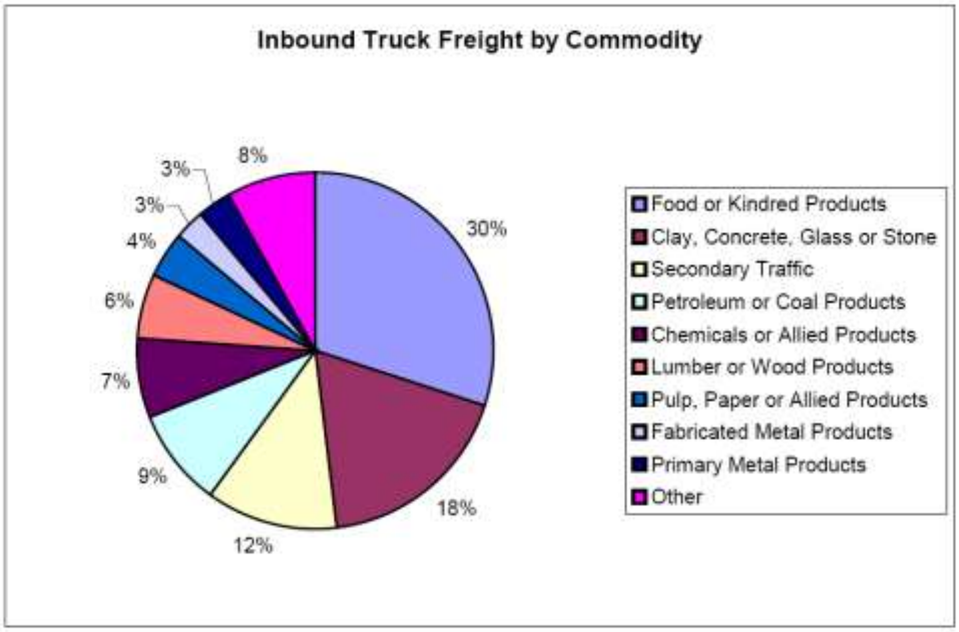
The location of Polk County and its extensive transportation network underscores the importance of transportation not only in the State, but nationwide. The interstate corridors of I-35 and I-80 are critical trade corridors for national freight movements. Many other U.S. and state highways within Polk County and throughout the eight county area that comprise the Central Iowa Regional Transportation Planning Alliance (CIRTPA) also play an important role in freight movement across Iowa and the nation.

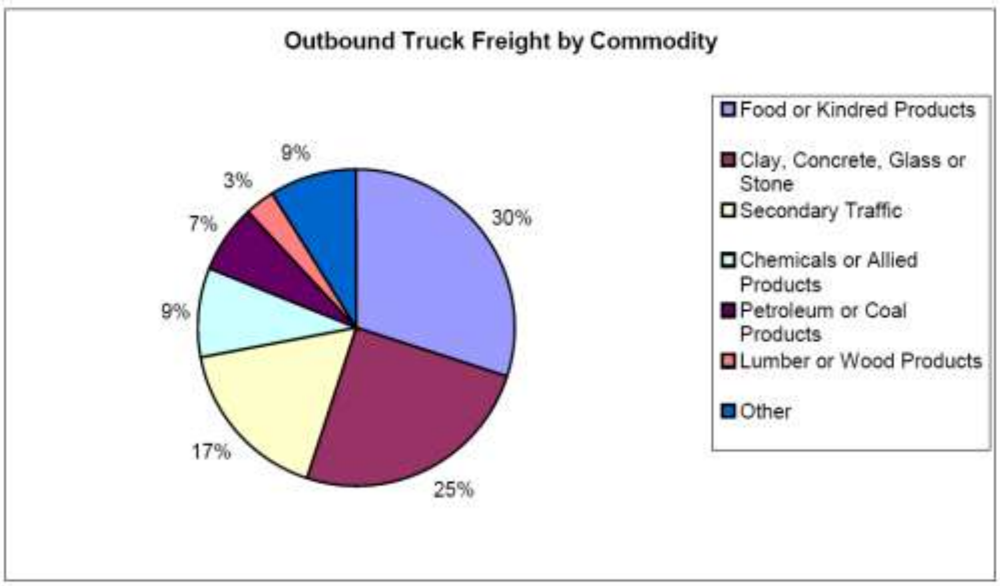
Truck Transport

The segments of I-35 and I-80 within Polk County and the Des Moines metropolitan area all have truck traffic counts above 13,000 vehicles per day. Other roadways within this area that experience higher truck volumes include U.S. 6, Iowa 141, and Iowa 160. These traffic volumes come from the Iowa DOT counts conducted in 2000 for the Des Moines Area Metropolitan Planning Organization.

The amount of inbound freight delivered by trucks to the eight-county CIRTPA area in the year 2000 was 30,687,148 short tons. The amount of freight moved out of this region by truck during the same year was 19,165,276 short tons. Freight movement by trucking is the primary means of moving commodities in or out of the CIRTPA area. A breakdown of the types of commodities that are delivered and exported to/from this region by trucks is provided in **Figure 3.58**. Approximately 50 percent of all inbound and 42 percent of outbound freight delivered by truck originate or end in one of the other Iowa counties outside the CIRTPA area. As shown in the figure, chemicals or allied products and petroleum or coal products account for 7 percent and 9 percent of both inbound and outbound truck freight respectively.

Figure 3.58. Inbound and Outbound Truck Freight by Commodity





Source: Goods Movement in the Des Moines Metropolitan Area report by the Des Moines Area Metropolitan Planning Organization, June 2002

Rail Transport

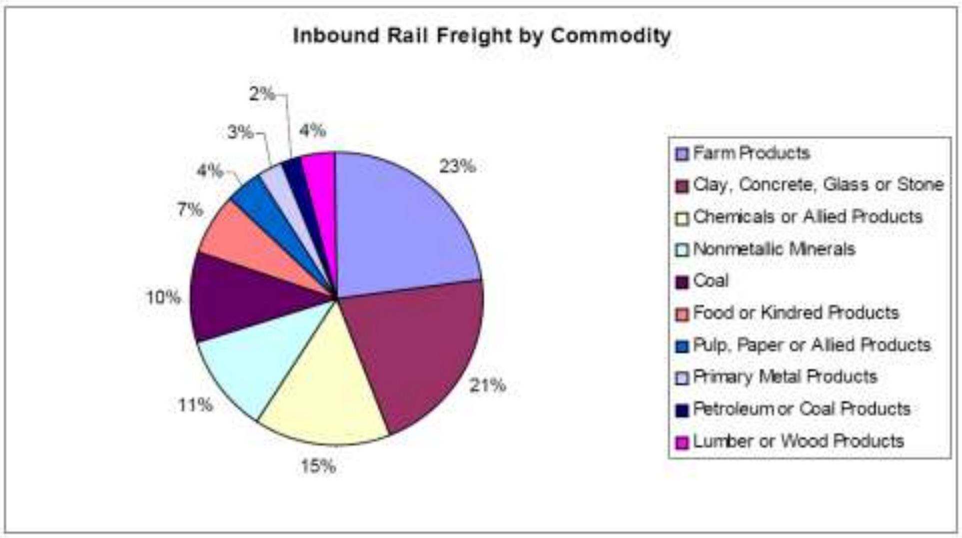
Four freight railroad companies operate in the eight-county area composing the CIRTPA. This area is served by three Class I railroads:

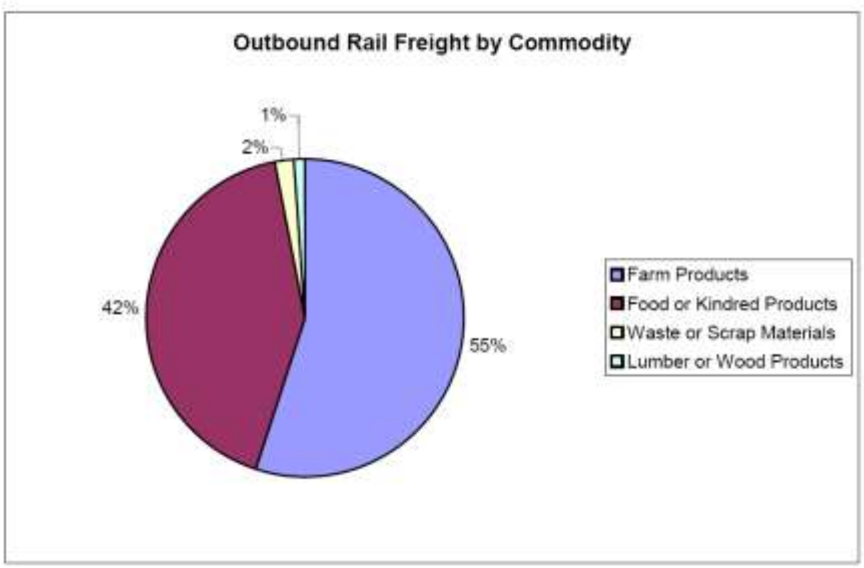
- Burlington Northern Santa Fe (BNSF) Railroad
- Norfolk Southern (NS) Railroad
- Union Pacific (UP) Railroad

A Class I railroad is defined as a long-haul rail carrier with operating revenue in excess of $258.5 million in 1999. The fourth railroad company serving this area is the Iowa Interstate Railroad (IAIS). The IAIS is a Class II railroad, which is defined as line-haul railroads operating 350 or more miles of track and/or with revenue of at least $40 million in 1999. There are also several Class III railroads, also known as "short-lines," operating in the state of Iowa but none serve Polk County directly.

Figure 3.59 provides the inbound and outbound railroad freight by commodity in the CIRPTA eight-county area. As the figure demonstrates, chemicals or allied products and petroleum or coal products comprise 15 percent and 2 percent of inbound rail freight respectively. These categories of commodity do not comprise any of the outbound rail freight.

Figure 3.59. Inbound and Outbound Rail Freight by Commodity





Source: Goods Movement in the Des Moines Metropolitan Area report by the Des Moines Area Metropolitan Planning Organization, June 2002

Air Freight

Polk County and central Iowa are served by the Des Moines International Airport and eight regional airports and airfields that are located within the county borders.

The Des Moines International Airport is owned by the City of Des Moines and is governed through a seven member Airport Board of Trustees. The Board is comprised of Des Moines citizens appointed by the Des Moines City Council. The Des Moines International Airport serves as the major air passenger and airfreight center for an 18-county area of central Iowa, with its primary service area being Polk, Dallas, and Warren Counties.

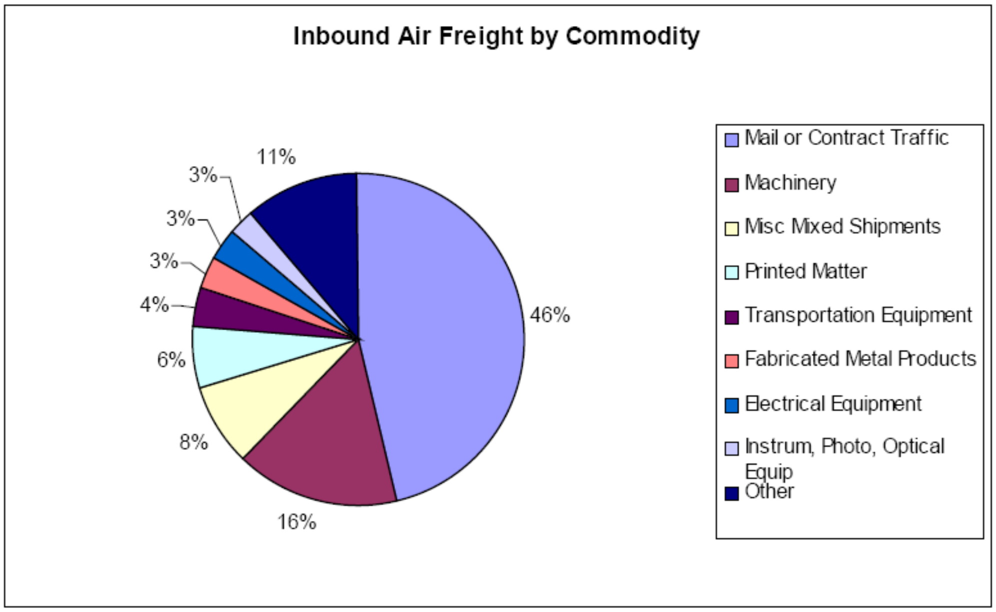
The Ankeny Regional Airport is the principal reliever facility for the Des Moines International Airport.

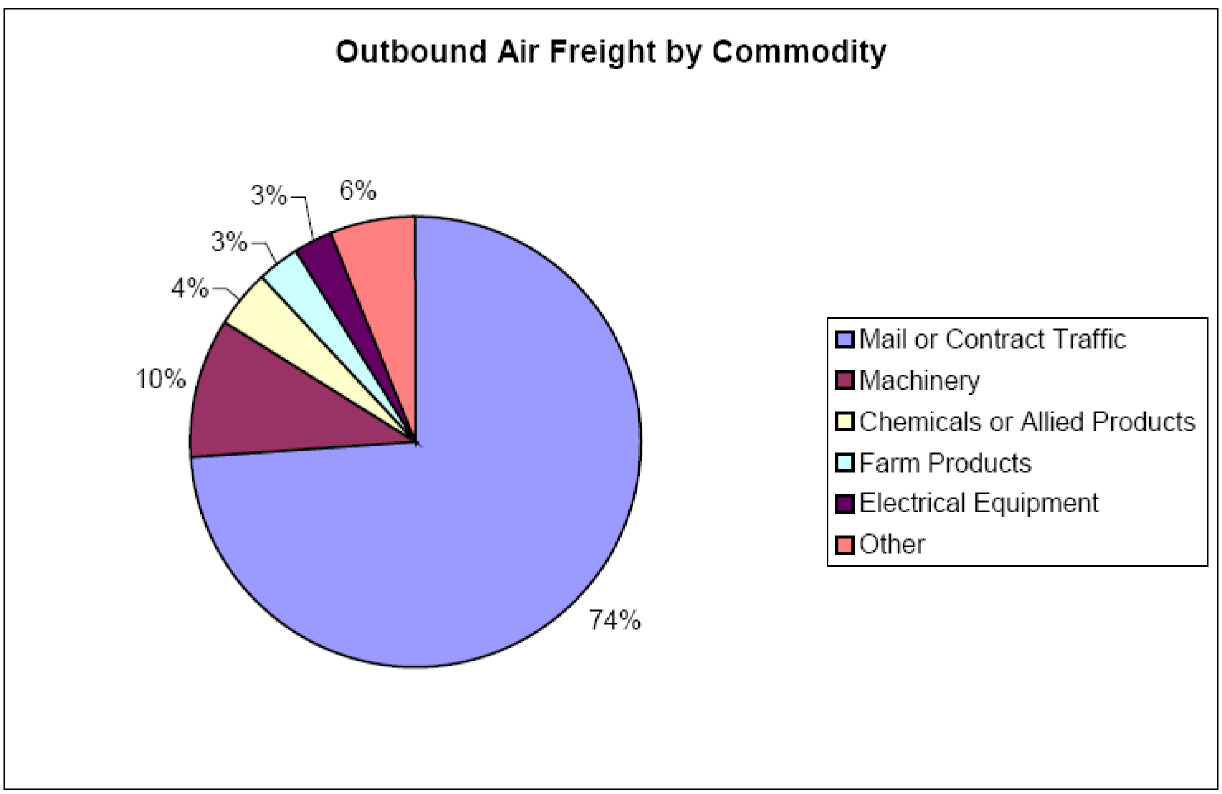
Other regional airports and local airfields in Polk County are:

- Morningstar Field
- Todd Field
- Robel Field
- DeLouis Field
- Day Field
- Kern Field
- Tuinstra Airfield

As Iowa's largest airport, DMIA handles a great deal of passengers and goods. Freight that is moved through the DMIA includes mail and cargo such as bulk freight and express/small packages. The amount of cargo/freight shipped by air through DMIA ranged from 115 to 140 tons per year. The DMIA is ranked among the top 50 airports in the nation in terms of the amount of cargo shipped. The other airports within the CIRTPA area are all classified as general aviation airports with no commercial air service. A breakdown by type of commodity for air freight traffic at DMIA is provided in **Figure 3.60**. As the charts show, there is no inbound freight category of chemical commodities and chemicals or other allied products accounts for only 4 percent of outbound air freight.

Figure 3.60. Inbound and Outbound Air Freight by Commodity



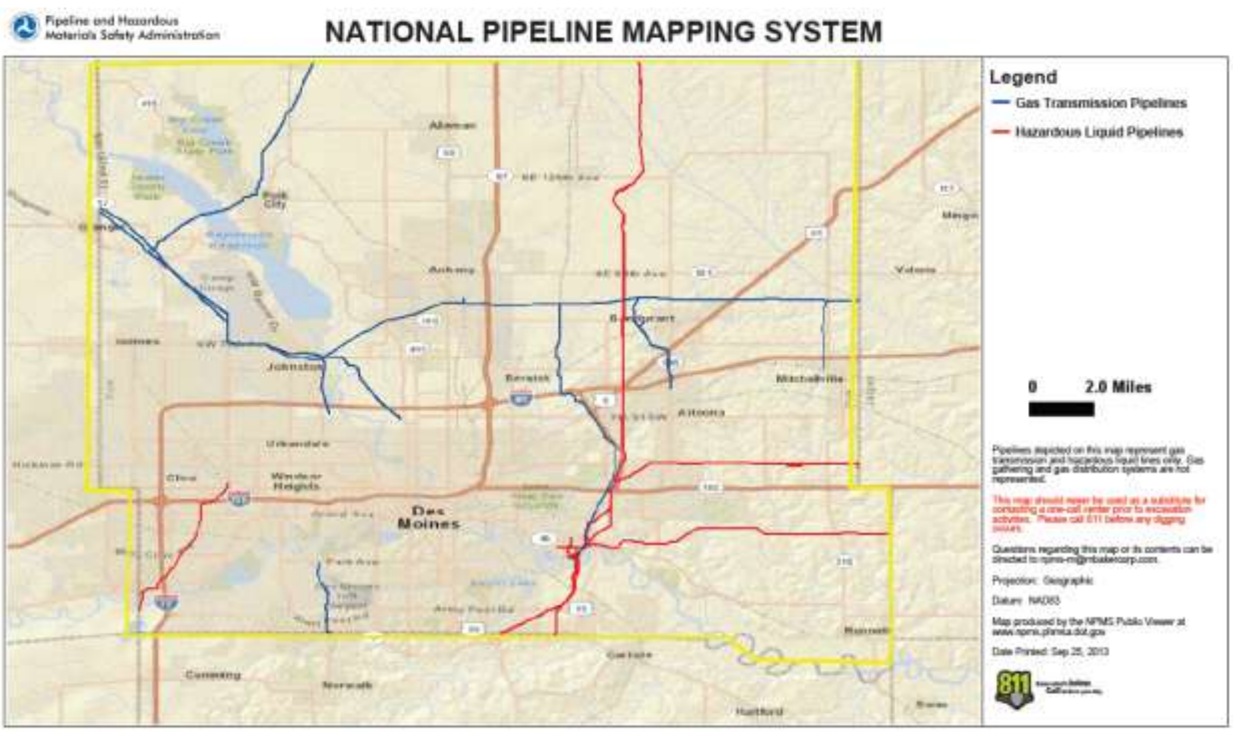


Source: Goods Movement in the Des Moines Metropolitan Area report by the Des Moines Area Metropolitan Planning Organization, June 2002

Pipeline Incident

There are 102 miles of gas pipelines and 1,571 miles of liquid pipelines in Polk County. **Figure 3.61** provides the locations of pipelines in Polk County. The data for this map consists of gas transmission pipelines and hazardous liquid trunklines. It does not contain gathering or distribution pipelines, such as lines which deliver gas to a customer's home. Therefore, not all pipelines in the County will be visible.

Figure 3.61. Pipelines in Polk County



Source: Pipeline and Hazardous Materials Safety Administration, National Pipeline Mapping System, https://www.npms.phmsa.dot.gov/PublicViewer/ retrieved on 9/25/2013

Previous Occurrences

In Iowa, hazardous materials spills are reported to the Department of Natural Resources. According to Iowa Administrative Code Chapter 131, *Notification of Hazardous Conditions*, any person manufacturing, storing, handling, transporting, or disposing of a hazardous substance must notify the Department of Natural Resources and the local police department or the office of the sheriff of the affected county of the occurrence of a hazardous condition as soon as possible but not later than six hours after the onset of the hazardous condition or the discovery of the hazardous condition. The Department of Natural Resources maintains a database of reported spills.

According to the DNR database, from 1995 to July 2013, there have been 1,738 hazardous materials spills reported in Polk County. Of the 1,738 spills, 124 were air releases, 198 affected ground water, 1,550 were on land, and 52 affected surface water. Please note: some spills had multiple mediums of release. **Table 3.49** provides a summary of the reported spills during this time period for each jurisdiction indicated in the database.

Table 3.49. Polk County Hazardous Materials Spills Reported to Iowa DNR, 1995-July 2013

Location	Reported Spills
Unincorporated County	18
Alleman	5
Altoona	84
Ankeny	110
Bondurant	24
Carlisle	3
Clive	85
Des Moines	963
Elkhart	9
Granger	2
Grimes	21
Johnston	59
Mitchellville	18
Norwalk	1
Pleasant Hill	84
Polk City	11
Runnells	8
Sheldahl	1
Urbandale	95
West Des Moines	121
Windsor Heights	16
Total	**1,738**

Source: Iowa Department of Natural Resources, http://www.iowadnr.gov/InsideDNR/RegulatoryLand/EmergencyPlanningEPCRA/SpillReporting.aspx, retrieved 7/23/2013

Another source consulted to report previous Hazardous Materials Incidents is the Environmental Protection Agency's Toxics Release Inventory (TRI). This inventory tracks the management of over 650 toxic chemicals that pose a threat to human health and the environment. U.S. facilities in certain industry sectors that manufacture, process, or otherwise use these chemicals in amounts above established levels must report how each chemical is managed through recycling, energy recovery, treatment, and releases to the environment. A "release" of a chemical means that it is emitted to the air or water, or placed in some type of land disposal. The information submitted by facilities to the EPA and states is compiled annually as the Toxics Release Inventory or TRI, and is stored in a publicly accessible database in Envirofacts.

TRI data are available for all facilities that have submitted a Form R or Form A to EPA since the program began in 1987. TRI facilities are legally required to report to EPA by July 1st of each year**. Table 3.50** provides the TRI on-site and off-site reported disposed of or otherwise released report for industries in Polk County that have TRI reporting requirements for 2011.

Table 3.50. TRI On-site and Off-site Reported Disposed of or Otherwise Released (in pounds), for All Industries, for All Chemicals, Polk County, Iowa, 2012

Chemical	Total On-site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
1,2,4-Trimethylbenzene	48,704.00	.	48,704.00
1-(3-Chloroallyl)-3,5,7-Triaza-1-Azoniaadamantane Chloride	255	.	255
2,4-D Butoxyethyl Ester	.	.	.
Aluminum (Fume Or Dust)	0	548	548
Ammonia	1,005.00	.	1,005.00
Barium Compounds	8	42,000.00	42,008.00
Benfluralin	1,000.00	.	1,000.00
Benzo(G,H,I)Perylene	1	2.3	3.3
Certain Glycol Ethers	45,315.00	589	45,904.00
Chlorine	.	.	.
Chromium	0	0	0
Chromium Compounds(Except Chromite Ore Mined In The Transvaal Region)	7,339.00	13,185.00	20,524.00
Copper	0	0	0
Copper Compounds	16.48	1,716.30	1,732.78
Dichloromethane	91	.	91
Diisocyanates	11.79	.	11.79
Dioxin And Dioxin-Like Compounds	0.0002472	0	0.0002472
Ethylbenzene	152	.	152
Ethylene Glycol	70.81	.	70.81
Hexazinone	.	.	.
Lead	4,067.04	667.8763	4,734.92
Lead Compounds	33.25	134.73	167.98
Manganese	5,981.00	1,698.00	7,679.00
Manganese Compounds	1,025.90	2,697.11	3,723.01
Methanol	2,223.12	.	2,223.12
Methyl Isobutyl Ketone	94	.	94
N-Butyl Alcohol	18,966.00	.	18,966.00
N-Hexane	508,745.00	.	508,745.00
Naphthalene	10	.	10
Nickel	2,606.00	1	2,607.00
Nitrate Compounds	28,460.00	.	28,460.00
Oxydiazon	.	.	.
Pendimethalin	10	.	10
Polycyclic Aromatic Compounds	9.72	83.8	93.52
Propanil	1,500.00	.	1,500.00
Propylene	3,515.00	.	3,515.00
Selenium Compounds	3.02	314.4	317.42
Sethoxydim	.	.	.
Toluene	395	.	395
Trichloroethylene	76	.	76
Trifluralin	10	.	10
Xylene (Mixed Isomers)	11,423.00	.	11,423.00
Zinc Compounds	21,285.10	22,017.95	43,303.05
Total	714,407.23	85,655.47	800,062.70

Source: Environmental Protection Agency Toxics Release Inventory (TRI), http://iaspub.epa.gov/triexplorer/tri_release.chemical, retrieved 9/25/2013

TRI data reflect releases and other waste management activities of chemicals, not whether (or to what degree) the public has been exposed to those chemicals. Release estimates alone are not sufficient to determine exposure or to calculate potential adverse effects on human health and the environment. TRI data, in conjunction with other information, can be used as a starting point in evaluating exposures that may result from releases and other waste management activities which involve toxic chemicals. The determination of potential risk depends upon many factors, including the toxicity of the chemical, the fate of the chemical, and the amount and duration of human or other exposure to the chemical after it is released.

Pipelines

The U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration maintains a database of pipeline incidents and mileage reports. According to the "Significant Incidents Listing", there have been three significant pipeline incidents in Polk County from 2002-July 2013.

Table 3.51. Polk County "Significant" Pipeline Incidents 2002-July 2013

Date	City	Operator	Cause	Sub-Cause	Fatalities	Injuries	Property Damage	Gross Barrels Spilled (Haz Liq)	Net Barrels Lost (Haz Liq)
01/02/2002	Des Moines	Williams Pipe Line Company	Mat'l/Weld/ Equip Failure	Malfunction of Control/Relief Equipment	0	0	$6,214	0	0
01/25/2008	Des Moines	Magellan Pipeline Company Lp	Natural Force Damage	Temperature	0	0	$117,686	2	1
05/12/2011	Des Moines	Midamerican Energy Company	All Other Causes	Unknown Cause	0	1	$5,335	N/A	N/A
01/22/2012	Pleasant Hill	Oneok Ngl Pipeline Llc	M at'l/Weld/ Equip Failure	Threaded Connection/Coupling Failure	0	0	$5,393	12	6
Totals					**0**	**0**	**$134,628**	**14**	**7**

Source: Pipeline & Hazardous Materials Safety Administration, http://primis.phmsa.dot.gov/comm/reports/safety/IncDetSt_st_IA_flt_sig.html?nocache=3712#_all).
Note: N/A = Not Available

Probability of Future Occurrence

Based on the annual average of 94 spills per year reported to Iowa DNR since 1995 (1,738 reported from 1995 to July 2013-18.5 years), the probability of future occurrence of hazardous materials incidents is determined to be "Highly Likely".

<u>Probability Score</u>: 4—Highly Likely

<u>Vulnerability</u>

Vulnerability Overview

A hazardous materials incident can occur almost anywhere. So, all jurisdictions are considered to have at least some vulnerability to this hazard. People, pets, livestock, and vegetation in close proximity to facilities producing, storing, or transporting hazardous substances are at higher risk. Populations downstream, downwind, and downhill of a released substance are particularly vulnerable. Depending on the characteristics of the substance released, more people, in a larger area may be in danger from explosion, absorption, injection, ingestion, or inhalation.

Most of the hazardous materials incidents are localized and are quickly contained or stabilized. Depending on the characteristic of the hazardous material or the volume of product involved, the affected area can be as small as a room in a building or as large as 5 square miles or more. Many times, additional regions outside the immediately affected area are evacuated for precautionary reasons. More widespread effects occur when the product contaminates the municipal water supply or water system such as river, lake, or aquifer. Although hazardous materials incidents are generally localized and quickly contained or stabilized, the magnitude was determined to be "limited" rather than "negligible" due to the high population densities in most of the planning area.

<u>Magnitude Score: 2</u>—Limited

Potential Losses to Existing Development

The impact of this type of disaster will likely be localized to the immediate area surrounding the incident. The initial concern will be for people, then the environment. If contamination occurs, the spiller is responsible for the cleanup actions and will work closely with responders in the local jurisdiction, the Iowa Department of Natural Resources, and the Environmental Protection Agency to ensure that cleanup is done safely and in accordance with federal and state laws.

As mentioned, it is difficult to determine the potential losses to existing development because of the variable nature of a hazardous materials spill. For example, a spill of a toxic airborne chemical in a populated area could have greater potential for loss of life. By contrast a spill of a very small amount of a chemical in a remote rural area would be much less costly and possibly limited to remediation of soil.

According to the Pipelines and Hazardous Materials Safety Administration in the Department of Transportation, the overall average per-gallon response cost for crude oil, gasoline, and other fuels is $1,270 per gallon. To determine the potential cost for future hazardous materials spills in Polk County, the average number of gallons spilled in incidents with a material type indicated as "petroleum" was calculated. From 1995 to July 2013, there were 39 incidents that involved “petroleum” material with a total 4,508 spilled for an average of was determined to be 115.6 gallons per spill. At $1,270 per gallon, this translates to $146,812 per spill. During the 18.5 year reporting period, there were an average 2.1 spills per year that involved spill of “petroleum” materials. Therefore, considering just this type of spill for which clean up estimates are available, cleanup costs an average of $308,305 per year.

To analyze critical facilities at risk in the planning area, the planning committee compiled an inventory of 2,853 critical and essential facilities and infrastructure in the planning area.   This list included critical facilities inventories from Des Moines Area Regional GIS Partnership that were then updated and validated/corrected by participating jurisdictions.   A comparison was made with the locations of Tier II Facilities to determine those critical/essential facilities that are within ½ mile of Tier II fixed chemical facilities. This analysis revealed 1,376 critical or essential facilities within ½ mile of fixed chemical facilities with the Tier II reporting requirement. Appendix E contains the results of analysis. This Appendix is “For Official Use Only”. To obtain access for official use, contact the Polk County Emergency Manager.

Future Development

Interstates 35 and 80 are two of the United States’ most important freight corridors for east/west and north/south movements. Both of these Interstates are projected to experience substantial growth in freight traffic over the coming years. Interstate 80 is perhaps one of the most significant roadways in the United States connecting many major cities including New York, Cleveland, Chicago, Salt Lake City and San Francisco. Interstate 35 provides a major route from Mexico to Canada. These two important interstates intersect in the Des Moines metropolitan area (Goods Movement Study Update Report, 2006).

The number and types of hazardous chemicals stored and transported through Polk County will likely continue to increase. As populations grow, this also increases the number of people vulnerable to the impacts of hazardous materials spills. Population and business growth along major transportation corridors increases the vulnerability to transportation hazardous materials spills.

Hazardous Materials Hazard Summary by Jurisdiction

Transportation Hazardous Materials Incidents can occur in all jurisdictions. Therefore all jurisdictions are considered to have some probability for transportation hazardous materials incidents. Similarly, all jurisdictions have pipelines near them. Therefore, all jurisdictions are considered to have some probability for pipeline hazardous materials incidents. However, fixed facility incidents at Tier II facilities are limited to those jurisdictions that have these facilities. Based on available data, it was determined that the following participating jurisdictions have less than 4 Tier II fixed facilities: Alleman, Bondurant, Elkhart, Mitchellville, Polk City, Runnells, and Windsor Heights. As a result, these cities and school districts that serve these cities were assigned a probability of 2, occasional. For Des Moines Water Works, the analysis revealed several facilities within the ½ mile buffer zone of Tier II facilities. In addition, with the majority of operations within the city limits of Des Moines, Des Moines Water Works was assigned the same rating levels.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	4	2	4	1	3.10	High
Cities						
City of Alleman	2	2	4	1	2.20	Moderate
City of Altoona	4	2	4	1	3.10	High
City of Ankeny	4	2	4	1	3.10	High
City of Bondurant	2	2	4	1	2.20	Moderate
City of Clive	4	2	4	1	3.10	High
City of Des Moines	4	2	4	1	3.10	High
City of Elkhart	2	2	4	1	2.20	Moderate
City of Grimes	4	2	4	1	3.10	High
City of Johnston	4	2	4	1	3.10	High
City of Mitchellville	2	2	4	1	2.20	Moderate
City of Pleasant Hill	4	2	4	1	3.10	High
City of Polk City	2	2	4	1	2.20	Moderate
City of Runnells	2	2	4	1	2.20	Moderate
City of Urbandale	4	2	4	1	3.10	High
City of West Des Moines	4	2	4	1	3.10	High
City of Windsor Heights	2	2	4	1	2.20	Moderate
Des Moines Water Works	4	2	4	1	3.10	High
School Districts						
Ankeny, 261	4	2	4	1	3.10	High
Bondurant-Farrar, 720	2	2	4	1	2.20	Moderate
Dallas Center-Grimes, 1576	4	2	4	1	3.10	High
Des Moines Independent, 1737	4	2	4	1	3.10	High
Johnston, 3231	4	2	4	1	3.10	High
North Polk, 4779	4	2	4	1	3.10	High
Saydel, 5805	4	2	4	1	3.10	High
Southeast Polk, 6101	4	2	4	1	3.10	High
Urbandale, 6579	4	2	4	1	3.10	High
West Des Moines	4	2	4	1	3.10	High

3.4.10 Human Disease

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
2	3	2	4	2.50	Moderate

Profile

Hazard Description

A human disease outbreak is a medical, health or sanitation threat to the general public (such as contamination, epidemic, plague and insect infestation). The outbreak may be spread by direct contact with an infected person or animal, ingesting contaminated food or water, vectors such as mosquitoes or ticks, contact with contaminated surroundings such as animal droppings, infected droplets, or by aerosolization.

Iowa's public health and health care communities work to protect Iowans from infectious diseases and preserve the health and safety of Iowans by rapidly identifying and containing a wide range of biological agents. Local public health departments and the Iowa Department of Public Health, Center for Acute Epidemiology investigate disease "outbreaks" of routine illnesses. There are a number of biological diseases/agents that are of concern to the state of Iowa such as vaccine preventable disease, foodborne disease and community associated infections having significant impact on the morbidity of Iowans. The following descriptions are general and it should be noted that individuals may experience more or less severe consequences.

Vaccine Preventable Disease

In the U.S., there are common infectious diseases that include polio, measles, diphtheria, pertussis, rubella, mumps, tetanus and *Haemophilus influenzae* type b that are now rare because of widespread use of vaccines. Routine childhood immunizations have helped protect both individuals and communities each year saving nearly $14 billion in direct medical costs and $69 billion in costs to society according to the U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

The immunization rates in Iowa are consistent with national average as seen in **Table 3.55** and **Table 3.56** that compares the Polk County, state of Iowa and National rates. Vaccine preventable diseases continue to threaten the health of Iowans when children, adolescents and adults are un-immunized or under-immunized.

Influenza

Influenza (flu) is a viral infection of the nose, throat, bronchial tubes, and lungs. There are two main types of virus: A and B. Each type includes many different strains, which tend to change each year. In Iowa, influenza occurs most often in the winter months. Illnesses resembling influenza may occur in the summer months, but these are usually the result of other viruses that exhibit symptoms commonly referred to as influenza-like illness or ILI.

Influenza is highly contagious and is easily transmitted through contact with droplets from the nose and throat of an infected person during coughing and sneezing. Typical symptoms include headache, fever, chills, cough, and body aches. Although most people are ill for only a few days some may have secondary infections, such as pneumonia, and may need to be hospitalized. Anyone can get influenza, but it is typically more serious in the elderly and people with chronic illnesses such as cancer, emphysema, or diabetes or weak immune systems. It is estimated that thousands of people die each year in the United States from flu or related complications.

In 2012, influenza and pneumonia combined was the 8^{th} leading causes of death in Iowa with 657 deaths. **Table 3.53** under Previous Occurrence shows the number of deaths and rate from 2000-2012.

Pandemic Influenza

A pandemic is a global disease outbreak. A pandemic flu is a human flu that causes a global outbreak, or pandemic, of serious illness. A flu pandemic occurs when a new influenza virus emerges for which people have little or no immunity, and for which there is no vaccine.

This disease spreads easily person-to-person, causing serious illness, and can sweep across the country and around the world in a very short time. The Centers for Disease Control and Prevention (CDC) has been working closely with other countries and the World Health Organization to strengthen systems to detect outbreaks of influenza that might cause a pandemic and to assist with pandemic planning and preparation.

During 2009 and 2010 health professionals around the globe worked to combat the H1N1 influenza virus. This relatively mild and stable influenza virus circulated across the globe and caused one of the most robust worldwide vaccination campaigns since the 1970s. Health professionals continue to monitor the possibility of an avian (bird) flu pandemic associated with a highly pathogenic avian H5N1 virus. Since 2003, avian influenza has been spreading through Asia. A growing number of human H5N1 cases contracted directly from handling infected poultry have been reported in Asia, Europe, and Africa, and more than half the infected people have died. There has been no sustained human-to-human transmission of the disease, but the concern is that H5N1 will evolve into a virus capable of human-to-human transmission.

An especially severe influenza pandemic could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Pandemics are generally thought to be the result of novel strains of viruses. Because of the process utilized to prepare vaccines, it is impossible to have vaccine pre-prepared to combat pandemics. A portion of the human and financial cost of a pandemic is related to lag time to prepare a vaccine to prevent future spread of the novel virus. In some cases, current vaccines may have limited activity against novel strains.

Foodborne Disease

There are several agents that can cause illness when consumer in contaminated food, beverages or water. Foodborne illness (food poisoning) can also be spread person-to-person as well as from contact with animals. **Table 3.52** is a list of common foodborne diseases

Table 3.52. Common Foodborne Diseases

Organism	Onset of Symptoms	Associated Food(s)
Botulism	12 – 36 hours	Canned fruits and vegetables
Campylobacter	2 – 5 days, range 1 – 10 days	Undercooked chicken or pork, unpasteurized milk
Cholera	12 – 72 hours	Undercooked or raw seafood, especially oysters
Cryptosporidium	7 days, range 1 – 12 days	Unpasteurized beverages, contaminated food or water, person-to-person
E. coli (shiga-toxin)	3 – 4 days, range 2 – 10 days	Undercooked ground meats, unpasteurized milk, contaminated fruits or vegetables, person-to-person
Giardia	7 – 10 days, range 3 – 25 days	Contaminated water, person-to-person
Hepatitis A	28 – 30 days, range 15 – 50 days	Raw produce, undercooked foods, person-to-person
Listeria	3 weeks, range 3 – 70 days	Soft cheeses, unpasteurized milk, ready-to-eat deli meats, hot dogs, undercooked poultry, unwashed raw vegetables
Norovirus	24 – 48 hours, range 10 – 50 hours	Contaminated ready-to-eat food, undercooked shellfish, person-to-person
Salmonella	12 – 36 hours, range 6 – 72 hours	Contaminated eggs, poultry, beef, raw fruits and vegetables, unpasteurized milk or juice, cheese
Shigella	1 – 3 days, range 12 – 96 hours	Contaminated food or water, person-to-person
Trichinosis	8 – 15 days, range 5 – 45 days	Raw or undercooked pork or wild game meat

Source: Iowa Department of Public Health, Center for Acute Disease Epidemiology http://www.idph.state.ia.us/Cade/Foodborne.aspx).

Warning Time Score: 2—12 to 24 hours

Duration Score: 4—More than 1 week

Geographic Location/Extent

A human disease outbreak has no geographic boundaries. Because of our highly mobile society, disease can move rapidly through a school, university, business and across the nation within days, weeks or months. Many of the infectious diseases that are designated as notifiable at the national level result in serious illness if not death. Some are treatable, for others only the symptoms are treatable.

Previous Occurrences

There have been four acknowledged pandemics in the past century:

- **2009 H1N1 Influenza**—The 2009 H1N1 Pandemic Influenza caused 659 hospitalizations with lab confirmed H1N1 since 9/1/09 and resulting in 41 fatalities. Typically people who became ill were the elderly, the very young and people with chronic medical conditions and high risk behaviors.

- **1968–69 Hong Kong flu (H3N2)** —This strain caused approximately 34,000 deaths in the United States and more than 700,000 deaths worldwide. It was first detected in Hong Kong in early 1968 and spread to the United States later that year. Those over age 65 were most likely to suffer fatal consequences. This virus returned in 1970 and 1972 and still circulates today.
- **1957–58 Asian flu (H2N2)** —This virus was quickly identified because of advances in technology, and a vaccine was produced. Infection rates were highest among school children, young adults and pregnant women. The elderly had the highest rates of death. A second wave developed in 1958. In total, there were about 70,000 deaths in the United States. Worldwide deaths were estimated between one and two million.
- 1**918–19 Spanish flu (H1N1)** —This flu is estimated to have sickened 20-40 percent of the world's population. Over 20 million people lost their lives. Between September 1918 and April 1919, 500,000 Americans died. The flu spread rapidly; many died within a few days of infection, others from secondary complications. The attack rate and mortality was highest among adults 20-50 years old; the reasons for this are uncertain.

Other Reportable Diseases

Table 3.53 shows the historical reported deaths in Iowa from Influenza and Pneumonia.

Table 3.53. Influenza and Pneumonia Deaths by Year 2000-2012 Resident Data

Year	Number	Rate per 100,000 population
2012	656	21.3
2011	657	21.5
2010	557	18.3
2009	633	23.1
2008	825	27.5
2007	748	25.0
2006	765	25.7
2005	893	30.1
2004	884	29.9
2003	1,032	35.1
2002	940	32.1
2001	878	30.0
2000	930	31.8

Source: Iowa Department of Public Health, Bureau of Health Statistics, http://www.idph.state.ia.us/apl/health_statistics.asp 2012 Vital Statistics

Table 3.54 provides the number of common reportable diseases in Polk County from 2012 to 2006 from the Iowa Department of Public Health, Center for Acute Epidemiology Annual Reports. There were approximately 417 percent more persons with pertussis in 2012 compared to the average of the past five years. In Polk County, there were 70 confirmed and probable cases in 2012. The Iowa Department of Public Health Director Medical Director believes that most adults have not had a pertussis vaccination since childhood so they probably have no immunity left to pertussis. Then they get the disease, their symptoms are milder and are often mistaken for a lingering cough, but they still spread the disease to others.

Table 3.54. Iowa Common Reportable Diseases by Year in Polk County

Year	2012	2011	2010	2009	2008	2007	2006
AIDS (diagnosis)	21	25	25	29	22	25	NR
HIV (diagnosis)	37	47	36	40	33	44	NR
Campylobacter	35	108	85	43	37	32	29
Chlamydia	2,035	2053	2076	1632	1976	1934	NR
Cryptospora	29	34	51	17	23	79	70
E. Coli	16	17	13	13	28	19	10
Giardia	48	1	0	2	111	0	77
Gonorrhea	593	62	63	79	375	82	NR
Hemolytic Uremic Syndrome	2	513	519	258	2	481	0
Hep A	2	3	0	1	15	0	1
Hep B, Acute	1	1	1	9	3	18	4
Hep B, Chronic	65	5	4	85	83	6	8
Legionella	1	1	46	4	3	103	2
Listeria	0	0	2	0	0	3	0
Lyme Disease	10	3	0	6	7	1	8
Meningococcal Disease	0	2	4	1	1	4	0
Mumps	1	2	0	4	3	2	71
Pertussis	172	21	0	36	23	1	33
Rabies (Animal)	2	2	44	3	2	20	NR
Rocky Mountain Spotted Fever	0	0	1	0	0	3	1
Salmonella	89	56	0	68	49	0	55
Shigella	36	6	60	24	30	85	33
Syphilis	61	22	7	10	13	7	NR
Tuberculosis	12	11	12	7	6	16	NR
West Nile Virus	1	0	1	0	0	7	NR

Source: Iowa Department of Public Health, Center for Acute Disease Epidemiology Annual Reports. 2012-2006.
http://www.idph.state.ia.us/cade/default.aspx
Note: * in the HIV row indicates only 1-3 HIV diagnoses reported and NR=not reported.

Probability of Future Occurrence

On an annual basis, the Iowa Department of Public Health, Center for Acute Disease Epidemiology produces a report that details the legally reportable diseases statewide numbers and in each county in Iowa. The surveillance of notifiable health conditions in Iowa allows the Department of Public Health to establish what, how and when events impact the public's health and help predict the likelihood of future diseases. Typically people who become ill are the elderly, the very young and people with chronic medical conditions and high risk behaviors. The HMPC determined the possibility of a large-scale human disease epidemic to be "**Occasional**."

Probability Score: 2—Occasional

Vulnerability

Overview

Although infectious diseases do not respect geographic boundaries, several populations in Polk County are at specific risk to infectious diseases. Communicable diseases are most likely to spread quickly in institutional settings such as prisons, dormitories, long-term care facilities, day care facilities, and schools. **Table 3.10** in the Assets at Risk, **Section 3.2** provides the number of institutional facilities in Polk County.

According to the Iowa Department of Public Health – Immunization Program Audit Report from 2011-2012 school year, Polk County had 99.78 percent with immunization certificates in kindergarten thru 12th grade. The County Immunization Assessment for 2-year old coverage with the State of Iowa and the U.S. National percent averages for 2012 are in **Table 3.55** and the 13 -17 Year old coverage with the state of Iowa and the U.S. National percent averages for 2012 are in Table 3.56. The State of Iowa and the U.S. National percent averages are from the National Immunization Survey which is sponsored by the National Center for Immunizations and Respiratory Diseases (NCIRD) and conducted jointly by NCIRD and the National Center for Health Statistics, Centers for Disease Control and Prevention.

Table 3.55. 2-Year Old Vaccination Coverage Percent of Individual Vaccines and Selected Vaccination Series in Polk County, State of Iowa and U.S. National.

	4 Dtap	1 MMR	3 Hib	3 Hep B	1 Varicella	4 PCV	*Up-to-Date 4-3-1-3-3-1-4
Polk County	80%	89%	90%	92%	89%	81%	74%
Iowa	88.2%	93.3%	96.4%	93.7%	94.4%	86.4%	74.8%
U.S. National	82.5%	90.8%	93.3%	89.7%	90.2%	81.9%	68.4%

Sources: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2011 U.S. Vaccination Coverage Reported via NIS, http://www.cdc.gov/vaccines/stats-surv/nis/default.htm#nis
2012 County Immunization Assessment, http://www.idph.state.ia.us/ImmTB/Immunization.aspx?prog=Imm&pg=ImmHome
The percent estimates for the State of Iowa and the U.S. National are presented as point estimates and have +/- variances.
* Note: Up-to-date are children who have completed the 4 DtaP, 3 Polio, 1 MMR, 3 Hib, 3 Hep B, 1 Varicella, 4 PCV by 24 months of age.

Table 3.56. 13-15-Year Old Coverage of Individual Vaccines and Selected Vaccination Series in Polk County State of Iowa and U.S. National.

	3 Hep B	Meningococcal	2 MMR	1 Td	1 Tdap	2 Varicella	*Up-to-Date 3-1-2-1-2
Polk County	78%	63%	77%	2%	66%	52%	38%
Iowa	93.8%	60.5%	91..5%	80.2%	77.8%	**62.1%	N/A
U.S. National	92.8%	70.5%	91.4%	88.5%	84.6%	**82.6%	N/A

Sources: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2011 U.S. Vaccination Coverage Reported via NIS, http://www.cdc.gov/vaccines/stats-surv/nis/default.htm#nis2012 County Immunization Assessment, http://www.idph.state.ia.us/ImmTB/Immunization.aspx?prog=Imm&pg=ImmHome
The percent estimates for the State of Iowa and the U.S. National are presented as point estimates and have +/- variances.
*Note: Up-to-date are Adolescents 13 – 15 Year Olds that have completed the 3 Hep B, 1 Meng, 2 MMR, 1 Td or Tdap, 2 Varicella Series.
** The percent is for >2 doses vaccine if had no history of disease.
N/A: Not Available.

The HMPC ranked human disease outbreak as critical based on a pandemic scenario. The magnitude of an infectious disease outbreak is related to the ability of the public health and medical communities to stop the spread of the disease. Most disease outbreaks that cause critical numbers of deaths are communicable in nature, meaning that they are spread from person to person. The key to reducing the critical nature of the event is to stop the spread of disease. This is generally done in three ways: (1) identification and isolation of the ill, (2) quarantine of those exposed to the illness to prevent further spread, and (3) education of the public about methods to prevent transmission. The public health and health care providers in Iowa County routinely utilize all three methods to reduce morbidity and mortality from infectious disease.

Magnitude Score: 3—Critical

Potential Losses to Existing Development

According to *The annual impact of seasonal influenza in the US: Measuring disease burden and costs* by Molinari et al., nationally the economic burden of influenza medical costs, medical costs plus lost earnings, and the total economic burden was $10.4 billion, $26.8 billion and $87.1 billion respectively. The financial burden of healthcare-associated infections nationally has been estimated at $33 billion annually. Specific amounts for Polk County are not available. Using pandemic influenza as the worst case scenario for estimating projected numbers of people affected and based on the 1918 pandemic, 30 percent of the overall population could be ill in this scenario. **Table 3.57** lists the number of persons affected by jurisdiction in Polk County based on the 2010 census population.

Table 3.57. Pandemic Influenza Worst Case Scenario Projected Numbers of People Affected

Jurisdiction	County	2010 Population	30% of Population Affected
City of Alleman	Polk	432	130
City of Altoona	Polk	14,541	4,362
City of Ankeny	Polk	45,580	13,674
City of Bondurant	Polk	3,860	1,158
City of Carlisle	Polk	82	25
City of Clive	Dallas	4,713	1,414
City of Clive	Polk	10,728	3,218
City of Des Moines	Polk	204,122	61,237
City of Des Moines	Warren	625	188
City of Elkhart	Polk	683	205
City of Granger	Polk	212	64
City of Grimes	Dallas	14	4
City of Grimes	Polk	8,232	2,470
City of Johnston	Polk	17,278	5,183
City of Mitchellville	Jasper	26	8
City of Mitchellville	Polk	2,228	668
City of Norwalk	Polk	0	0
City of Pleasant Hill	Polk	9,009	2,703
City of Polk City	Polk	3,416	1,025
Polk County	Polk	26,581	7,974
City of Runnells	Polk	507	152
City of Sheldahl	Polk	134	40
City of Urbandale	Dallas	6,339	1902
City of Urbandale	Polk	33,070	9921
City of West Des Moines	Dallas	11,764	3,529
City of West Des Moines	Madison	3	1
City of West Des Moines	Polk	44,999	13,500
City of West Des Moines	Warren	41	12
City of Windsor Heights	Polk	4,860	1,458
Total		454,165	136,121

Source: U.S. Census, 2010 and Polk County *Pandemic Influenza Response Plan 2009*'

The Iowa Hospital Association website, www.iowahospitalcharges.com has a comparison tool of hospital charges in Iowa for common/high volume services. **Table 3.58** is the inpatient described costs for a respiratory, non-surgical pneumonia during the April 2012 to March 2013 timeframe. The worst case scenario compares the charges at the Broadlawns Medical Center in Des Moines and the Mercy Medical Center-West Lakes in West Des Moines where if 30 percent of the population needs inpatient services, **Table 3.58** shows the costs for minor, moderate, major and extreme severity cases of pneumonia per hospital.

Table 3.58. Hospital Inpatient Services and Described Costs at Mary Greeley Medical Facility and Polk County Medical Center

	Broadlawns Medical Center in Des Moines	Mercy Medical Center-West Lakes in West Des Moines
Minor Severity – 15% Affected		
Number of Discharges	16	5
Average Length of Stay	2.7 Days	2.6 Days
Average Charge	$9,233	11,574
15% of Population Affected	30,712 from Des Moines	8,521 from West Des Moines
Total Cost	$283,563,896	98,622,054
Moderate Severity – 10% Affected		
Number of Discharges	39	45
Average Length of Stay	3.7 Days	3.3 Days
Average Charge	$11,709	$15,061
10% of Population Affected	20,475 from Des Moines	5,681 from West Des Moines
Total Cost	239,741,775	85,557,023
Major Severity – 3% Affected		
Number of Discharges	25	57
Average Length of Stay	5.6Days	4.4 Days
Average Charge	$18,047	$21,670
3% of Population Affected	6,142 from Des Moines	1,704 from West Des Moines
Total Cost	$110,853,073	$36,930,230
Extreme Severity – 2% Affected		
Number of Discharges	6	12
Average Length of Stay	2.8 Days	8.8
Average Charge	$14,934	47,493
2% of Population Affected	4,095 from Des Moines	1,136 from West Des Moines
Total Cost	$61,154,730	53,958,697

Source: Iowa Hospital Association http://www.iowahospitalcharges.com/

The U.S. Centers for Disease Con roll and Prevention (CDC) estimates 76 million people suffer foodborne illnesses each year in the United States, accounting for 325,000 hospitalizations and more than 5,000 deaths. Foodborne disease is extremely costly. Health experts estimate that the yearly cost of all foodborne diseases in this country is $5 to $6 billion in direct medical expenses and lost productivity. Infections with the bacteria *Salmonella* alone account for $1 billion yearly in direct and indirect medical costs.

Buildings, infrastructure, and critical facilities are not vulnerable to this hazard. It affects only persons susceptible to the illness. The impacts and potential losses are largely economic and are dependent on the type, extent and duration of the illness.

Future Development

As populations increase throughout Polk County and in the cities that are experiencing record growth, and the cost of health care climbs, potential losses can be expected to rise.

Human Disease Hazard Summary by Jurisdiction

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	2	3	2	4	2.50	Moderate
Cities						
City of Alleman	2	3	2	4	2.50	Moderate
City of Altoona	2	3	2	4	2.50	Moderate
City of Ankeny	2	3	2	4	2.50	Moderate
City of Bondurant	2	3	2	4	2.50	Moderate
City of Clive	2	3	2	4	2.50	Moderate
City of Des Moines	2	3	2	4	2.50	Moderate
City of Elkhart	2	3	2	4	2.50	Moderate
City of Grimes	2	3	2	4	2.50	Moderate
City of Johnston	2	3	2	4	2.50	Moderate
City of Mitchellville	2	3	2	4	2.50	Moderate
City of Pleasant Hill	2	3	2	4	2.50	Moderate
City of Polk City	2	3	2	4	2.50	Moderate
City of Runnells	2	3	2	4	2.50	Moderate
City of Urbandale	2	3	2	4	2.50	Moderate
City of West Des Moines	2	3	2	4	2.50	Moderate
City of Windsor Heights	2	3	2	4	2.50	Moderate
Des Moines Water Works	2	3	2	4	2.50	Moderate
School Districts						
Ankeny, 261	2	3	2	4	2.50	Moderate
Bondurant-Farrar, 720	2	3	2	4	2.50	Moderate
Dallas Center-Grimes, 1576	2	3	2	4	2.50	Moderate
Des Moines Independent, 1737	2	3	2	4	2.50	Moderate
Johnston, 3231	2	3	2	4	2.50	Moderate
North Polk, 4779	2	3	2	4	2.50	Moderate
Saydel, 5805	2	3	2	4	2.50	Moderate
Southeast Polk, 6101	2	3	2	4	2.50	Moderate
Urbandale, 6579	2	3	2	4	2.50	Moderate
Wes Des Moines	2	3	2	4	2.50	Moderate

3.4.11 Infrastructure Failure

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
2	2	4	4	2.50	Moderate

Profile

Hazard Description

Critical infrastructure involves several different types of facilities and systems including: communications, energy (electricity and natural gas), other utilities such as water and sewer systems, and transportation facilities such as roads and bridges. Failure of these utilities or other components of the infrastructure in the planning area can seriously impact public health, functioning of communities and the economy. Disruption of any of these services could result from the majority of the natural, technological, and manmade hazards described in this plan. In addition to a secondary or cascading impact from another primary hazard, utilities and infrastructure can fail as a result of faulty equipment, lack of maintenance, degradation over time, or accidental damage such as damage to buried lines or pipes during excavation.

Communications Failure

Communications failure is the widespread breakdown or disruption of normal communication capabilities. This could include major telephone outages, internet interruption, loss of cellular telephone service, loss of local government radio facilities, long-term interruption of electronic broadcast services, or emergency 911. Law enforcement, fire, emergency medical services, public works, and emergency warning systems are just a few of the vital services which rely on communications systems to effectively protect citizens. In addition, business and industry rely heavily on various modes of communication. Mechanical failure, traffic accidents, power failure, line severance, and weather can all affect communications systems and disrupt service. Disruptions and failures can range from localized and temporary to widespread and long-term.

The types of hazards and impacts to internet and telecommunications infrastructure are very similar to electric power supply. Land line phone lines often utilize the same poles as electric lines. So, when weather events such as windstorm or winter weather cause lines to break, both electricity and telephone services experience outages. With the increasing utilization of cellular phones, hazard events such as tornado that can damage cellular repeaters can cause outages. In addition, during any hazard event, internet and telecommunications systems can become overwhelmed due to the surge in call/usage volume.

Energy Failure

Energy failure includes interruption of service to electric, petroleum, or natural gas. Disruption of electric power supply can be a cascading impact of several other hazards. Electric power is the type of energy failure that is most often a secondary impact of other hazard events. The most common hazards analyzed in this plan that disrupt power supply are: flood, tornado, windstorm, and winter weather as these hazards can cause major damage to power infrastructure. To a lesser extent, extreme temperatures, dam and levee failure, lightning, and terrorism can disrupt power. Extreme heat can disrupt power supply when air conditioning use spikes during heat waves which can cause brownouts. Dam and levee failure, are similar to flood in that infrastructure can be damaged or made inaccessible by water. Lightning strikes can damage substations and transformers, but is usually isolated to small areas of outage. Many forms of terrorism could impact power supply either by direct damage to infrastructure or through cyber-terrorism targeting power supply networks.

Electricity in Polk County is provided by: MidAmerican Energy, Interstate Power and Light Company, Midland Power Rural Electric Cooperative, Consumer's Energy Rural Electric Cooperative, and Carlisle Municipal Energy

Primary hazards that can impact natural gas and oil pipelines are earthquake, expansive soils, land subsidence, landslide, and terrorism.

Natural gas providers in Polk County include MidAmerican Energy, Consumers Energy, Black Hills Energy, and Alliant/Interstate Power and Light.

Interstate pipelines connect the local distribution system to the gas suppliers and to natural gas hubs. Polk County has two pipeline connections to the Northern Natural Gas Company transportation system (now owned by MidAmerican Energy). The primary connection is to the City of Boone, where several pipeline branches converge. MidAmerican recently built a second smaller natural gas pipeline connecting the County to pipeline systems in the southern part of the State.

Other Utility Failure

Interruption of other utilities such as water and sewer systems can be a devastating, costly impact. The primary hazards that can impact water supply systems are: drought, flood, hazardous materials, and terrorism. (Note: Terrorism is not profiled in this plan). Winter storm can also impact water supply if low temperatures cause failure/breakage of water infrastructure. The primary hazard that impacts sewer systems is flood.

<u>Warning Time Score:</u> 4—less than six hours warning time

<u>Duration Score</u>: 4—More than 1 week

Geographic Location/Extent

The entire planning area is at risk to all types of infrastructure failure included in the hazard description section, either from primary failure due to malfunction, degradation, or accidental or intentional damage or as a result of a secondary impact related to another hazard event.

Additional information is provided for specific types of infrastructure based on available data.

Polk County is well served for internet access and broadband services. Des Moines is the center of Iowa's statewide fiber optic network, installed by the state of Iowa in the early 1990s, which is now administered by the Iowa Communications Network.

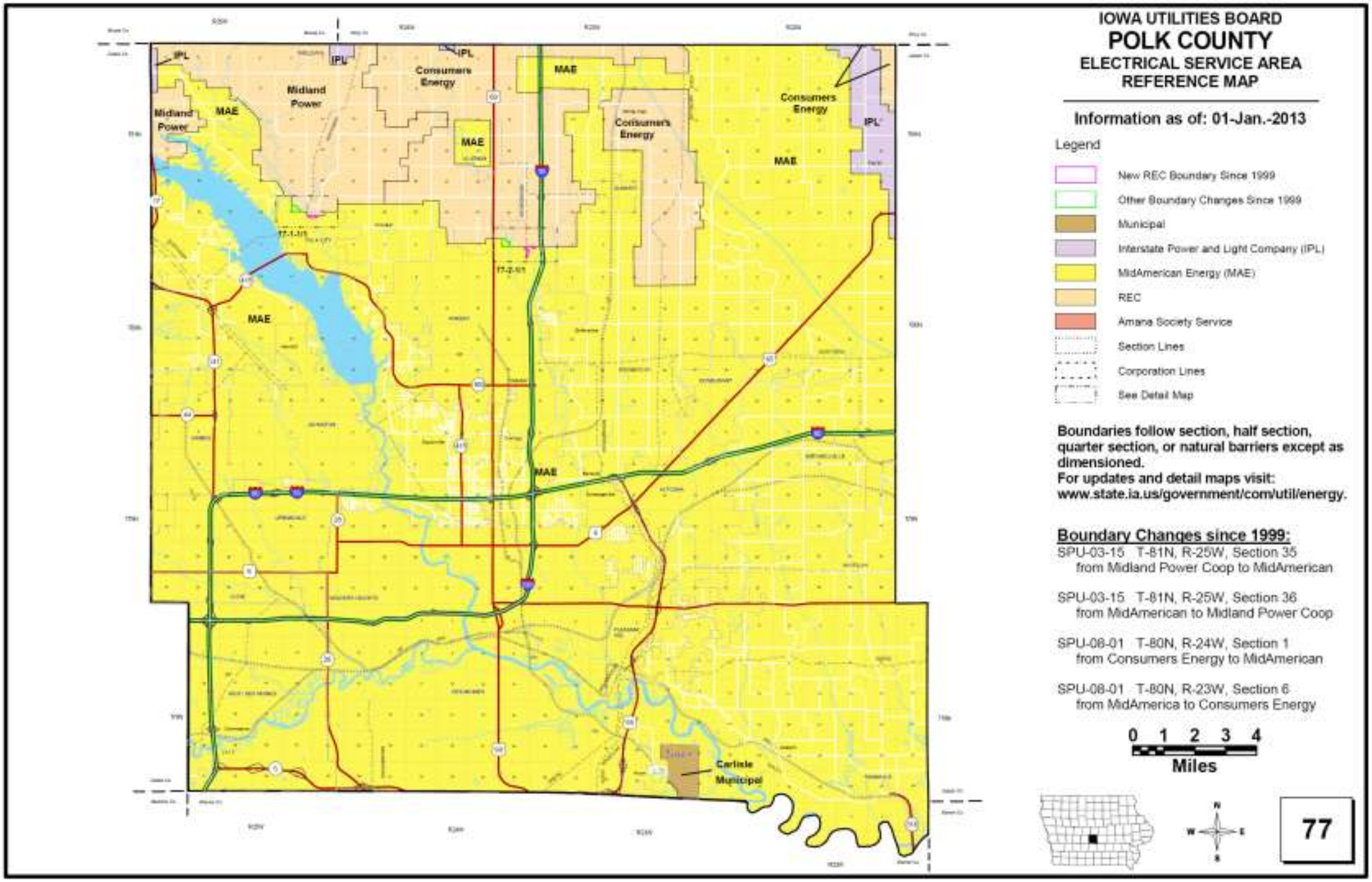
Table 3.59 provides the names of electric, natural gas, and landline telephone service providers for each jurisdiction in Polk County. **Figure 3.62** that follows is the electrical service area map for Polk County.

Table 3.59. Electric, Natural Gas, and Landline Telephone Service Providers

Jurisdiction	Electric Service Providers	Gas Service Providers	Landline Telephone Service Providers
Uninc. County	MidAmerican Energy Midland Power Consumers Energy	MidAmerican Energy	Windstream Communications
City of Alleman	MidAmerican Energy Consumers Energy	MidAmerican Energy	Windstream Communications
City of Altoona	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of Ankeny	MidAmerican Energy Consumers Energy	MidAmerican Energy Consumers Energy	CenturyLink McLeodUSA
City of Bondurant	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of Carlisle	Carlisle Municipal MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of Clive	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of Des Moines	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of Elkhart	MidAmerican Energy	MidAmerican Energy	Windstream Communications
City of Granger	MidAmerican Energy	Black Hills Energy	CenturyLink McLeodUSA
City of Grimes	MidAmerican Energy	Black Hills Energy	CenturyLink McLeodUSA
City of Johnston	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of Mitchellville	MidAmerican Energy	MidAmerican Energy	CenturyLink
City of Norwalk	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of Pleasant Hill	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of Polk City	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of Runnells	MidAmerican Energy	Not Reported	CenturyLink McLeodUSA
City of Sheldahl	Alliant/Interstate Power and Light	Alliant/Interstate Power and Light	Windstream Communications
City of Urbandale	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of West Des Moines	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA
City of Windsor Heights	MidAmerican Energy	MidAmerican Energy	CenturyLink McLeodUSA

Source: Iowa Utilities Board, http://www.state.ia.us/government/com/util/docs/misc/TownProviderList_current.pdf accessed on 9/26/2013

Figure 3.62. Electrical Service Areas in Polk County



http://www.iowadot.gov/maps/msp/electrical/Polk_77.pdf

There are relatively few private wells supplying potable water within Polk County. Instead, most water is provided by public water suppliers, both municipal and private.

The Des Moines Water Works is the largest public water supplier, serving residential and commercial customers within an approximately 50-mile radius around the City of Des Moines. Water comes directly from the Des Moines and Raccoon Rivers and from an infiltration gallery or radial collector wells in the sands and gravels along the Raccoon River. Water is treated prior to distribution at the Fleur Drive treatment plant in the City of Des Moines and a new facility at Maffitt Reservoir southwest of the Des Moines metro area. Des Moines Water Works sells water to many smaller public water suppliers and other entities in Central Iowa. Des Moines Water Works sells water to the cities of Ankeny, Bondurant, Clive, Johnston, Pleasant Hill, Polk City and West Des Moines, to the local water systems in Berwick and Saylorville, and to the Southeast Polk and Xenia Rural Water Districts. These purchasers of water generally maintain their own distribution systems, billing, and other services.

While the water supply comes from Des Moines Water Works, rural water systems located in the unincorporated areas operate the distribution networks. Most of the southeast portion of the county is served the Southeast Polk Rural Water District, the northwestern portion by the Xenia Rural Water District, and the northeastern corner by the Central Iowa Water Association. Most of the north-central portion of the County is expected to connect to the SE Polk Rural Water System as service becomes available. **Figure 3.63** provides the water service areas and improvements from the 2006 Polk County Comprehensive Plan.

Figure 3.63. Water Service Areas and Improvements

Source: Polk County Comprehensive Plan, May 9, 2006, http://www.polkcountyiowa.gov/publicworks/polk-county-comprehensive-plan-2030/

Previous Occurrences
As indicated in the Description Section, Infrastructure Failure often occurs as a secondary impact to other hazard events. For specific descriptions, please see the Previous Occurrences section of the other hazards included in this plan.

Probability of Future Occurrences
Although infrastructure failure does occur on a routine basis, events that are life threatening, damaging, or otherwise adversely impact the economy in the planning area occur only occasionally.

Probability Score: 2—Occasional

Vulnerability

Vulnerability Overview
While every community in the planning area is at risk to some type of utility/infrastructure failure, the vulnerability is somewhat elevated in the more urbanized areas of the county due to the higher population density, development, and economic activities is those areas. Agricultural areas of the planning area are also vulnerable to prolonged outage events as modern agricultural practices are reliant on energy; such as electric milking machines, and irrigation pivots.

In addition, generally the smaller utility suppliers such as small electrical suppliers have limited resources for mitigation. This could mean greater vulnerability in the event of a major, widespread disaster, such as a major flood, severe winter storm or ice storm. The majority of the municipal utilities purchase power on the wholesale market for resale to their customers. This may make them more vulnerable to regional shortages of power as well.

Magnitude Score: 2—Limited

Potential Losses to Existing Development
Since utility/infrastructure failure is generally a secondary or cascading impact of other hazards, it is not possible to quantify estimated potential losses specific to this hazard due to the variables associated with affected population, duration of outages, etc.

Although the variables make it difficult to estimate specific future losses, FEMA has developed standard loss of use estimates in conjunction with their Benefit-Cost Analysis methodologies to estimate the cost of lost utilities on a per-person, per-use basis (See **Table 3.60**).

Table 3.60. FEMA Standard Values for Loss of Service for Utilities and Roads/Bridges

Loss of Electric Power	Cost of Complete Loss of Service
Total Economic Impact	$126 per person per day
Loss of Potable Water Service	Cost of Complete Loss of Service
Total Economic Impact	$93 per person per day
Loss of Wastewater Service	Cost of Complete Loss of Service
Total Economic Impact	$41 per person per day
Loss of Road/Bridge Service	Cost of Complete Loss of Service
Vehicle Delay Detour Time	$38.15 per vehicle per hour
Vehicle Delay Mileage	$0.55 per mile (or current federal mileage rate)

Source: FEMA BCA Reference Guide, June 2009, Appendix C

Future Development

Increases in development and population growth increase the demand for utilities and use of infrastructure as well as the level of impacts when the utilities or infrastructure fail.

Infrastructure Failure Incident Hazard Summary by Jurisdiction

All jurisdictions within the planning area are at risk to infrastructure failure.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	2	2	4	4	2.50	Moderate
Cities						
City of Alleman	2	2	4	4	2.50	Moderate
City of Altoona	2	2	4	4	2.50	Moderate
City of Ankeny	2	2	4	4	2.50	Moderate
City of Bondurant	2	2	4	4	2.50	Moderate
City of Clive	2	2	4	4	2.50	Moderate
City of Des Moines	2	2	4	4	2.50	Moderate
City of Elkhart	2	2	4	4	2.50	Moderate
City of Grimes	2	2	4	4	2.50	Moderate
City of Johnston	2	2	4	4	2.50	Moderate
City of Mitchellville	2	2	4	4	2.50	Moderate
City of Pleasant Hill	2	2	4	4	2.50	Moderate
City of Polk City	2	2	4	4	2.50	Moderate
City of Runnells	2	2	4	4	2.50	Moderate
City of Urbandale	2	2	4	4	2.50	Moderate
City of West Des Moines	2	2	4	4	2.50	Moderate
City of Windsor Heights	2	2	4	4	2.50	Moderate
Des Moines Water Works	2	2	4	4	2.50	Moderate
School Districts						
Ankeny, 261	2	2	4	4	2.50	Moderate
Bondurant-Farrar, 720	2	2	4	4	2.50	Moderate
Dallas Center-Grimes, 1576	2	2	4	4	2.50	Moderate
Des Moines Independent, 1737	2	2	4	4	2.50	Moderate
Johnston, 3231	2	2	4	4	2.50	Moderate
North Polk, 4779	2	2	4	4	2.50	Moderate
Saydel, 5805	2	2	4	4	2.50	Moderate
Southeast Polk, 6101	2	2	4	4	2.50	Moderate
Urbandale, 6579	2	2	4	4	2.50	Moderate
West Des Moines	2	2	4	4	2.50	Moderate

3.4.12 Levee Failure

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
2	3	4	4	2.80	Moderate

Profile

Hazard Description

Levees are earth embankments constructed along rivers and coastlines to protect adjacent lands from flooding. Floodwalls are concrete structures, often components of levee systems, designed for urban areas where there is insufficient room for earthen levees. When levees and floodwalls and their appurtenant structures are stressed beyond their capabilities to withstand floods, levee failure can result in loss of life and injuries as well as damages to property, the environment, and the economy.

Levees range from small agricultural levees that protect farmland from high-frequency flooding to large urban areas that protect people and property from larger-less frequent flooding events such as the 100-year and 500-year flood levels. For purposes of this discussion, levee failure will refer to both overtopping and breach of a levee as defined in FEMA's Publication "So You Live Behind a Levee" (http://content.asce.org/ASCELeveeGuide.html).

Overtopping: When a Flood Is Too Big

Overtopping occurs when floodwaters exceed the height of a levee and flow over its crown. As the water passes over the top, it may erode the levee, worsening the flooding and potentially causing an opening, or breach, in the levee.

Breaching: When a Levee Gives Way

A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. The resulting torrent can quickly swamp a large area behind the failed levee with little or no warning.

Earthen levees can be damaged in several ways. For instance, strong river currents and waves can erode the surface. Debris and ice carried by floodwaters—and even large objects such as boats or barges—can collide with and gouge the levee. Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be. Burrowing animals can create holes that enable water to pass through a levee. If severe enough, any of these situations can lead to a zone of weakness that could cause a levee breach. In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity can also cause levees to slide or slump, both of which can lead to failure.

Warning Time Score: 4—Minimal or no warning

Duration Score: 4—More than 1 week

Geographic Location/Extent
There are likely agricultural levees and other non-regulated levees within the planning area that are not inventoried or inspected. These levees that are not designed to provide protection from the 1-percent annual chance flood would overtop or fail in the 1-percent annual chance flood scenario. Therefore, any associated losses would be taken into account in the loss estimates provided n the Riverine Flood Hazard Section.

For purposes of the levee failure profile and risk assessment, those levees indicated on the Preliminary DFIRM as providing protection from at least the 1-percent annual chance flood will be discussed and further analyzed. It is noted that with the increased discharges that are being taken into account in revision of the flood maps as part of the RiskMap efforts that are underway may result in changes to the flood protection level that existing levees are certified as providing. Levee owners in the planning area have already initiated discussion/plans for modifications that may be necessary for these levees to be accredited as providing protection from the 1-percent annual chance flood. There are two jurisdictions within the planning area that have levees providing protection from the 1-percent annual chance flood.

City of Des Moines

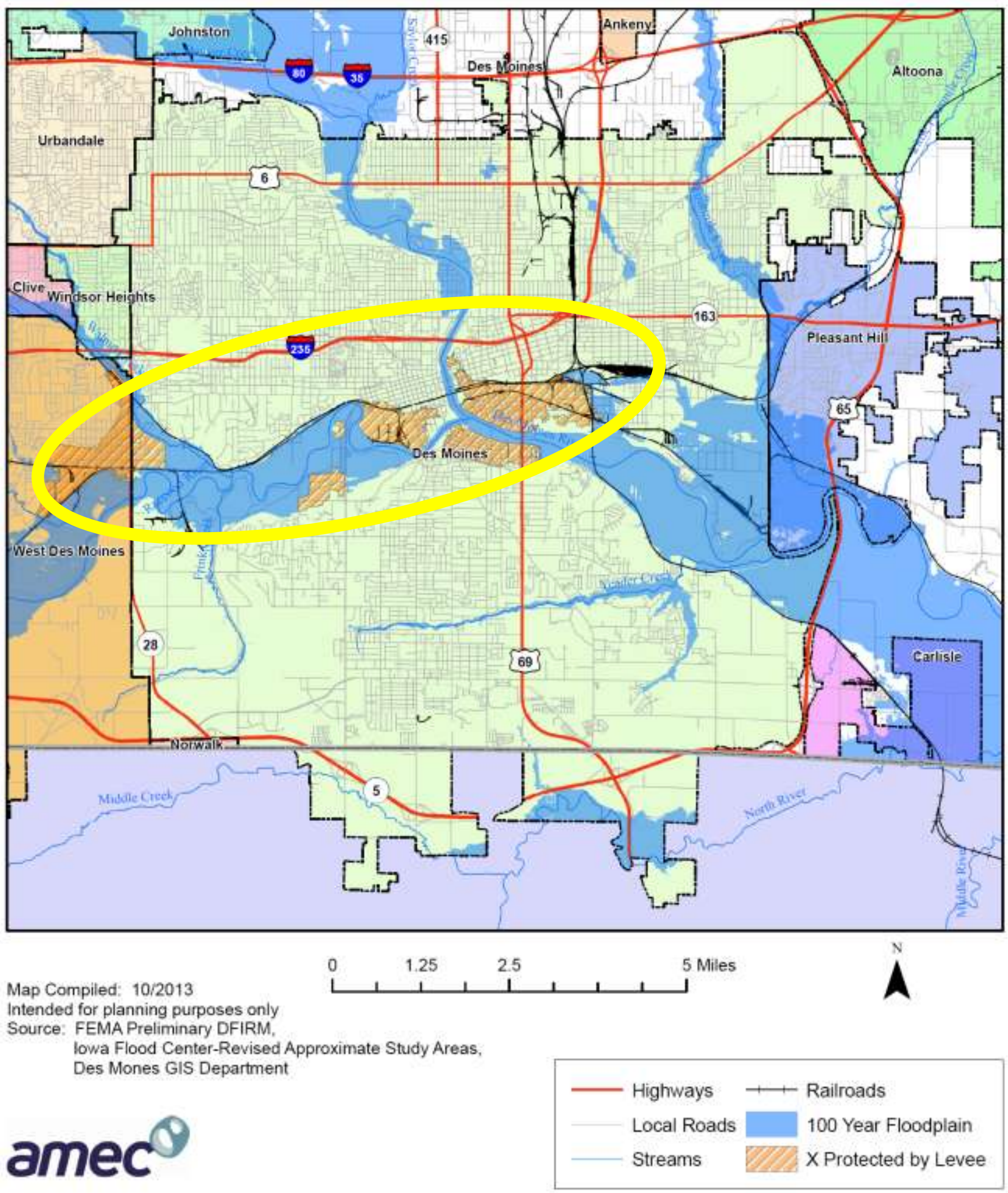
The City of Des Moines is protected by a series of levees in and around the City. There are six different levee systems that have been shown on the Preliminary DFIRM issued by FEMA as providing flood protection against the 1-percent annual chance flood event. It is noted however, that a 2011 study by the U.S. Army Corps of Engineers (USACE) shows increases in discharge amounts on the Des Moines River. As a result of these findings, the protection levels provided by the levee systems are being re-evaluated.

Five of the levee systems protecting the City of Des Moines are in the U.S. Army Corps of Engineers (USACE) Levee Safety Program (LSP) and one, the Des Moines Water Works Levee is not in the USACE LSP. The levee systems and locations are listed below:

- Downtown East Levee (USACE LSP) – Located on the eastern bank of the Des Moines River, upstream and downstream of the confluence with Raccoon River;
- Downtown West Levee (USACE LSP) – Located on the western bank of the Des Moines River and the northern bank of the Raccoon River, at their confluence;
- Downtown South Levee (USACE LSP) – Located on the south bank of the Des Moines River and the Raccoon River;
- Raccoon River Section 205 Levee (USACE LSP) – Located along the south bank of the Raccoon River, upstream of Fleur Drive;
- Des Moines Water Works Levee (nonfederal) – A ring levee located surrounding the Des Moines Water Works; and
- West Des Moines Levee (USACE LSP) – Located along the northern bank of Raccoon River and the western bank of Walnut Creek.

Figure 3.64 shows the leveed areas shown as protected from the 1-percent annual chance flood on the Preliminary DFIRM. The leveed areas are within the yellow oval on the map.

Figure 3.64. City of Des Moines Levees Shown on Preliminary DFIRM as Providing Protection from the 1-Percent Annual Chance Flood



In addition to the levees mentioned above that are shown on the Preliminary DFIRM, the Birdland (a.k.a. Central Place) levees have

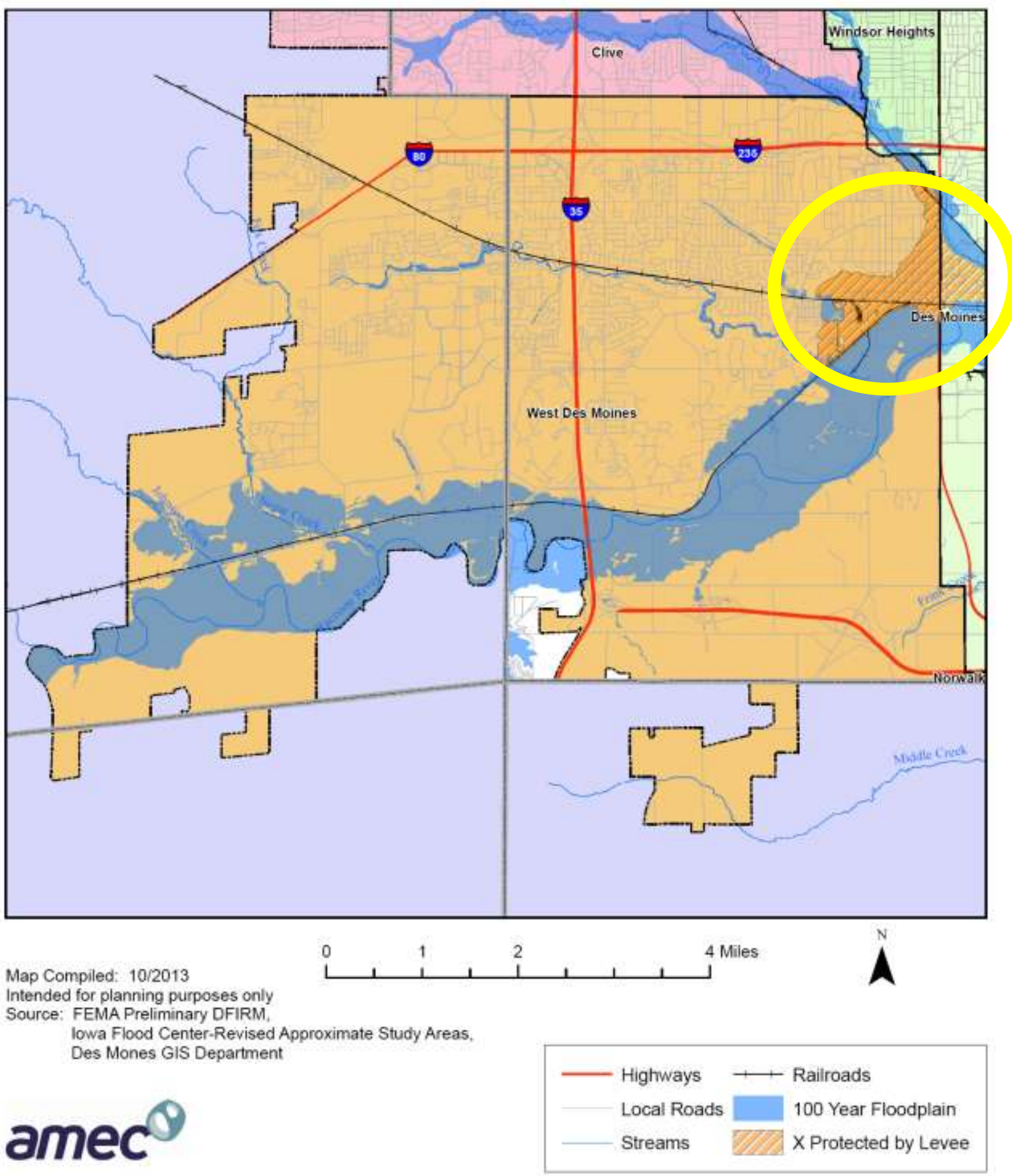
In addition to the levees mentioned above that are shown on the Preliminary DFIRM, the Birdland (a.k.a. Central Place) levees have been improved by the U.S. Army Corps of Engineers to provide protection to the 1 percent annual chance flood level and have been submitted to FEMA for certification/accreditation. As of the finalization of this plan update, the certification was still pending. Since the protected areas behind this levee system have not been published on a preliminary of effective regulatory product, data was not available to analyze the protected assets that are then vulnerable in the event of failure of the levees.

City of West Des Moines

The City of West Des Moines has a local flood protection levee that was designed and built by the USACE, Rick Island District that protects the City from the 1-percent annual chance flood from Raccoon River and Walnut Creek.

Figure 3.65 shows the leveed areas shown as protected from the 1-percent annual chance flood on the Preliminary DFIRM. The leveed areas are within the yellow oval on the map.

Figure 3.65. City of West Des Moines Levees Shown on Preliminary DFIRM as Providing Protection from the 1-Percent Annual Chance Flood



Previous Occurrences

- **2010 Birdland Park Levee "Leak"**—during this event, the Birdland Park Levee was closely monitored and a small "leak" or seepage was discovered. However, the levee did not fail or overtop during this event.
- **2008 Birdland Park Levee Breach**—very high water along the Des Moines River put stress on the levee system in Des Moines. The crest had passed. However, water levels were still within about one foot of the record crest. A weak spot in the levee in the Birdland park area gave way in spite of efforts by citizens and the National Guard to reinforce the levee. A breach of about 100 feet in width occurred causing very rapid water rises of about four feet in the flooded area within an hour and about 6 feet within several hours. A mandatory evacuation order was given by the Des Moines Police. About 271 homes were affected by the flooding as well as several businesses and a high school. One fertilizer and chemical business sustained an estimated $3 million in damages and the damage to North High School was estimated at $1.1 million
- **1993 Birdland Park Levee Failure**

Probability of Future Occurrence

Based on previous occurrences in the planning area, the Hazard Mitigation Planning Committee determined that the probability of future occurrence of failure of the known levees in the planning area is occasional.

Probability Score: —Occasional

Vulnerability

Vulnerability Overview

Levee failure is typically an additional or secondary impact of another disaster such as flooding or earthquake. The main difference between levee failure and the types of losses associated with riverine flood is that failure of any size levee in the midst of a flood event has the potential to result in more destruction to property and infrastructure as well as an increased potential for loss of life due to the speed of onset and greater depth, extent, and velocity of flooding.

As previously mentioned, agricultural levees and levees that are not designed to provide flood protection from at least the 1-percent annual chance flood likely do exist in the planning area. However, none of these levees are indicated on the Preliminary DFIRM or enrolled in the USACE Levee Safety Program. As a result, an inventory of these types of levees is not available to conduct analysis. Additionally, since these types of levees do not provide protection from the 1-percent annual chance flood, losses associated with overtopping or failure are captured in the Riverine Flood Section.

Based on the scope of the Levee Failure Risk Assessment being defined as failure of levees indicated as providing protection from the 1-percent annual chance flood, there are two jurisdictions within the planning area that are vulnerable to this type of levee failure:

- City of Des Moines, portions in Polk County
- City of West Des Moines, portions in Polk County

To determine the numbers and values of buildings as well as estimated population at risk to levee failure, GIS-based analysis was performed utilizing the areas shown as "X-protected by levee" on the Revised Preliminary DFIRM overlaid with the parcel and building data supplied by the Des Moines Area Regional GIS Partnership.

Table 3.61 and **Table 3.62** provide the results of this analysis.

Table 3.61. Building Count and Estimated Population Vulnerable to Failure of Levees Providing Protection from 1-Percent Annual Chance Flood Event

Jurisdiction	Residential	Commercial	Government	School	Industrial	Agricultural	Total Test	Average Household Size	Est. Population at Risk
Des Moines (Polk)	1,872	457	155	5	157	1	2,647	2.43	4,549
West Des Moines (Polk)	1,302	321	132	2	37		1,794	2.32	3,021
Total	**3,174**	**778**	**287**	**7**	**194**	**1**	**4,441**	**N/A**	**7,570**

Source: FEMA Preliminary DFIRM, Revised Approximate Study Areas from the Iowa Flood Center, Des Moines Area Regional GIS Partnership, 2013; * Data is for the portion of these cities that is in Polk County only

Table 3.62. Building Values Vulnerable to Levees Providing Protection from 1-Percent Annual Chance Flood Event

Jurisdiction	Residential	Commercial	Government	School	Industrial	Agricultural	Total
Des Moines (Polk)	$85,867,900	$147,089,390	$2,553,540	$1,615,000	$31,005,600	$0	$268,131,430
West Des Moines (Polk)	$60,079,200	$37,525,600	$638,300	$0	$13,264,300	$0	$111,507,400
Total	**$145,947,100**	**$184,614,990**	**$3,191,840**	**$1,615,000**	**$44,269,900**	**$0**	**$379,638,830**

Source: FEMA Preliminary DFIRM, Revised Approximate Study Areas from the Iowa Flood Center, Des Moines Area Regional GIS Partnership, 2013; * Data is for the portion of these cities that is in Polk County only

Potential Losses to Existing Development

It is difficult to determine specific economic losses to existing development as a result of levee failure. As stated previously, losses as a result of levee failure would be expected to be greater than that of riverine flood due to the speed of onset and the velocity and wave action that would occur. For riverine flood losses, 20-percent loss to existing development is an acceptable range based on the Flood Insurance Administration depth-damage curves utilized in both HAZUS and FEMA's Benefit Cost Analysis software for flooding at a level of 2 feet in a one-story residential structure. Based on this assumption, levee failure damages could be expected to approach 50-percent losses. This would result in $134,065,715 in damages in the City of Des Moines and $55,753,700 in damages in the City of West Des Moines.

An analysis has been performed of identified critical and essential facilities within each jurisdiction that fall within the areas protected by levees. The results of this analysis are included in a secure appendix, Appendix E. For additional details, please contact the Polk County Emergency Management Coordinator.

<u>Magnitude Score</u>: 2—Limited

Future Development

Additional development in the areas protected by the levees in the City of Des Moines and the City of West Des Moines would increase the vulnerability to this hazard. From 2000 to 2010 both jurisdictions experienced growth. The City of Des Moines had a 2.8 percent increase in population and a 4.7 percent increase in housing units. Development in the City of West Des Moines was even higher with an increase of 22 percent in population and an increase in 26 percent in housing units.

Levee Failure Hazard Summary by Jurisdiction

This summary reflects those jurisdictions that have assets in X-protected by levee areas.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	N/A	N/A	N/A	N/A	N/A	N/A
Cities						
City of Alleman	N/A	N/A	N/A	N/A	N/A	N/A
City of Altoona	N/A	N/A	N/A	N/A	N/A	N/A
City of Ankeny	N/A	N/A	N/A	N/A	N/A	N/A
City of Bondurant	N/A	N/A	N/A	N/A	N/A	N/A
City of Clive	N/A	N/A	N/A	N/A	N/A	N/A
City of Des Moines	2	3	4	4	2.80	Moderate
City of Elkhart	N/A	N/A	N/A	N/A	N/A	N/A
City of Grimes	N/A	N/A	N/A	N/A	N/A	N/A
City of Johnston	N/A	N/A	N/A	N/A	N/A	N/A
City of Mitchellville	N/A	N/A	N/A	N/A	N/A	N/A
City of Pleasant Hill	N/A	N/A	N/A	N/A	N/A	N/A
City of Polk City	N/A	N/A	N/A	N/A	N/A	N/A
City of Runnells	N/A	N/A	N/A	N/A	N/A	N/A
City of Urbandale	N/A	N/A	N/A	N/A	N/A	N/A
City of West Des Moines	2	3	4	4	2.80	Moderate
City of Windsor Heights	N/A	N/A	N/A	N/A	N/A	N/A
Des Moines Water Works	2	3	4	4	2.80	Moderate
School Districts						
Ankeny, 261	N/A	N/A	N/A	N/A	N/A	N/A
Bondurant-Farrar, 720	N/A	N/A	N/A	N/A	N/A	N/A
Dallas Center-Grimes, 1576	N/A	N/A	N/A	N/A	N/A	N/A
Des Moines Independent, 1737	2	3	4	4	2.80	Moderate
Johnston, 3231	N/A	N/A	N/A	N/A	N/A	N/A
North Polk, 4779	N/A	N/A	N/A	N/A	N/A	N/A
Saydel, 5805	N/A	N/A	N/A	N/A	N/A	N/A
Southeast Polk, 6101	N/A	N/A	N/A	N/A	N/A	N/A
Urbandale, 6579	N/A	N/A	N/A	N/A	N/A	N/A
West Des Moines	2	3	4	4	2.80	Moderate

3.4.13 River Flooding

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	3	1	4	3.25	High

Profile

Hazard Description

Flooding has been a major problem for many of the communities in Polk County. Many of the communities were settled and developed largely because of their proximity to water resources. A flood is partial or complete inundation of normally dry land areas. Heavy precipitation can cause flooding either in the region of precipitation or in areas downstream. Heavy accumulations of ice or snow can also cause flooding during the melting stage. These events are complicated by the freeze/thaw cycles characterized by moisture thawing during the day and freezing at night. There are two main types of flooding in the planning area: riverine flooding and flash flooding which includes ice jam flooding. Flash flooding is discussed separately in **Section 3.4.7.**

Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt or ice melt. The areas adjacent to rivers and stream banks that carry excess floodwater during rapid runoff are called floodplains. A floodplain is defined as the lowland and relatively flat area adjoining a river or stream. The terms “base flood” and “100-year flood” refer to the area in the floodplain that is subject to a one percent or greater chance of flooding in any given year. Floodplains are part of a larger entity called a basin, which is defined as all the land drained by a river and its branches.

Flooding caused by dam and levee failure is discussed in **Section 3.4.1** and Section **3.4.12** respectively.

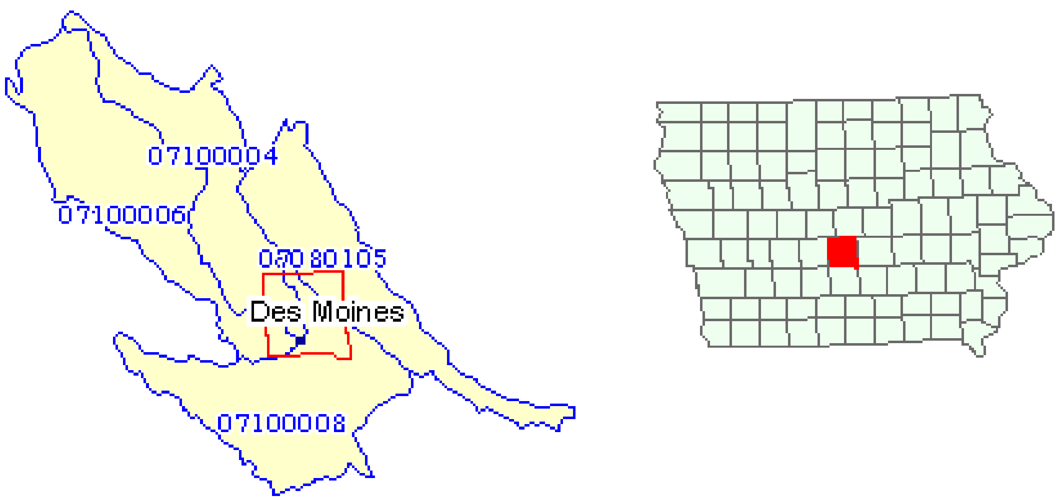
Warning Time Score: 1—More than 24 hours warning time

Duration Score: 4—More than 1 week

Geographic Location/Extent
Polk County crosses four watersheds as seen in **Table 3.63**:

1. 07080105 South Skunk
2. 07100004 Middle Des Moines
3. 07100006 North Raccoon
4. 07100008 Lake Red Rock

Table 3.63. Polk County, Iowa Watersheds (Polk County is red square)



Source: Environmental Protection Agency, http://cfpub.epa.gov/surf/county.cfm?fips_code=19153

For purposes of this hazard profile and vulnerability analysis, the geographic location/extent for river flooding will be considered as those areas at risk to the 100-year flood (also known as the 1-percent annual chance flood). The 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes.

Determining "Best Available Data" To Depict the 1-Percent Annual Chance Flood

As this plan update was under development, the effective Flood Insurance Rate Maps for Polk County consisted of the paper maps dating from 1979 to 1990, depending on the community. In 2009, as part of FEMA's Map Modernization Initiative, the process was begun to revise Polk County's Flood Insurance Rate Maps into a single county-level Digital Flood Insurance Rate Map (DFIRM). The Preliminary DFIRM was released. However, the process to make the revised map effective was put on hold due to a 2011 study undertaken by the U.S. Army Corps of Engineers (USACE).

In 2011, after publication of the Preliminary DFIRM, USACE released the results of a nine-month study undertaken to enhance understanding of flooding on the Des Moines River. This study included a scientific assessment to estimate the frequency and magnitude of future reservoir outflows and downstream river flows by updating and analyzing the period of record to account for an additional 14 years of data (1995-2008), including the Midwest Flood of 2008.

Consistent with the large flood events the basin has experienced over the past several decades, the study results showed that flood flow frequencies have increased over previous USACE estimates and that floods events in 1993 and 2008 are more likely than previously estimated. Thus, the floodplains adjacent to the Des Moines River and some areas once thought to be outside of the floodplain or that are protected by a flood-risk management project were determined to be at a greater risk of flooding than previously estimated.

Since the 2011 USACE study revealed increases in frequency and outflows, and therefore changes to the areas designated as at-risk, it was necessary to make substantial revisions to the preliminary DFIRM. As this plan update was under development, Polk County was involved in FEMA's RiskMap (Risk Mapping, Assessment, and Planning) program. One product from the RiskMap program will be revisions to the mapping data and reissue of the DFIRM with the updated frequency and outflow data from the USACE study.

At the time of the flood risk assessment update, revisions to the detailed study areas in Polk County were not yet complete. However, revised data was provided by the Iowa Flood Center (IFC) for the revised approximate study areas in Polk County. Since all revisions were not available, it was decided to use the "best available data" at the time of the plan update. Through coordination with FEMA, Polk County, AMEC and RiskMap mapping consultants, it was determined that the Preliminary DFIRM with integration of the available revised approximate study areas from the IFC would serve as the best available data for the flood risk analysis portion of this plan update (hereafter referred to as the "Revised Preliminary DFIRM". When this plan is updated according to the 5-year update cycle, the fully revised DFIRM should be effective and should be utilized for updated analysis.

Jurisdictional Flood Hazard Maps

The boundary of the 1-percent annual chance flood (100-year floodplain) was generated as described above, by integrating revised data from the IFC for the approximated study areas into the Revised Preliminary DFIRM. This flood boundary was overlaid with the corporate boundary data provided by the Des Moines Area Regional GIS Partnership to produce maps depicting the 1-percent annual chance floodplain areas for each jurisdiction. **Figure 3.66** to **Figure 3.86** provide the Revised Preliminary DFIRM 1-percent annual chance floodplain for all jurisdictions in the planning area. The county-level map is provided first and the remaining maps are provided in alphabetical order by city. Appendix E provides locations of available critical facilities in relation to the 1-percent annual chance floodplain. This will be discussed in greater detail in the vulnerability section.

Figure 3.66. Polk County 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

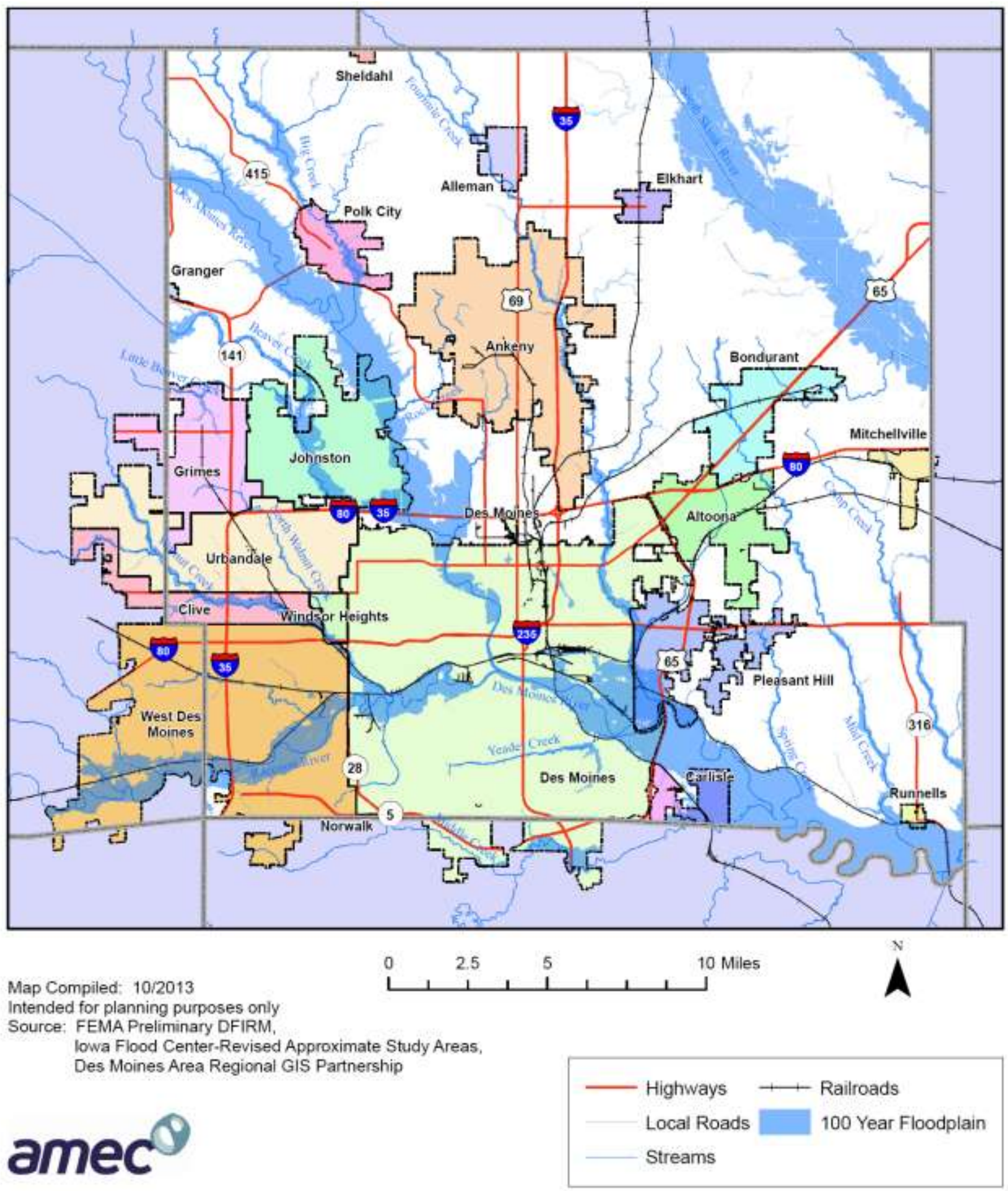


Figure 3.67. City of Alleman 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

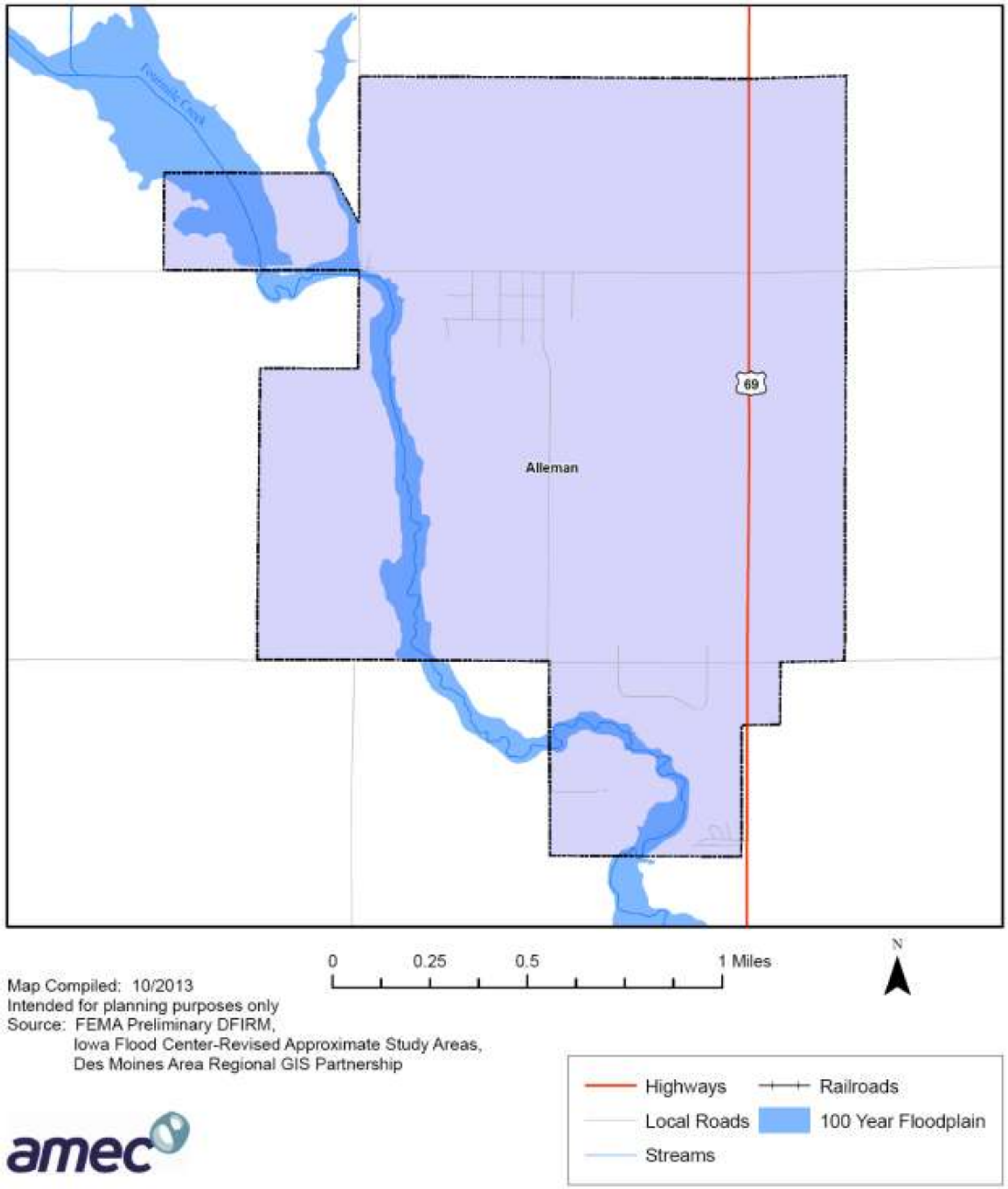


Figure 3.68. City of Altoona 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

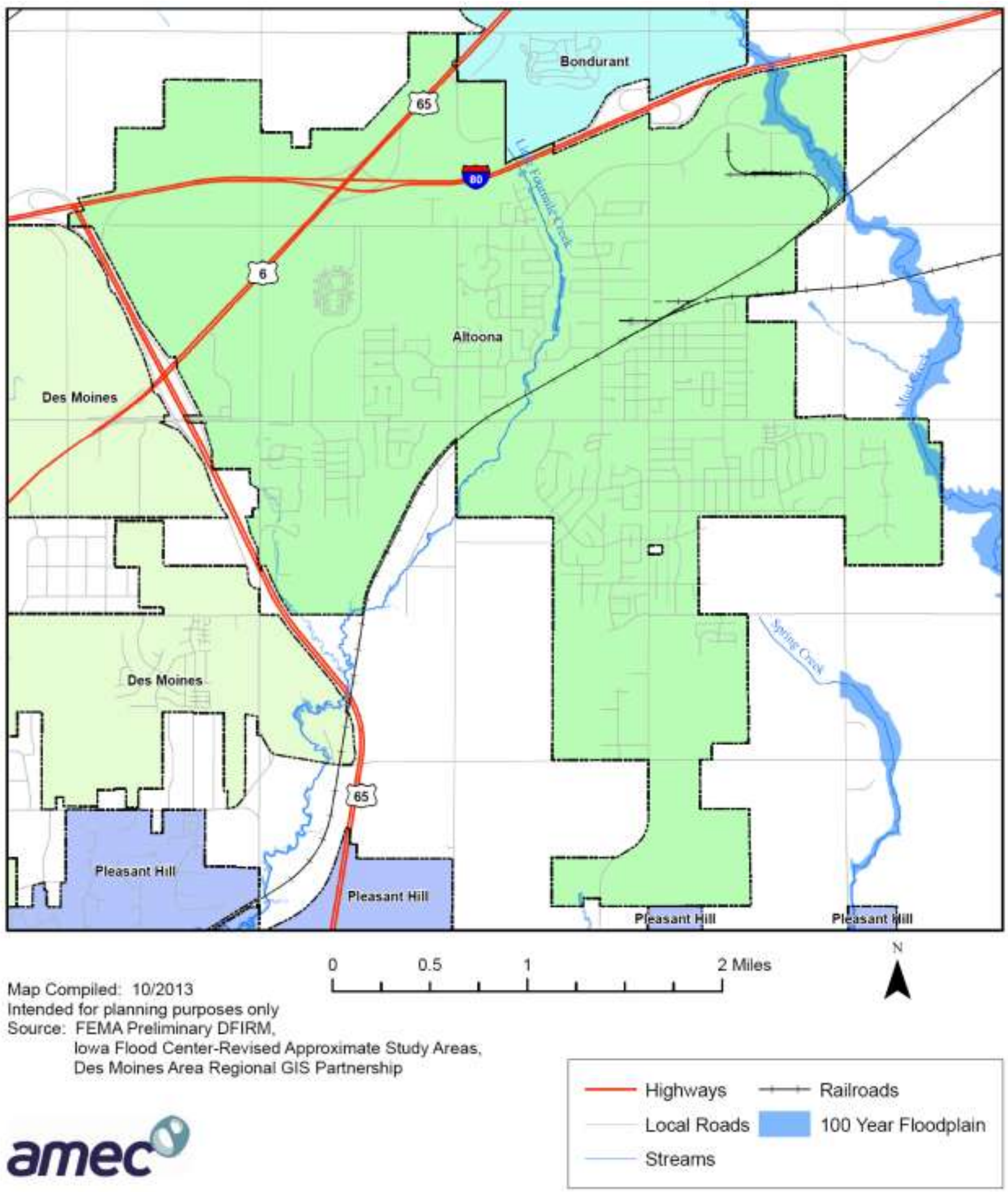
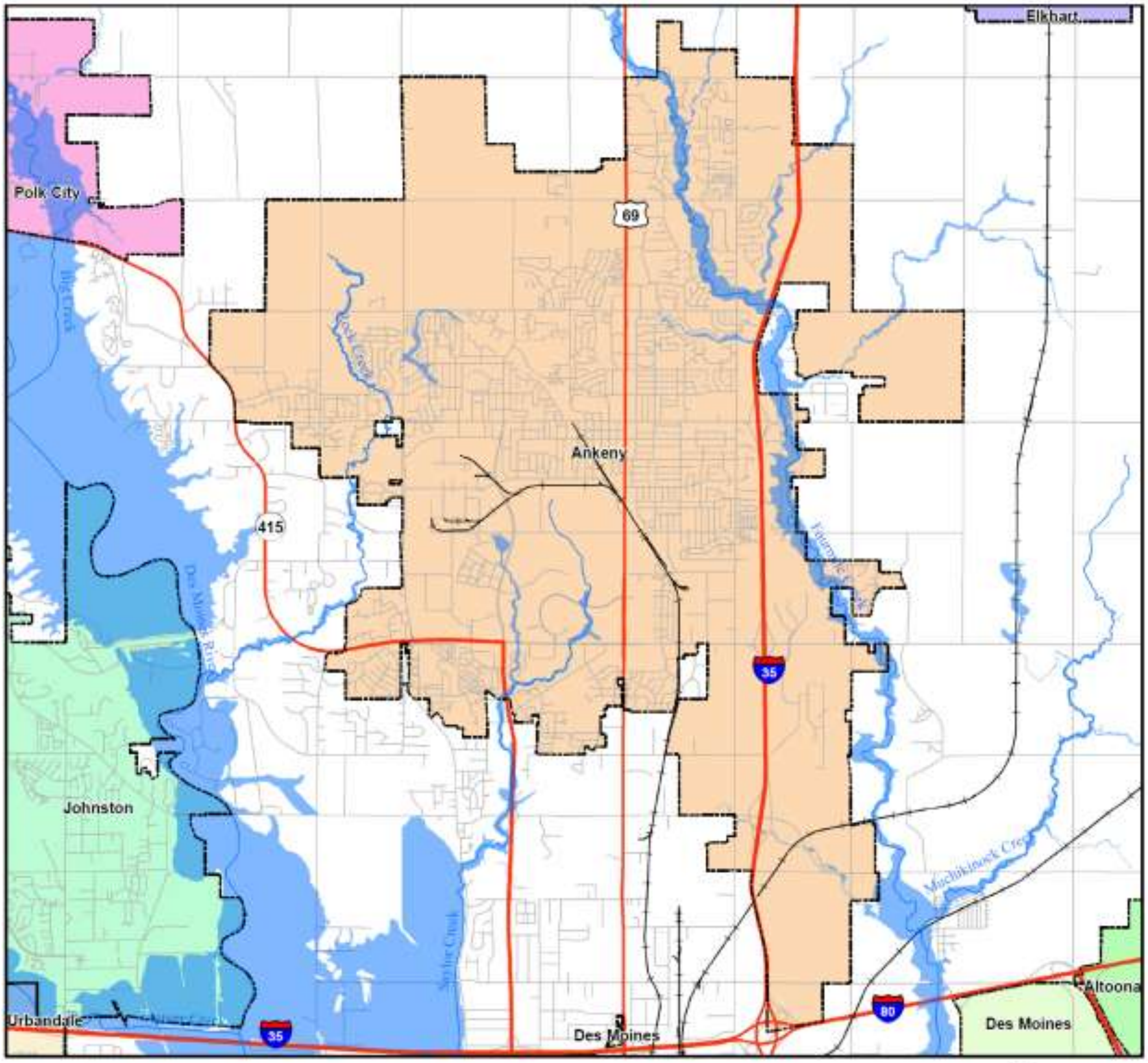


Figure 3.69. City of Ankeny 1-Percent Annual Chance Floodplain(100-Year Floodplain) Revised Preliminary DFIRM



0 1 2 4 Miles

N

Map Compiled: 10/2013
Intended for planning purposes only
Source: FEMA Preliminary DFIRM,
Iowa Flood Center-Revised Approximate Study Areas,
Des Moines Area Regional GIS Partnership

Highways
Railroads
Local Roads
100 Year Floodplain
Streams

Figure 3.70. City of Bondurant 1-Percent Annual Chance Floodplain(100-Year Floodplain) Revised Preliminary DFIRM

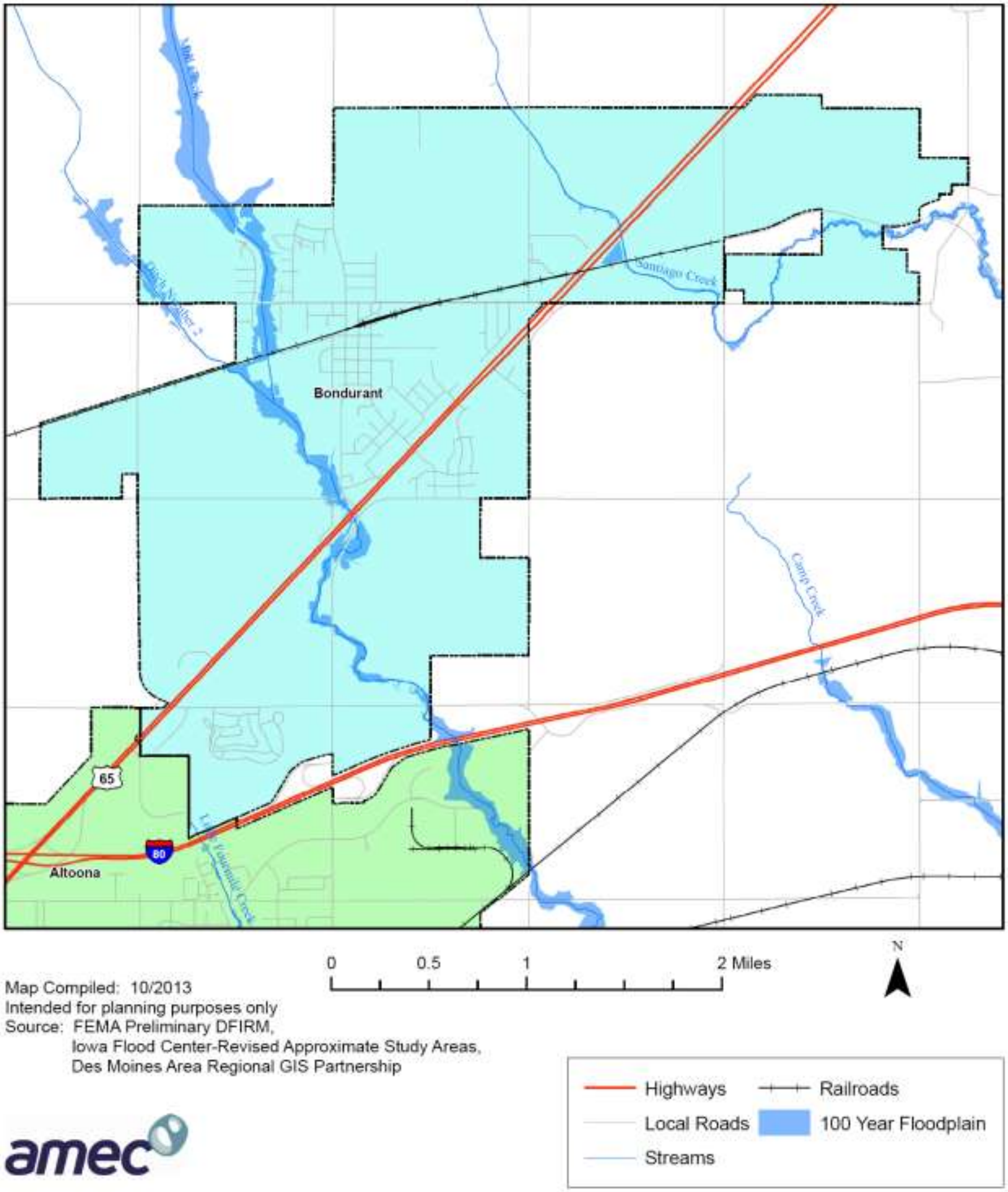


Figure 3.71. City of Carlisle1-Percent Annual Chance Floodplain(100-Year Floodplain) Revised Preliminary DFIRM-Polk County Portion Only

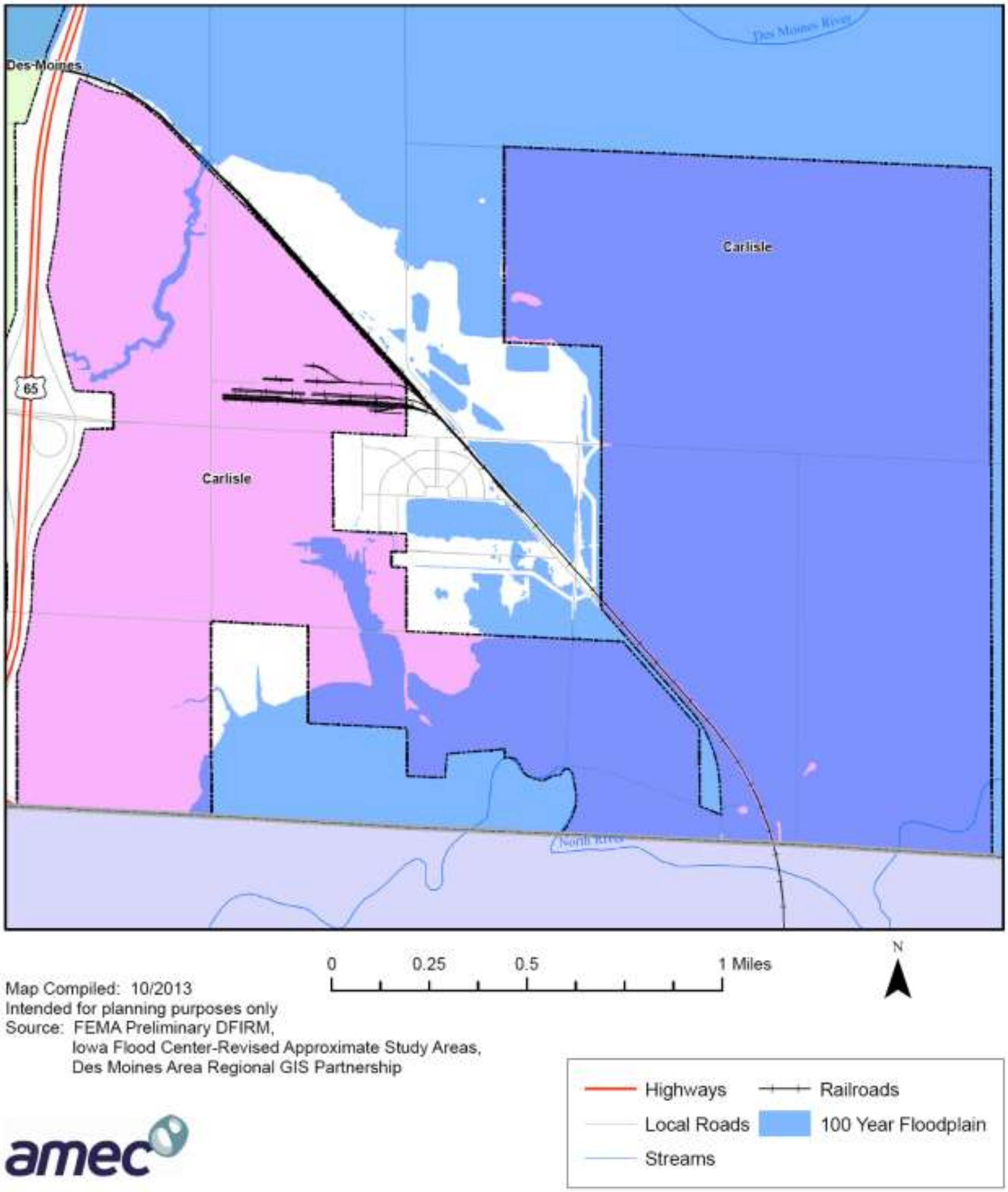


Figure 3.72. City of Clive 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

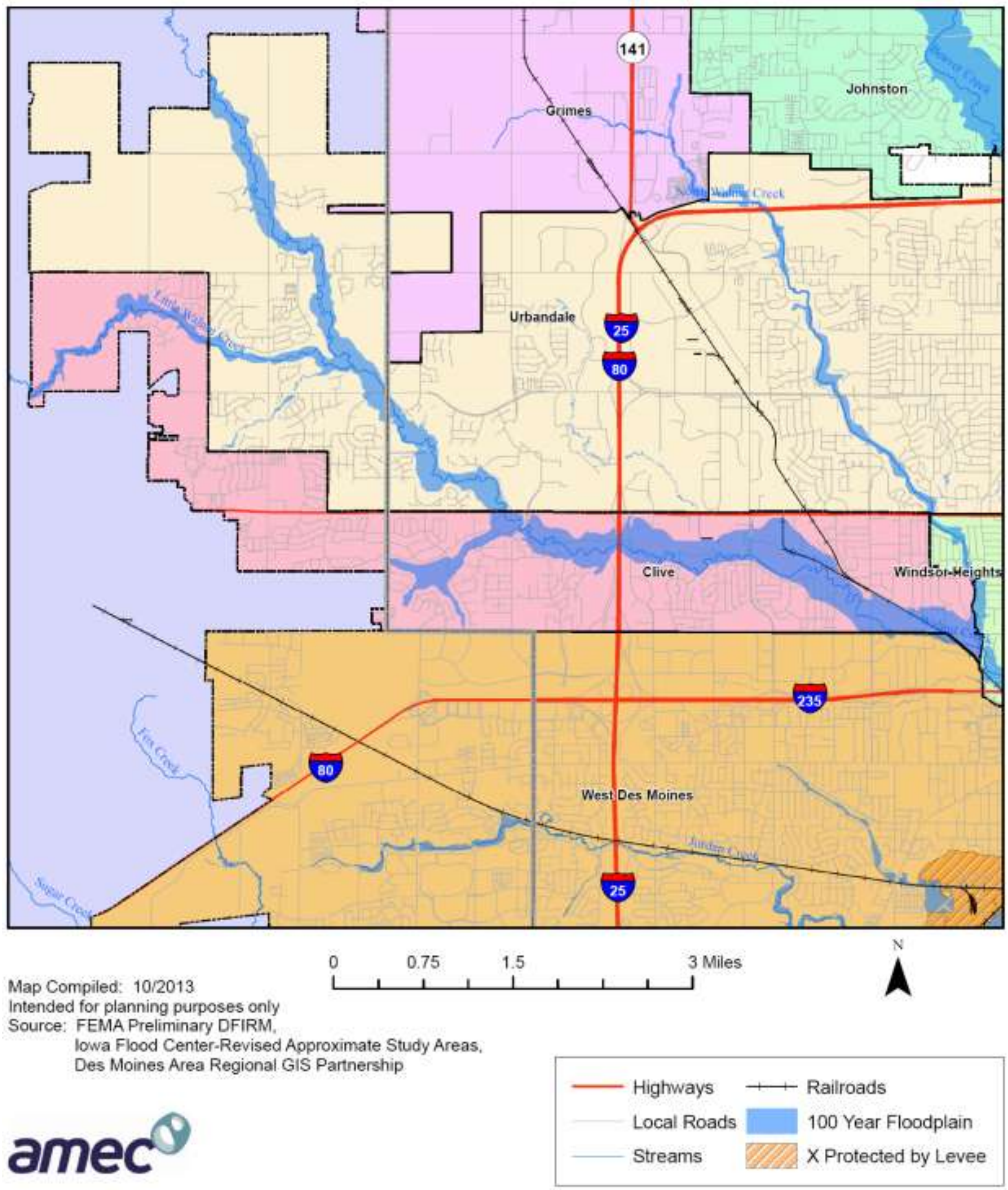


Figure 3.73. City of Des Moines 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

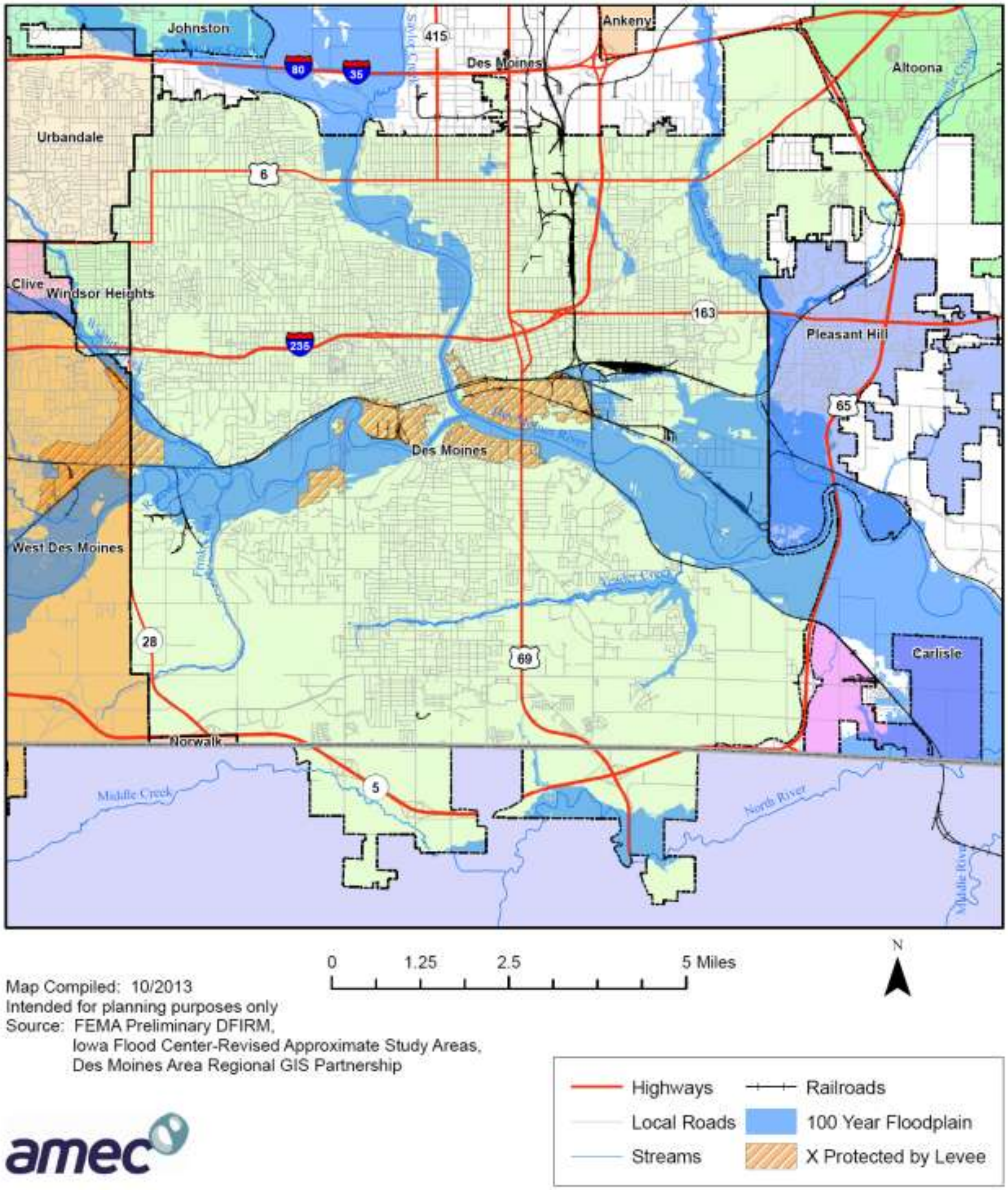


Figure 3.74. City of Elkhart 1-Percent Annual Chance Floodplain(100-Year Floodplain) Revised Preliminary DFIRM

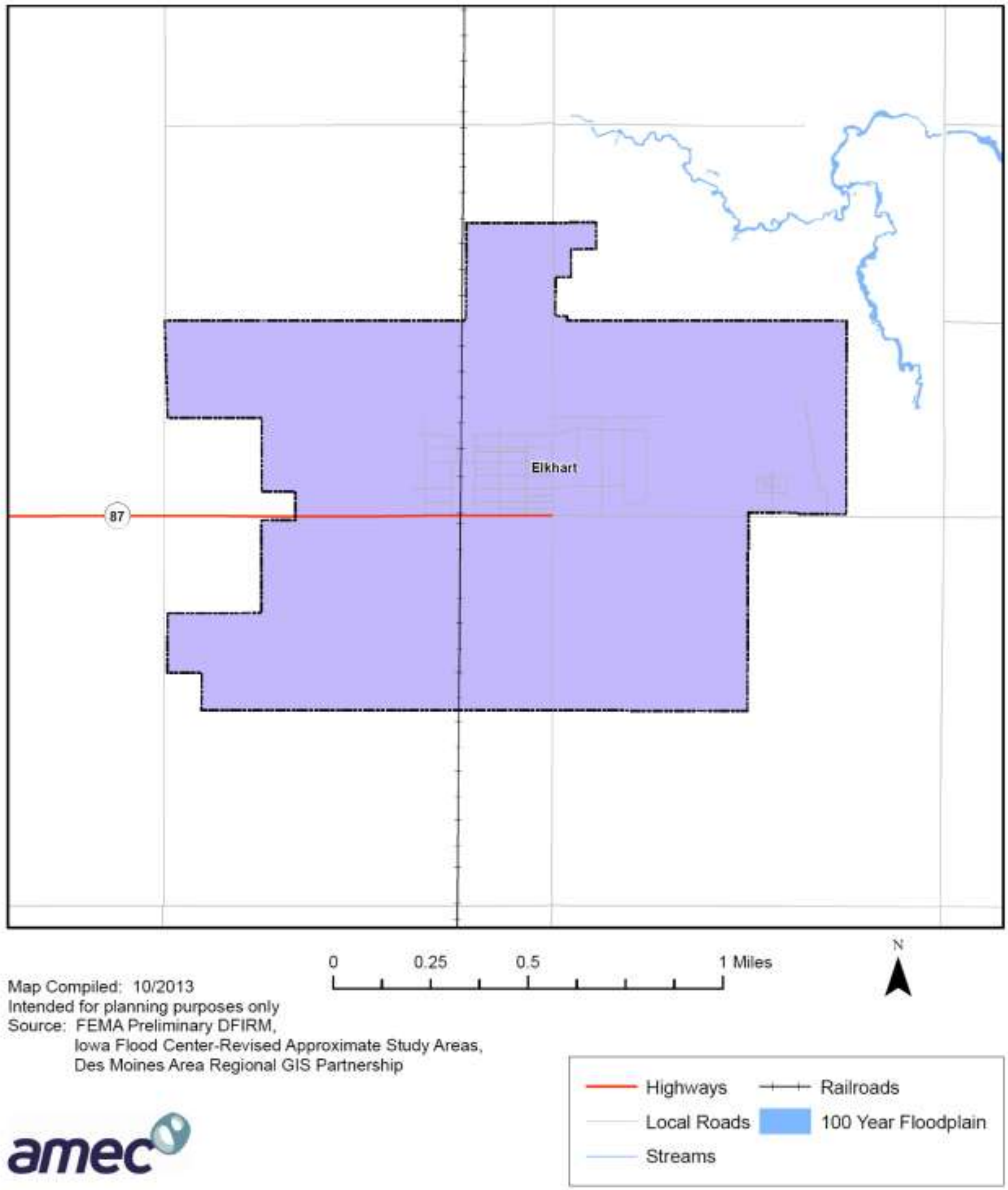


Figure 3.75. City of Granger 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM-Polk County Portion Only

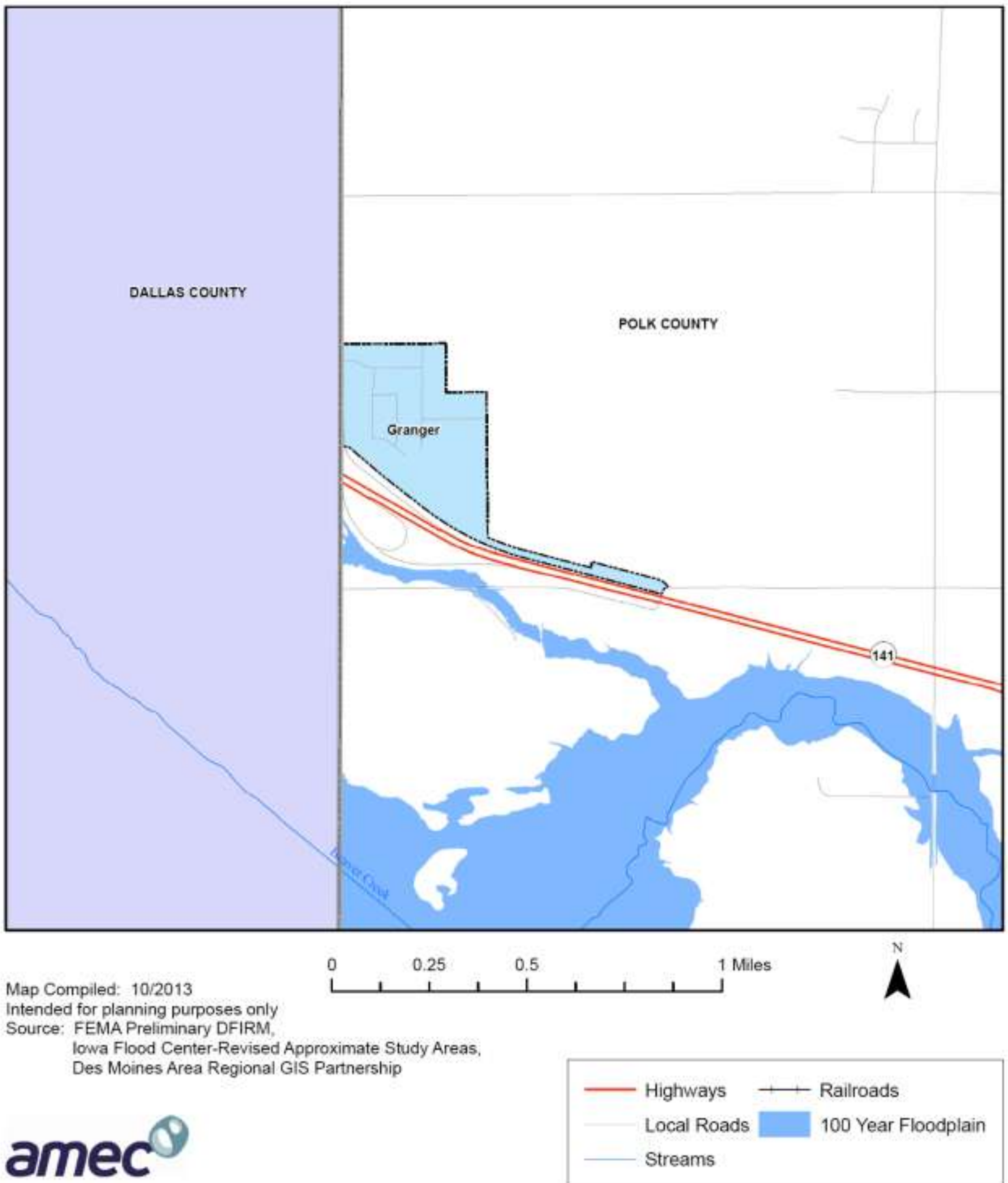


Figure 3.76. City of Grimes 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

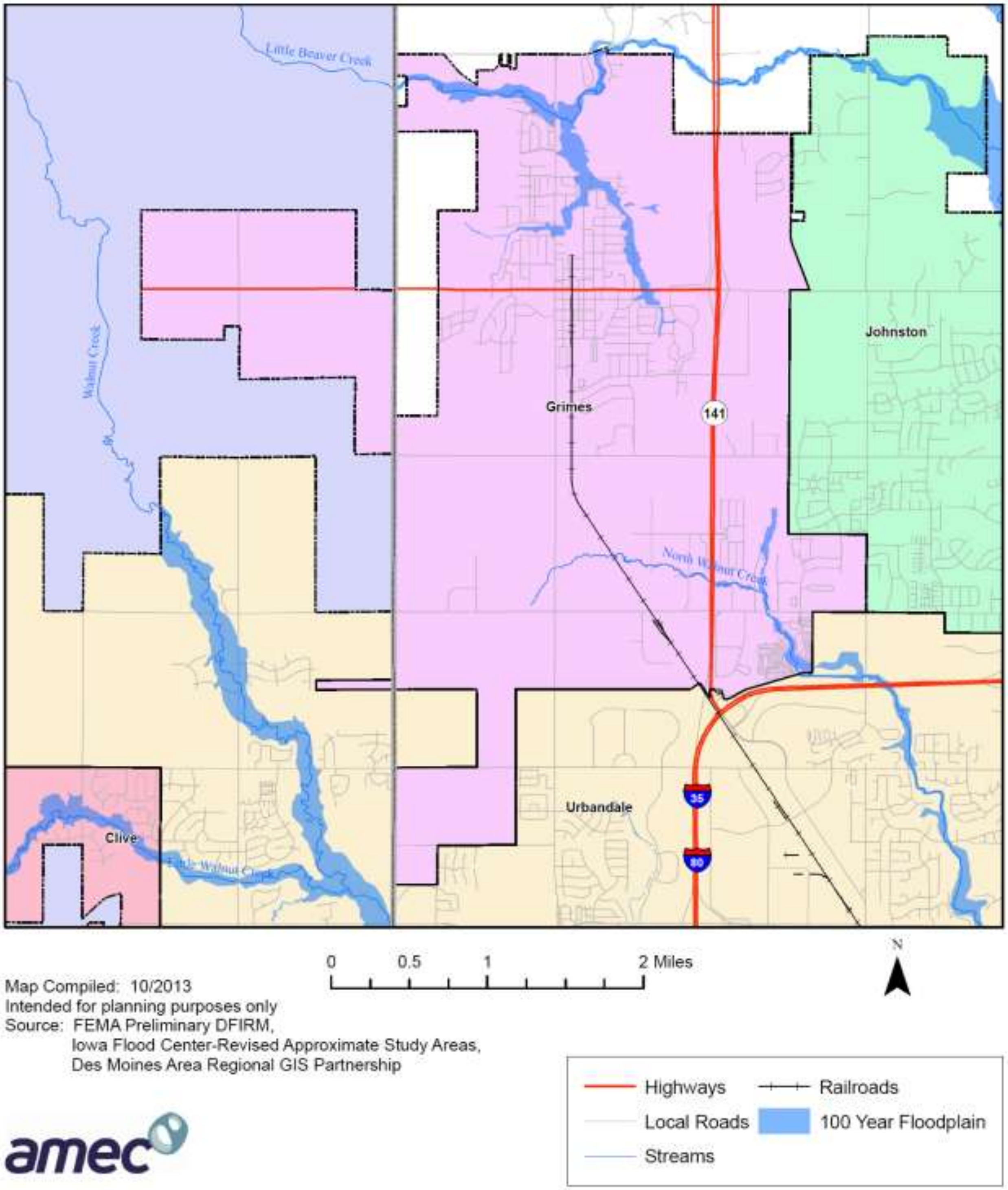


Figure 3.77. City of Johnston 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

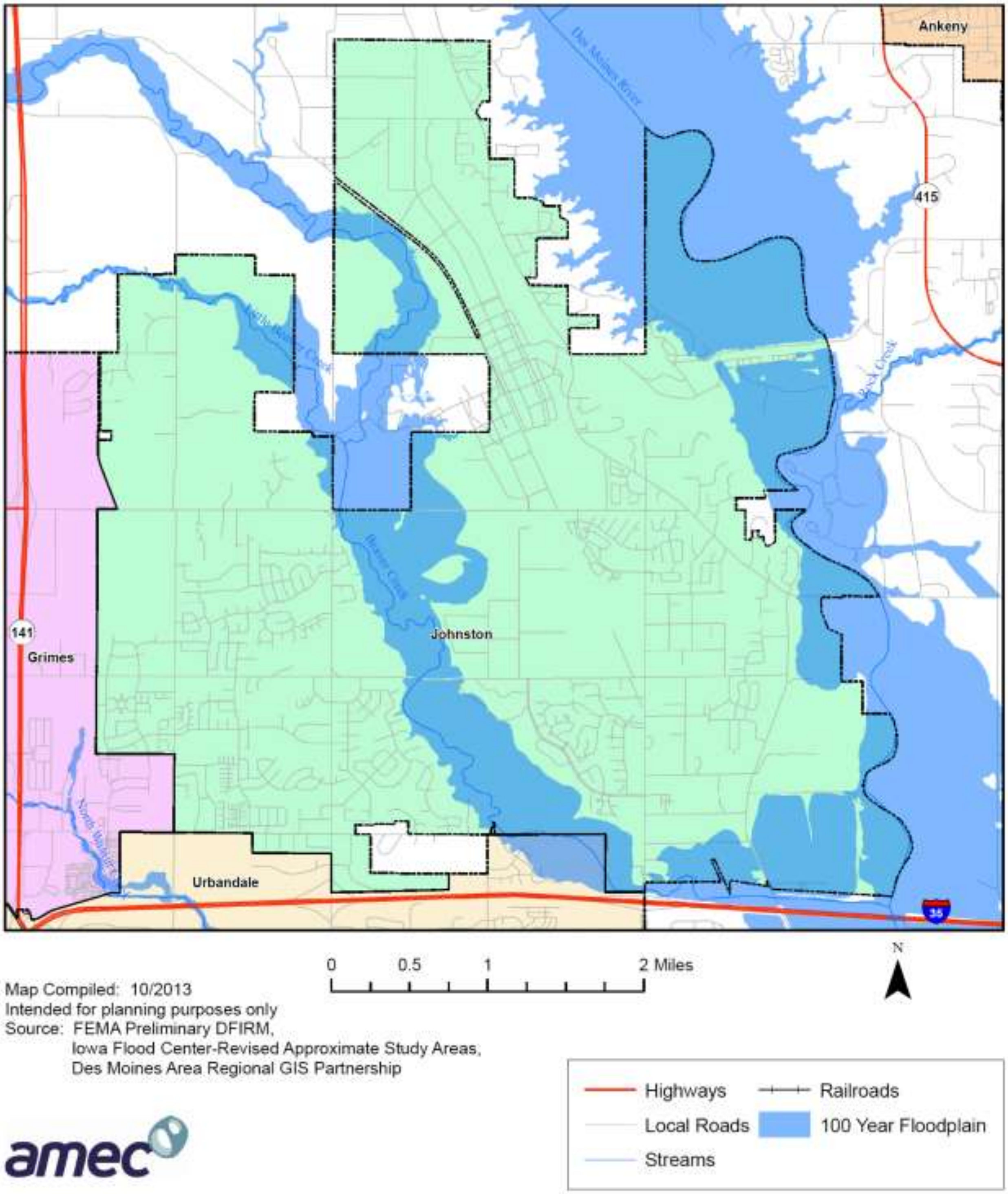


Figure 3.78. City of Mitchellville 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

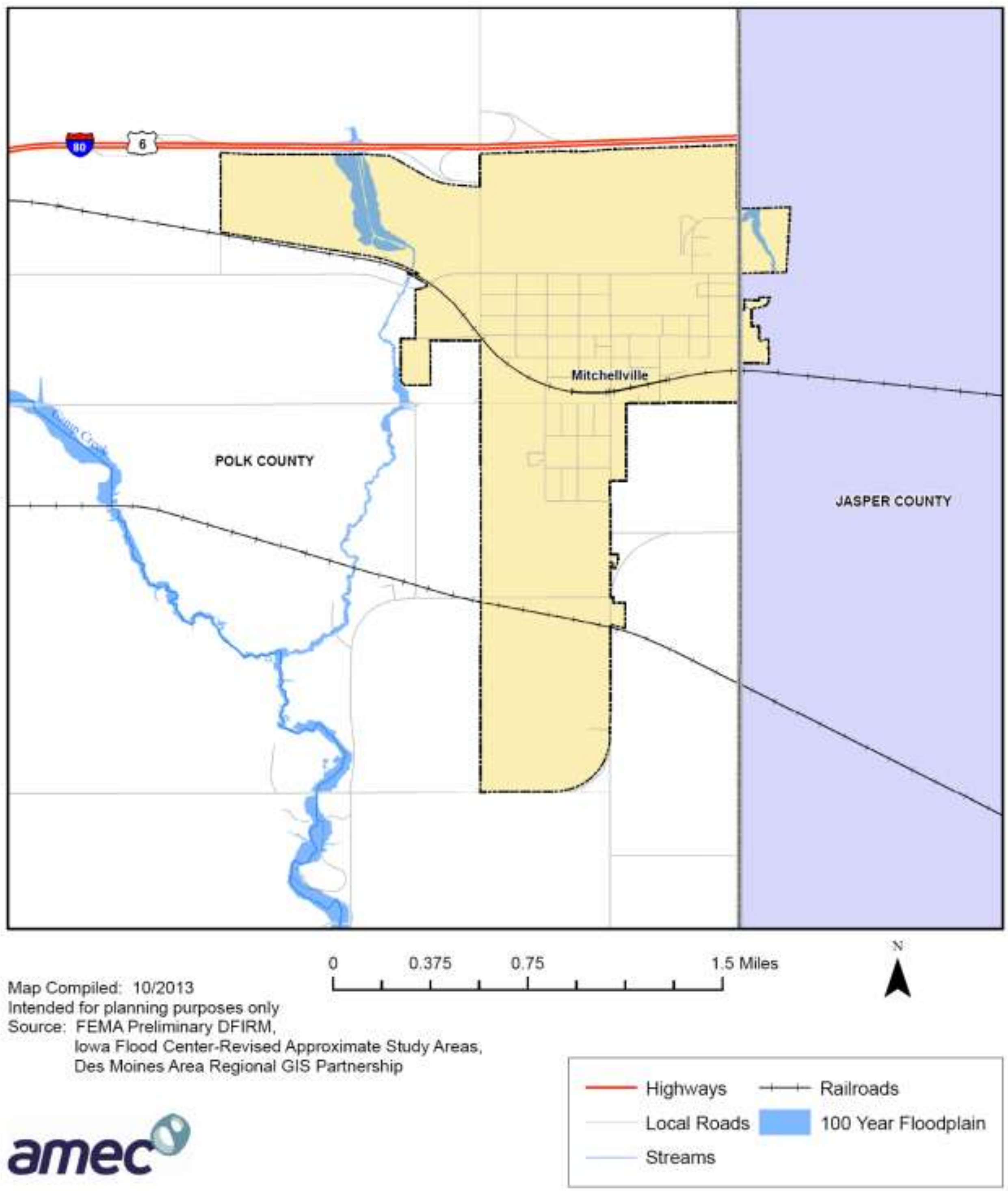


Figure 3.79. City of Norwalk 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM-Polk County Portion Only

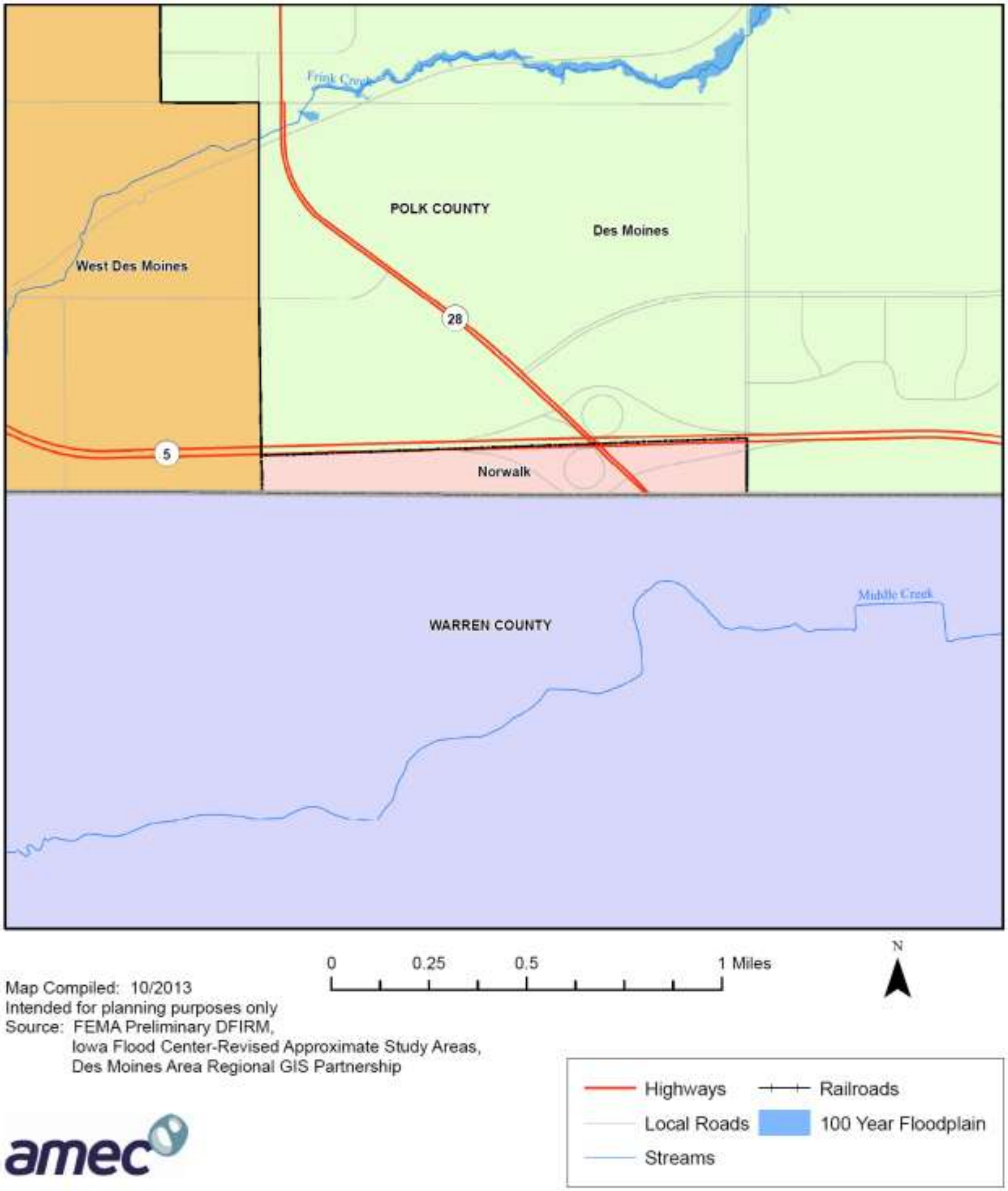


Figure 3.80. City of Pleasant Hill 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

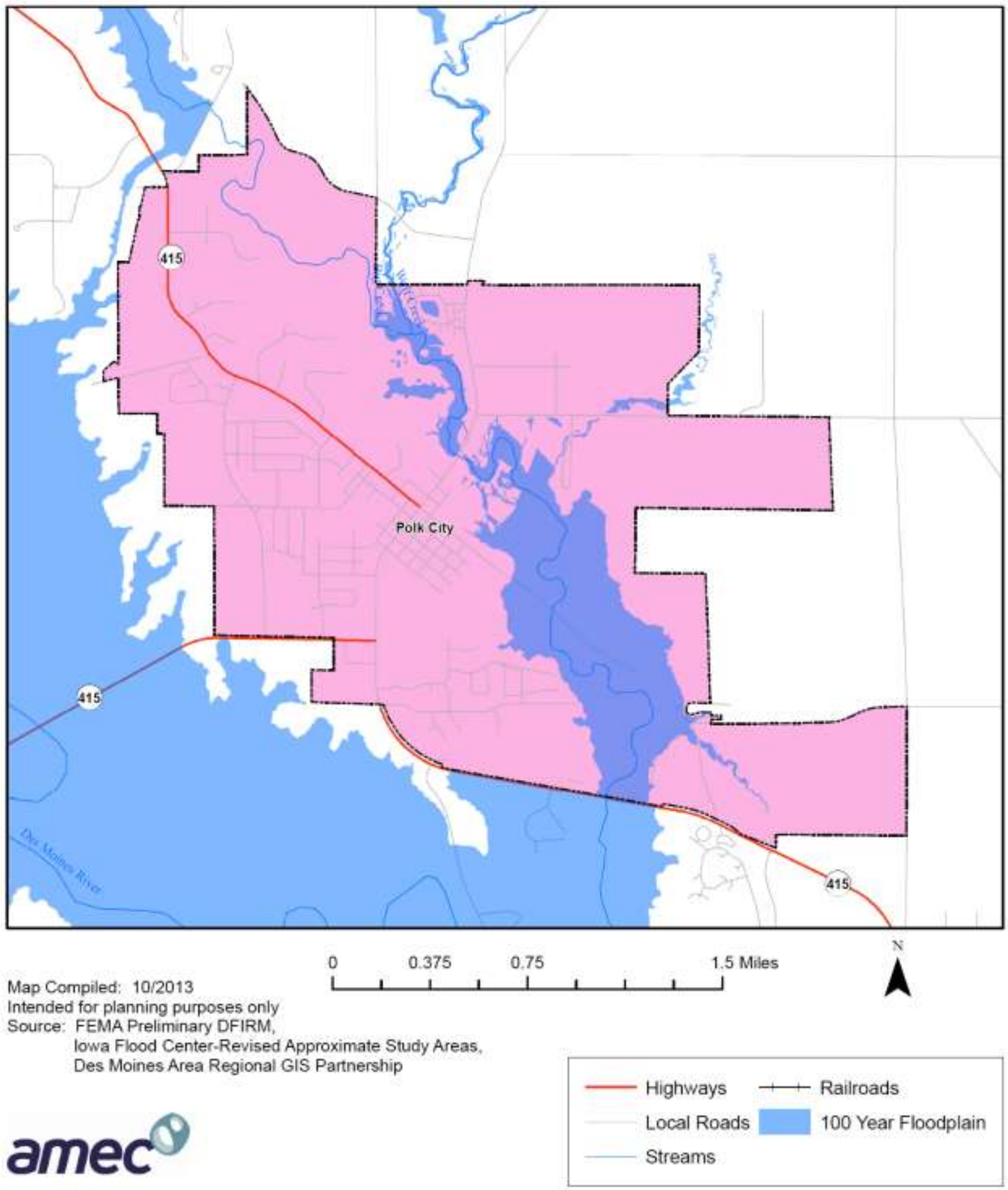


Figure 3.81. City of Polk City 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

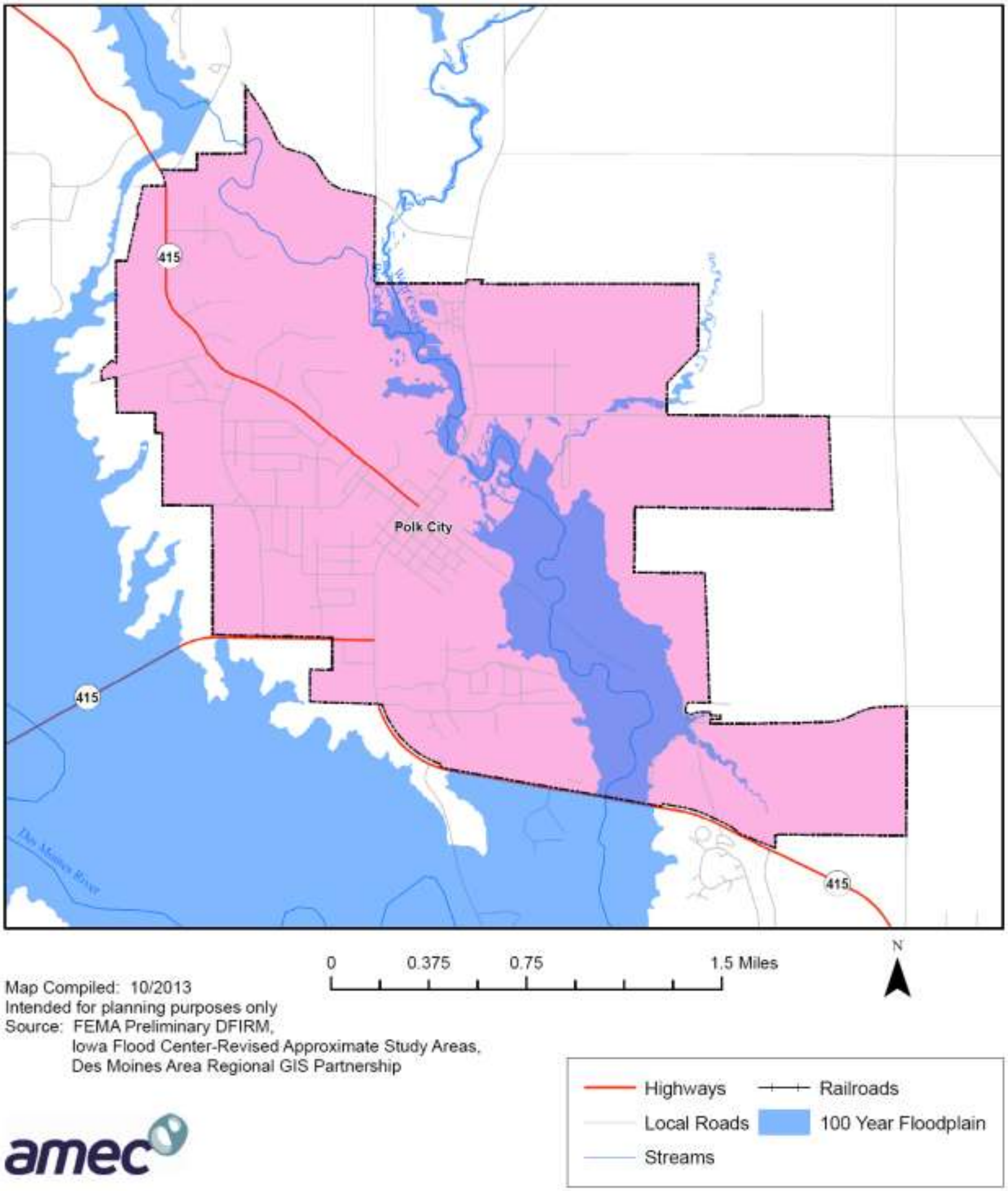


Figure 3.82. City of Runnells 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

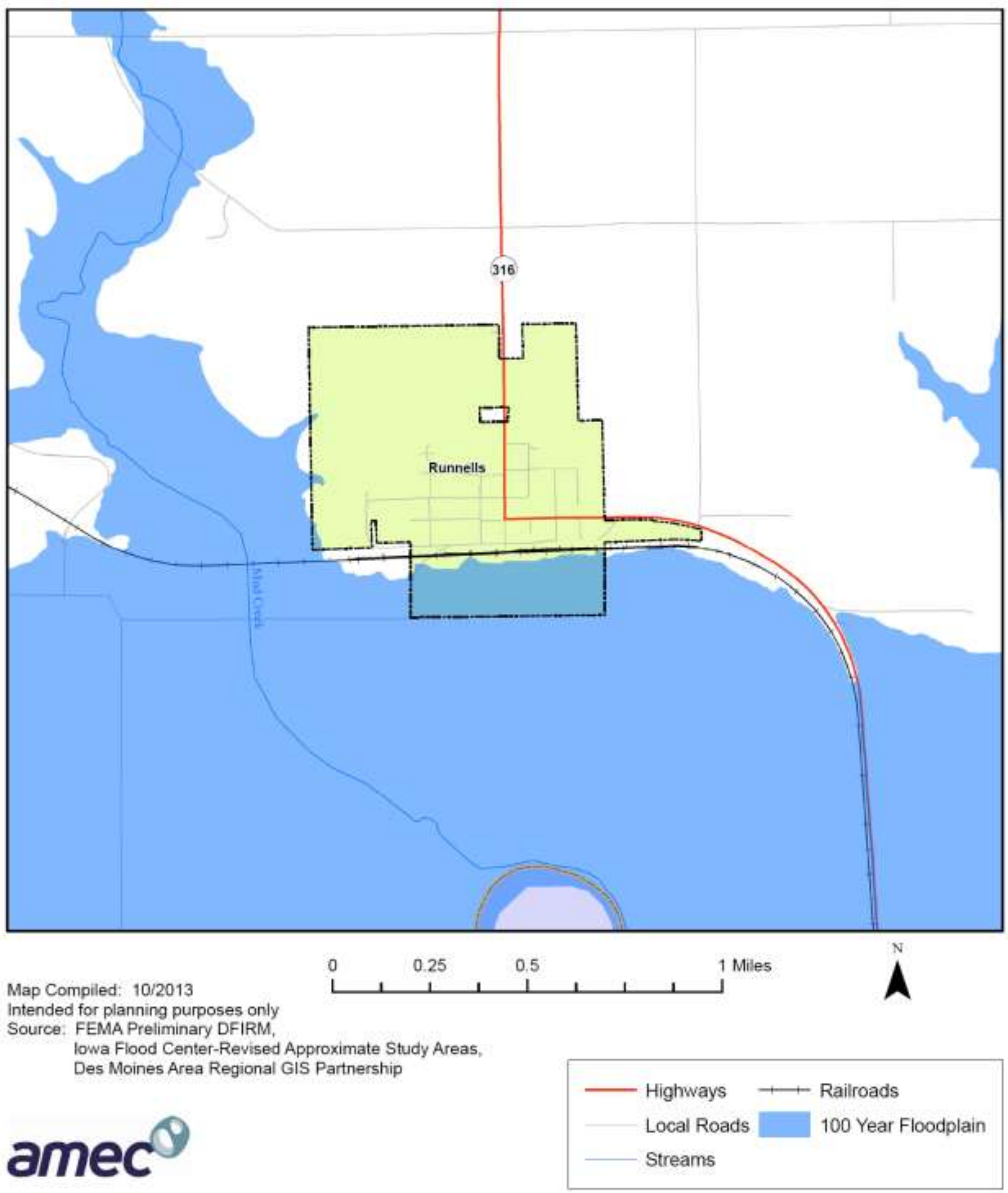


Figure 3.83. City of Sheldahl 1-Percent Annual Chance Floodplain(100-Year Floodplain) Revised Preliminary DFIRM-Polk County Portion Only

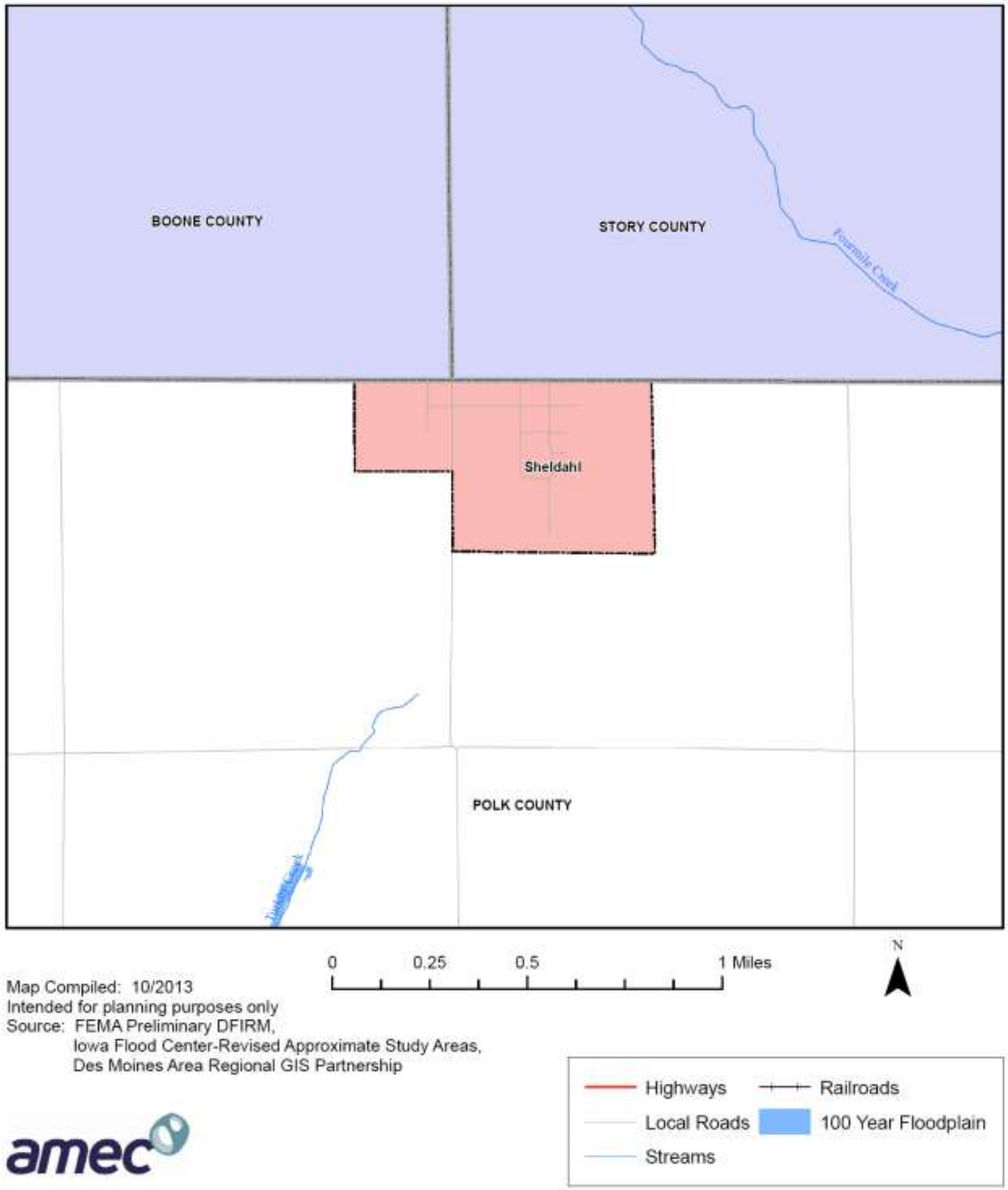


Figure 3.84. City of Urbandale 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

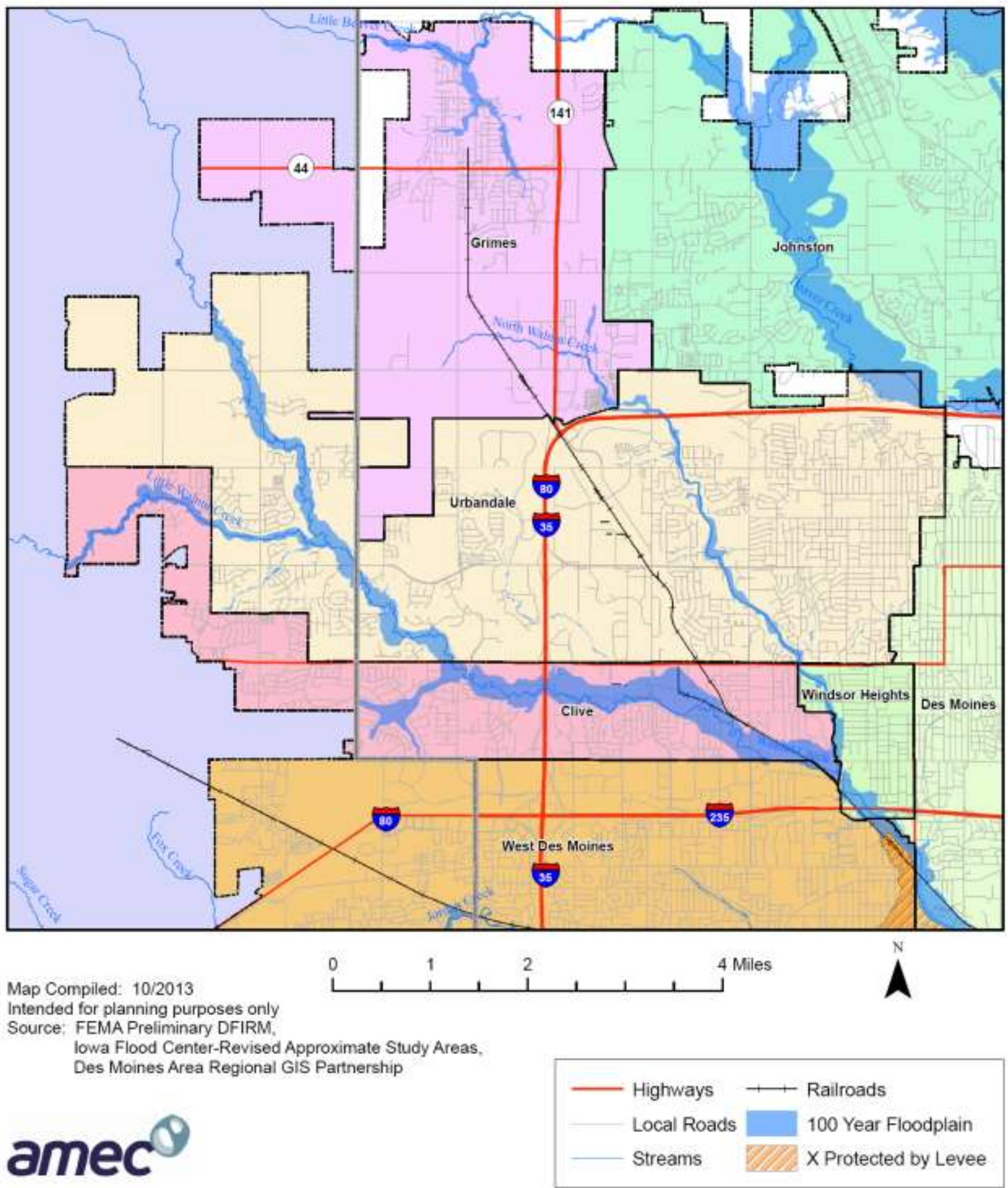


Figure 3.85. City of West Des Moines 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM

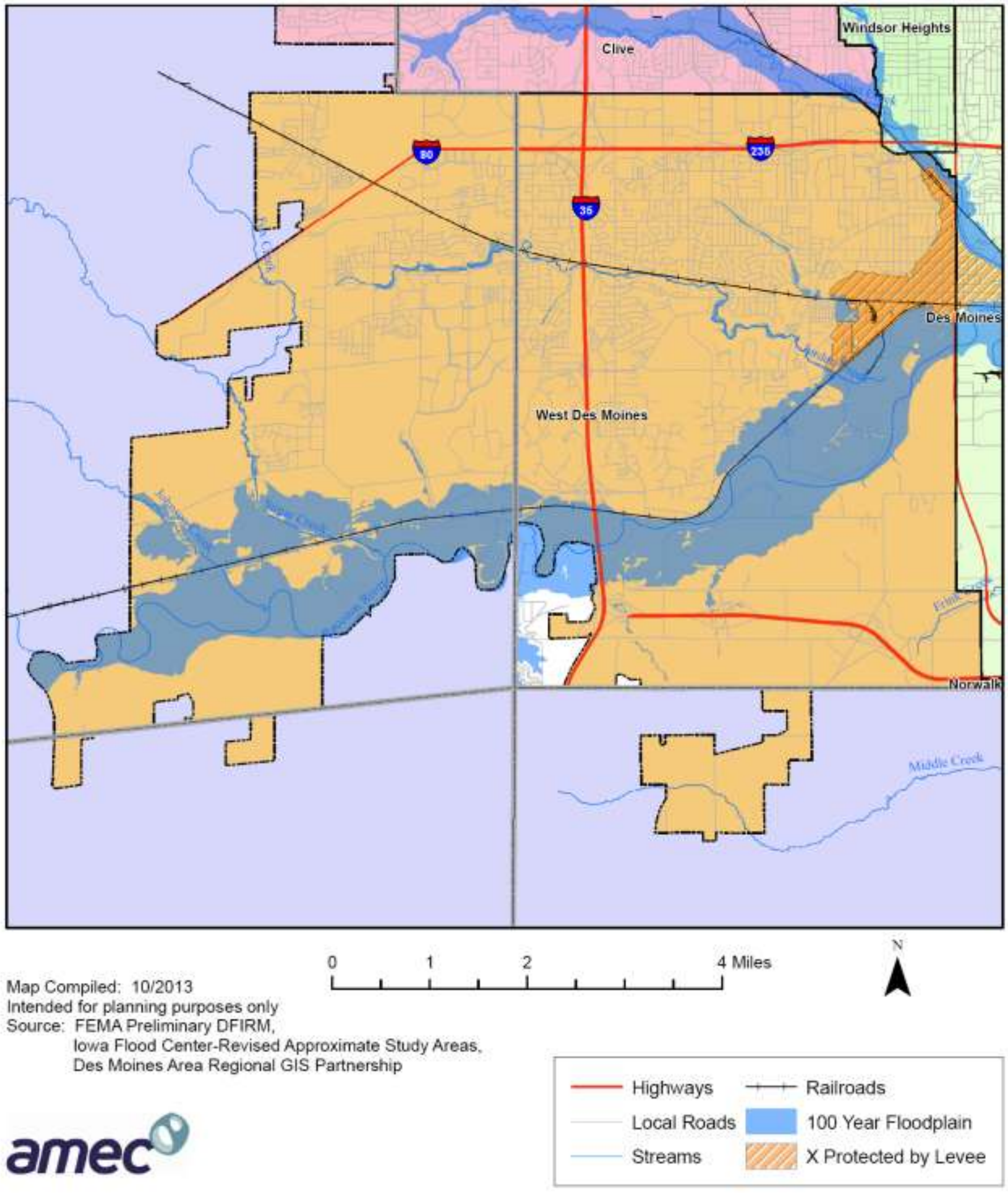
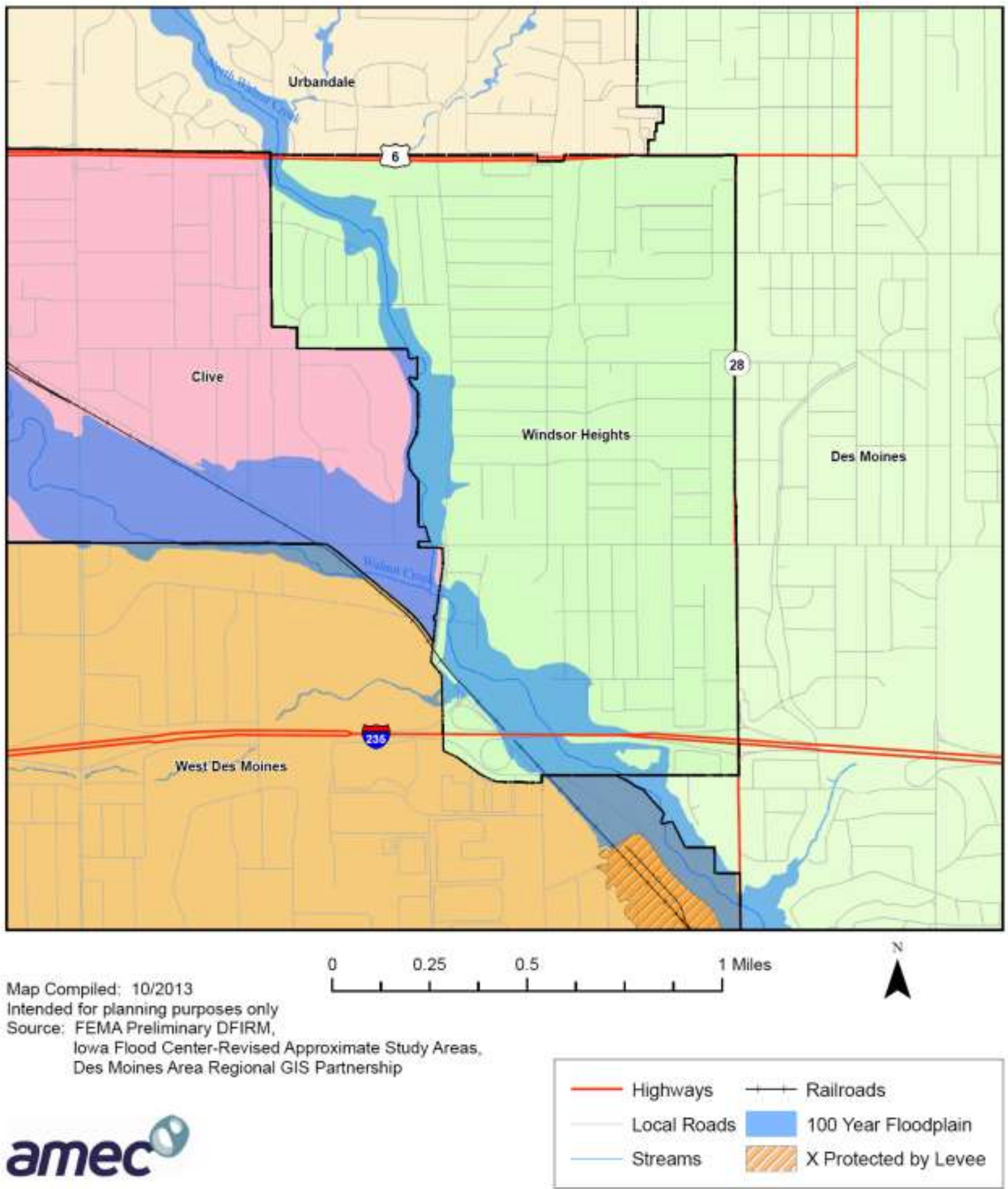


Figure 3.86. City of Windsor Heights 1-Percent Annual Chance Floodplain (100-Year Floodplain) Revised Preliminary DFIRM



Additional Flood Risk Studies

- *Fourmile Creek Watershed Study, December 2013—data from this study is being incorporated in the Risk MAP project*
- *2010 West Des Moines Watershed Assessment*
- *Flood Protection Study: Grand Avenue to Jordan Creek, 2008*
- *Fairmeadows Creek Study, 1997*
- *Grand Avenue River bottom Area Stormwater Drainage Study, 1989*
- *Jordan Creek Floodplain Study, 1980*
- *Jordan Creek Unsteady Flow Analysis, April 1996*
- *Jordan Creek Watershed Stormwater Master Plan, 1992*
- *West Des Moines Storm Drainage Study 1975*

In March of 2011, the City of Clive completed a Flood Response and Recovery Plan. As part of that effort, water surface elevations were determined for key locations within the City. **Table 3.64** provides the water surface elevation data. The column indicated as "ID" is a key for flood intervals. The ID of 15T equates to the discharge rate of the 1-percent annual chance flood at I-35 and I-80:

Table 3.64. Water Surface Elevations at Key Locations in the City of Clive

Water Surface Elevations (NAVD88) at Key Locations
Walnut Creek Flood Mapping Update (2010)
Snyder & Associates Project No. 109.0899

Walnut Creek discharge-elevations (NAVD88 and gage feet) at Interstate 35/80 based on HEC-RAS modeling

					Walnut Creek Water Surface Elevation (NAVD88)									
	ID	*Walnut Creek Discharge (cfs) at I-35/80*	*Water Surface Elevation (NAVD88) at I-35/80 (DS XS 44400)*	*Water Surface Elevation (Staff Gage ft) at I-35/80 (based on XS 44400)*	*114th St overtop (XS 44029)*	*Overtop 100th Street (XS 35572)*	*Swanson Blvd and 94th St (XS 32829)*	*Lincoln Av east of 93rd Ct (XS 32025)*	*Overtop 86th Street (XS 25549)*	*University Boulevard at 80th St (XS 22816)*	*Pumping Station at University Boulevard & 78th St (XS 21053)*	*Overtop to North Walnut Creek by 75th St (XS 20286)*	*Overtop from North Walnut Creek by 75th St (NWC XS 1252)*	*North Walnut Creek Discharge (cfs)*
KEY Elevation:			*850.0*	*0.0*	*862.6*	*851.9*	*846.5*	*845.6*	835.3 (south); 835.8 (north)	*832.0*	*835.4*	*827.8*	*827.8*	
Flood Scenarios	4T	4,000	860.9	10.9	859.4	849.4	843.8	842.7	834.1	830.1	826.2	825.6	827.3	1,891
	5T	5,000	861.5	11.5	859.9	850.0	844.4	843.3	835.2	830.8	827.3	826.6	828.4	2,244
	6T	6,000	862.1	12.1	860.4	850.6	844.9	843.9	836.2	831.3	827.4	826.4	828.4	2,582
	7T	7,000	862.6	12.6	860.8	850.0	845.3	844.4	837.0	831.7	828.3	827.2	828.2	2,907
	8T	8,000	863.1	13.1	861.2	850.5	845.7	844.8	837.8	832.3	829.0	828.0	829.0	3,222
	9T	9,000	863.5	13.5	861.6	851.1	846.1	845.3	838.5	832.8	829.8	828.7	829.7	3,527
	10T	10,000	863.9	13.9	861.9	851.6	846.6	845.8	842.2	833.1	830.5	829.3	830.3	3,825
	12T	12,000	864.6	14.6	862.6	852.8	847.2	846.5	842.5	833.7	831.6	830.3	831.4	4,400
	15T	15,000	865.5	15.5	863.6	855.1	848.0	847.3	842.6	835.1	833.7	832.9	833.7	5,224
	20T	20,000	866.7	16.7	865.1	856.5	849.2	848.5	843.1	836.4	835.1	834.2	834.9	6,517
	24T	24,000	867.6	17.6	866.0	859.1	850.0	849.2	843.5	837.2	835.8	834.7	835.6	7,498

Color Legend:

- Green = No anticipated impact.
- Yellow = Impact is possible.
- Orange = Impact is imminent.

Source: City of Clive Flood Response and Recovery Plan, 2011

This City of Altoona is also currently participating in a watershed study for Mud Creek.

Previous Occurrences

This section provides information on previous occurrences of riverine flooding in the planning area.

Presidential Declarations for Flooding in Planning Area

Since 1969 there have been 10 Presidential Disaster Declarations that included flooding in the planning area. Only two declarations during this time period did not include flooding. These two declarations were both for Winter/Snow Storm. Additional details of the flood-related disaster declarations are provided in **Table 3.65**

Table 3.65. FEMA Flood Disaster Declarations that included Polk County, Iowa, 1965-2013

Disaster Number	Description	Declaration Date Incident Period	Individual Assistance (IA) Public Assistance (PA)
DR-1930	Severe Storms, Flooding, & Tornadoes	7-29-2010 6-1-2010 to 8-31-3010	IA & PA
DR-1763	Severe Storms, Tornadoes, & Flooding	5-27-2008 5-25-2008 to 8-13-2008	IA & PA
DR-1518	Severe Storms, Tornadoes, & Flooding	5-25-2004 5-19-2004 to 6-24-2004	IA
DR-1230	Severe Weather, Tornadoes, & Flooding	7-2-1998 6-13-1998 to 7-15-1998	IA & PA
DR-996	Flooding, Severe Storm	7-9-1993 4-13-1993 to 10-1-1993	IA & PA
DR-868	Flooding, Severe Storm	5-26-1990 5-18-1990 to 7-6-1990	IA & PA
DR-443	Flooding, Severe Storm	6-24-1974 6-24-1974	IA & PA
DR-269	Heavy Rains, Flooding	8-14-69 8-14-69	IA & PA
DR-259	Flooding	4-25-1969 4-25-1969 to 4-25-1969	IA & PA
DR-193	Flooding	4-22-1965 4-22-1965 to 4-22-1965	IA & PA

Source: Federal Emergency Management Agency, www.fema.gov/

The following descriptions of principle flooding issues and previous flooding events in the planning area are from the Preliminary Flood Insurance Study and the Data Collection Guides completed by planning committee members.

Unincorporated Polk County

Major flooding occurred on the Des Moines River near Saylorville in June 1954, April 1965, July 1993, and June 2008. Discharges associated with these events are 60,000 cubic feet per second (cfs), 47,400 cfs, 45,700 cfs, and 50,500 cfs, respectively. Peak discharges were taken from the Des Moines River near Saylorville, Iowa stream gauge (USGS Gauge No. 05481650). Significant flooding occurred on Beaver Creek on June 13, 1966 and May 19, 1974 and July 10, 1993 and June 13, 2008. Discharges associated with these events are 5,470 cfs, 7,340, 14,300 cfs, and 7,010 cfs, respectively, at the Beaver Creek near Grimes, Iowa stream gauge (USGS Gauge No. 05481950).

City of Ankeny

Fourmile Creek and its tributaries, Saylor Creek and its tributaries, and tributaries of Rock Creek are all subject to flooding although there are no USGS gauging stations near the study areas in Ankeny. No high water marks are known to have been recorded within the study area.

City of Clive

The greatest flood problems in Clive are in the southeastern part of the City where commercial businesses have encroached upon the floodplains of Walnut Creek and North Walnut Creek. The greatest flood damages incurred in the City of Clive were from the flood of July 1, 1973 on Walnut Creek. The same storm system that produced the storm on Walnut Creek also caused a major flood on the Raccoon River. Flood damages from these floods in Polk County were estimated at approximately $1,354,000 by the Civil Defense Division, Iowa Department of Public Defense.

A USGS stream gauging station (Gauge No. 05484800) on Walnut Creek at the 63rd Street Bridge was established in October 1971. Fragmentary flood peak records prior to 1971 indicate that significant floods occurred in 1947, 1958, and 1964. The greatest of the known floods on Walnut Creek was the flood of July 1, 1973, but the 1947 flood may have been nearly equivalent. The recorded annual flood peaks for 1974 and 1975 were also relatively high and may have been greater than the 1958 and 1964 floods; however, flood peak data are not available at the same locations for direct comparisons. The 1973 flood peak was 9,000 cubic feet per second (cfs)

City of Des Moines

The City of Des Moines, located in Polk County, Iowa, has several streams that traverse the City, including the Des Moines River, Raccoon River, Walnut Creek, Fourmile Creek, and Seventh Ward Ditch. The areas adjacent to these streams frequently sustain substantial flood damages. During the Great Flood of 1993, Polk County suffered more than $152,000,000 in flood damages, mostly in the Des Moines metropolitan area. In addition, Des Moines was without water service for 19 days causing the closure of most of the businesses and industry in the City. More than 3,000 properties were inundated. In 2008, residents and business were evacuated as flows exceeded the 1-percent-annual chance flood estimate. Birdland Levee on the Des Moines River failed and inundated the area behind it.

The Des Moines River has two USGS gauging stations within the City of Des Moines, the Des Moines River at 2nd Avenue (Gauge No. 05482000) and the Des Moines River below Raccoon River (Gauge No. 05485500). Significant floods occurred at the 2nd Avenue gauge in 1954 and 2008 which resulted in a peak discharge of 60,200 cfs and 47,300 cfs respectively. The gauge was not in service between 1961 and 1997. The peak flows at the gauge on the Des Moines River below Raccoon River occurred in June 1947, April 1960, July 1993, and June 2008. The peak discharges were 77,000 cfs, 68,900 cfs, 116,000 cfs and 104,000 cfs respectfully.

The Raccoon River and Walnut Creek inflicted flood damages on the City of Des Moines in the floods of 1973. Even though the flooding on the two streams resulted from the same storm system, the Walnut Creek flood crested on July 1, whereas, flood flows on the Raccoon River were relatively high during the period of July 1 through July 5, with the flood peak occurring on July 4. A USGS gauging station is located on the Raccoon River near Van Meter, Iowa, (Gauge No. 05484500) 15 miles upstream of the City of Des Moines. The gauge has been active since 1915 and indicated that the July 1973 event had a peak flow of 35,600 cfs. Other flooding events included July 1993, June 1998, and June 2008. The peak discharges for these events were 70,100 cfs, 47,400 cfs, and4 3,500 cfs, respectfully. A USGS gauging station on Raccoon River at Fleur Street has been in place since 1984. Peak discharges within the period of record occurred in July 1993 and June 2008. Peak discharges were 67,900 cfs and 64,800 cfs, respectively.

A stream-gauging station on Walnut Creek at the 63rd Street Bridge (USGS Gauge No. 05484650) was established in October 1971. Fragmentary flood peak records prior to 1971 indicate that significant floods occurred in 1947, 1958, and 1964. The greatest of the known floods on Walnut Creek was the flood of July 1, 1973, but the 1947 flood may have been nearly equivalent. The recorded annual flood peaks for 1974 and 1975 were also relatively high and may have been greater than the 1958 and 1964 floods; however, flood peak data are not available at the same locations for direct comparisons. The 1973 flood peak was 9,000 cfs.

The greatest flood on Fourmile Creek since 1947 occurred in June 1966 and had a discharge of 7,430 cfs. The second greatest flood of 5,900 cfs occurred in June 1947. Estimated flood damage for the City of Des Moines was $116,000 for the 1947 flood and $43,000 for the 1966 flood. A USGS stream gauge is located at Easton Boulevard on Fourmile Creek (Gauge No. 05485640) since 1972. The peak flow recorded by the gauge was in the 2010 flood event.

Five hundred people were displaced from their homes and two lost their lives during the June 1947 flood. Damages to the city amounted to $850,000 plus $150,000 spent for emergency flood fighting. The June 1954 flood forced 1,800 people to evacuate their homes and cost the city $1,193,000 in damages and another $375,000 for flood fighting (Reference 13).

In many areas of the Seventh Ward Ditch, floodplain development has taken place near the stream channel with little consideration given to the flood potential of the stream. The stream channel itself is small and overgrown with vegetation in many areas, and many culverts are partially or almost completely filled with sediment. These factors, combined with the increasing urbanization of the watershed, have combined to cause increasingly frequent flooding problems.

The Hamilton Drain area along the northern edge of the City is subject to inundation at times of heavy rainfall due primarily to poor drainage.

City of Grimes

Little Beaver Creek and Little Beaver Creek Tributary within the City of Grimes are both subject to flooding. No USGS gauging stations are located in the City, and no high water marks are known to exist on either of these streams in Grimes.

City of Johnston

The City of Johnston is in the Des Moines River basin, which forms the eastern corporate boundary for much of the City. Flooding hazards from the Des Moines River are significantly reduced by Saylorville Dam, a major flood control structure at Johnston. Beaver Creek is another significant drainage way that affects flooding. Beaver Creek travels southeast through generally undeveloped areas in the City, and flows into the Des Moines River just southeast of Johnston. There is little development within the Beaver Creek floodplain. Current use is for municipal parks and gravel mining operations. The majority of the floodplain is woodlands and farmlands. The development within the Des Moines River floodplain is mainly woodlands and parkland along Saylorville Lake.

As a result of the 2008 flood, the City of Johnston reported damages to 41 commercial buildings with varying degrees of flood related damage. Additional damages to infrastructure in Johnston included a lift station, meter pit, trails, trail bridges, roads, and erosion to creek banks. Several roads were closed including NW Beaver Drive, NW Johnston Drive, and NW 62nd Avenue.

In Johnston, the 2010 flood event caused damage to the sanitary sewer main and creek bank erosion.

City of Pleasant Hill

Little Fourmile Creek is subject to flooding hazards although there are no USGS gauging stations near the City. A 1-percentannualchance flood is estimated to have a peak discharge of 5,720 cfs. No high water marks are known to exist on Little Fourmile Creek in the study area.

City of Polk City

As a result of the 2010 flood, the Polk City wastewater treatment plant was threatened with flooding, but was saved as a result of sandbagging efforts.

City of West Des Moines

A USGS gauging station is located on the Raccoon River near Van Meter, Iowa, (Gauge No. 05484500) 15 miles upstream of the City of Des Moines. The gauge has been active since 1915 and indicated that the July 1973 event had a peak flow of 35,600 cfs. Other flooding events included July 1993, June 1998, and June 2008. The peak discharges for these events were 70,100 cfs, 47,400 cfs, and 43,500 cfs, respectively.

A stream gauging station on Walnut Creek at the 63rd Street Bridge was established in October 1917. Fragmentary flood peak records prior to 1971 indicate that significant floods occurred in 1947, 1958, and 1964. The greatest of the known floods on Walnut Creek was the flood of May 10, 1986, but the 1947 flood may have been nearly equivalent. The recorded annual flood peaks for 1974 and 1986 were also relatively high and may have been greater than the 1958 and 1964 floods; however, flood peak data are not available at the same locations for direct comparisons. The 1986 flood peak was 12,500 cfs. Other significant flooding events on Walnut Creek include 1973 and 1993 which was 9,000 cfs and 6,460 cfs, respectively

Des Moines Water Works

In the July 1993 flooding, the Raccoon River crested at 26.8 feet which is 14.8 feet above flood stage. River water over-topped the water treatment plan levee and inundated the plant leaving 200,000 customers without water for 19 days. Many businesses shut down for the duration of this water outage. The infrastructure damages were estimated at $11.2 Million; $9.2 Million of the losses were insured. $1.2 Million was provided by federal/state disaster relief flooding. Improvements have since been made to the levee around the water treatment plan, but inundation could occur if flood levels are higher than the increased protection.

The second highest crest on the Raccoon River was 24.66 feet, which is 12.66 feet above flood stage. This occurred in the June 13, 2008 flood. The treatment plant was not inundated, but significant property damage occurred in large part to river bank erosion. The infrastructure damage caused as a result of this event was over $1.4 Million of which $883,000 was insured.

Previous Agricultural Impacts

Flooding and excess moisture take a toll on crop production in the planning area. According to the USDA's Risk Management Agency, payments for insured crop losses in the planning area as a result of excess moisture and flood conditions from 2003-2012 totaled $14,577,222. This translates to an annual average of $1,457,722. According to USDA Risk Management Agency's 2012 Iowa Crop Insurance Profile, 88 percent of insurable crops in Iowa were insured. **Table 3.66** summarizes the claims paid by year and type of event.

Table 3.66. Crop Insurance Claims Paid in Polk County for Crop Loss as a result of Excess Moisture/Precipitation/Rain and Flood (2003-2012)

Crop Year	Crop Insurance Paid
2003	$28,176
2004	$295,343
2005	$74,886
2006	$3,473
2007	$197,609
2008	$5,672,641
2009	$600,426
2010	$6,206,725
2011	$1,471,569
2012	$26,373
Total	**$14,577,222**

Source: USDA Risk Management Agency, 2013

National Flood Insurance Program (NFIP) Participation

Table 3.67 provides details on NFIP participation for the communities in the planning area and **Table 3.68** that follows provides the number of policies in force, amount of insurance in force, number of closed losses, and total payments for each jurisdiction, where applicable. The claims information is for the period from January 1, 1978 to July 31, 2013.

Table 3.67. NFIP Participation

Community ID #	Community Name	NFIP Participant (Y/N)	Current Effective Map Date	Regular-Emergency Program Entry Date
N/A	Alleman, City of	N	No Effective Map	N/A
190546	Altoona, City of	Y	(NSFHA)	11/10/1982
190226#	Ankeny, City of	Y	12/6/1999	05/16/83
190707	Bondurant, City of	Y	04/02/90(M)	04/02/90
190274#	Carlisle, City of	Y	03/02/09	08/04/87
190488#	Clive, City of	Y	10/16/1992	11/1/1979
190227#	Des Moines, City of	Y	07/15/88	02/04/81
N/A	Elkhart, City of	N	No Effective Map	N/A
190104#	Granger, City of	Y	12/4/07	06/01/87
190228#	Grimes, City of	Y	04/30/86	11/6/1985
190745#	Johnston, City of	Y	07/19/00	05/03/82
190619	Mitchellville, City of	Y	(NSFHA)	01/18/11
190631#	Norwalk, City of	Y	03/02/2009	11/20/98
190489#	Pleasant Hill, City of	Y	05/03/82	10/8/1982
N/A	Polk City, City of	N	No Effective Map	N/A
190901#	Polk County (unincorporated)	Y	07/19/00	03/01/84
190800	Runnells, City of	Y	09/19/75	02/17/11(E)
N/A	Sheldahl, City of	N	(NSFHA)	N/A
190230#	Urbandale, City of	Y	07/19/00	06/15/79
190231#	West Des Moines, City of	Y	02/16/06	11/1/1979
190687#	Windsor Heights, City of	Y	10/16/1992	06/15/79

Source: NFIP Community Status Book, 9/26/2013; BureauNet, http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book; M= No elevation determined – all Zone A, C, and X: NSFHA = No Special Flood Hazard Area; E=Emergency Program

Table 3.68. NFIP Policy and Claim Statistics as of 7/31/2013

Community Name	Policies in Force	Insurance in Force	Closed Losses	Total Payments
Altoona, City of	5	$825,000	1	$11,937
Ankeny, City of	50	$9,169,100	5	$18,916
Bondurant, City of	10	$2,091,000	0	$0
Carlisle, City of	5	$1,217,900	0	$0
Clive, City of	141	$42,576,900	28	$653,271
Des Moines, City of	747	$176,719,100	607	$17,027,471
Granger, City of	2	$560,000	0	$0
Grimes, City of	21	$4,873,500	2	$19,261
Johnston, City of	53	$19,721,400	13	$882,051
Mitchellville	0	$0	0	$0
Norwalk, City of	9	$1,937,100	0	$0
Pleasant Hill, City of	23	$2,295,100	6	$79,393
Polk County *	128	$26,393,000	68	$1,558,338
Runnells, City of	0	$0	0	$0
Urbandale, City of	47	$9,589,500	7	$49,543
West Des Moines, City of	137	$36,028,800	294	$3,542,116
Windsor Heights, City of	25	$6,950,300	6	$57,282
Total	1,403	$340,947,700	1,037	$23,899,579

Source: NFIP Community Status Book, 7/31/2013; BureauNet, http://bsa.nfipstat.fema.gov/reports/reports.html; *Closed Losses are those flood insurance claims that resulted in payment. Loss statistics are for the period from January 1, 1978 to July 31, 2013.

According to the policy and loss statistics, policy holders in the City of Des Moines have received the most in insurance payments by far with over $17 million in payments. The City of West Des Moines and then unincorporated Polk County follow with $3.5 million and $1.5 million in payments respectively.

Repetitive Loss/Severe Repetitive Loss Properties

Repetitive Loss: Repetitive Loss Properties are those properties with at least two flood insurance payments of $5,000 or more in a 10-year period. According to the Flood Insurance Administration, jurisdictions included in the planning area have a combined total of 136 repetitive loss properties. As of June 30, 2013, 107 have been mitigated, leaving 29 un-mitigated repetitive loss properties. **Table 3.69** provides a summary of the repetitive loss properties in the planning area. **Table 3.70** that follows indicates the types of repetitive loss properties by jurisdiction.

Table 3.69. Polk County Repetitive Loss Properties

Jurisdiction	# of Properties	# Mitigated	Building Payments	Contents Payments	Total Payments	Average Payment	# of Losses
Clive, City of	1	0	$8,863	$989	$9,853	$4,926	2
Des Moines, City of	94	74	$4,545,020	$924,957	$5,469,977	$2,080,559	243
Pleasant Hill, City of	1	0	$59,411	$0	$59,411	$29,706	2
Polk County (unincorporated)	5	0	$103,349	$0	$103,349	$41,937	12
Urbandale, City of	1	0	$3,210	$2,416	$5,626	$2,813	2
West Des Moines, City of	33	32	$1,006,805	$405,443	$1,412,248	$581,904	74
Windsor Heights, City of	1	1	$11,860	$0	$11,860	$5,930	2
Total	**136**	**107**	**$5,738,519**	**$1,333,805**	**$7,072,324**	**$2,747,775**	**337**

Source: Flood Insurance Administration as of June 30, 2013

Table 3.70. Types of Repetitive Loss Properties in Polk County

Jurisdiction	# of Properties	Types	# Mitigated	Types Mitigated
Clive, City of	1	1 single family residential	0	N/A
Des Moines, City of	94	4 – 2 to4 family residential 1 – multi family condo 7 – non-residential 82 – single family residential	74	4 – 2 to 4 family residential 1 – multi-family condo 69 – single family residential
Pleasant Hill, City of	1	1 - non-residential	0	N/A
Polk County (unincorporated)	5	5 - single family residential	0	N/A
Urbandale, City of	1	1 – 2 to 4 family residential	0	N/A
West Des Moines, City of	33	6 – non-residential 27 – single family residential	32	6 – non-residential 26 – single family residential
Windsor Heights, City of	1	1 – single family residential	1	1 – single family residential
Total	**136**	**5 – 2 to4 family residential** **1 – multi family condo** **14 – non-residential** **116 – single family residential**	**107**	**4 – 2 to4 family residential** **1 – multi family condo** **6 – non-residential** **96 – single family residential**

Source: Flood Insurance Administration as of June 30, 2013

Severe Repetitive Loss (SRL): SRL properties are defined it as “a single family property (consisting of one-to-four residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which four or more separate claims payments have been paid under flood insurance coverage with the amount of each claim payment exceeding $5,000 and with cumulative amounts of such claims payments exceeding $20,000; or for which at least two separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property.

There is one validated Severe Repetitive Loss property in Polk County. It is in the City of Des Moines and is un-mitigated. The total paid in NIFP insurance for this property is $91,754 for a total of four losses. There are also two non-residential properties in the planning area that meet the SRL definition in terms of number of losses and amount of payments. Both are in the City of Des Moines and are un-mitigated. The combined number of losses is 22, with combined total payments of $1,038,899.

Probability of Future Occurrence

With the extensive history of flooding in the planning area, it is highly likely that flooding of various levels will continue to occur frequently.

Probability Score: 4—Highly Likely

Vulnerability

Overview

The flood vulnerability and loss estimates for the unincorporated county and the incorporated cities were generated using the Revised Preliminary DFIRM data and the Polk County parcel and building data provided by the Des Moines GIS Department. GIS analysis was conducted to determine the number and values of buildings at risk to the 1-percent annual chance flood. For purposes of this analysis, if any portion of a parcel was within the 1-percent annual chance floodplain, then all buildings and the total value associated with the parcel were considered at risk to the 1-percent annual chance flood. Additionally, to determine the population at risk, the number of residential properties at risk was multiplied by the average household size.

Since both Revised Preliminary DFIRM data and GIS parcel data were available for the planning area, it was determined that the methodology described above would provide more accurate results than a Level I HAZUS analysis. The main reason for this is that HAZUS level I analysis utilizes census block data rather than actual parcel/building data. Additionally, the county parcel data did not have the necessary attributes to import into HAZUS building stock. As a result, the analysis utilizing the DFIRM and GIS parcel/building layer was chosen as the best method producing best available data.

Table 3.71 provides the numbers of buildings per jurisdiction by type that are in the 1-percent annual chance floodplain for the unincorporated county and cities. **Table 3.72** that follows provides the building exposure values in the floodplain for the unincorporated county and the incorporated cities in the planning area. It is noted that in some cases, the parcel data did not include building value for parcels where buildings occur. Conversely, in some cases, the parcel included a building value and the building data did not include a building count for the parcel. Even with these limitations, the data still provides a fairly accurate representation of those buildings and values at risk to the 1-percent annual chance flood.

According to this analysis, the unincorporated areas of Polk County have the greatest number of buildings in the floodplain with a total of 5,134, and 1,680 are residential. The next highest number of buildings in the floodplain is in the City of Des Moines 3,518, followed by the City of West Des Moines with 1,275. The greatest exposure of building value in the 1-percent annual chance floodplain is in the City of Des Moines with a total of $323,991,070 in improvements present in the 1-percent annual chance floodplain.

Table 3.71. Polk County, Iowa Building Counts In The 1-Percent Annual Chance Floodplain

Jurisdiction	Residential	Commercial	Government	School	Industrial	Agricultural	Total
Alleman	4	3	0	10	0	14	31
Altoona	32	123	36	0	2	27	220
Ankeny	395	69	33	36	11	54	598
Bondurant	52	109	29	21	3	30	244
Carlisle*	0	0	22	0	0	17	39
Clive (Dallas)	29	1	0	0	0	2	32
Clive (Polk)	451	185	17	0	16	0	669
Des Moines (Polk)	1,809	889	554	20	196	44	3,512
Des Moines (Warren)	0	3	0	0	0	3	6
Elkhart	0	0	0	0	0	0	0
Granger*	0	0	0	0	0	0	0
Grimes (Dallas)	0	0	0	0	0	0	0
Grimes (Polk)	284	393	18	0	2	3	700
Johnston	72	190	64	0	19	25	370
Mitchellville	0	0	0	0	0	0	0
Mitchellville (Jasper)	0	0	0	0	0	0	0
Norwalk*	0	0	0	0	0	0	0
Pleasant Hill	17	480	10	1	20	12	540
Polk City	22	4	10	0	0	9	45
Polk County Unincorporated	1,680	633	355	0	5	2,461	5,134
Runnells	0	2	13	0	0	0	15
Sheldahl*	0	0	0	0	0	0	0
Urbandale (Dallas)	97	2	0	0	0	28	127
Urbandale (Polk)	469	107	28	4	0	18	626
West Des Moines (Dallas)	8	52	0	0	0	32	92
West Des Moines (Madison)	0	0	0	0	0	0	0
West Des Moines (Polk)	423	632	87	2	17	22	1,183
West Des Moines (Warren)	0	0	0	0	0	0	0
Windsor Heights	128	40	14	4	0	0	186
Total	**5,972**	**3,917**	**1,290**	**98**	**291**	**2,801**	**14,369**

Source: FEMA Preliminary DFIRM, Revised Approximate Study Areas from the Iowa Flood Center, Des Moines Area Regional GIS Partnership, 2013; * Data is for the portion of these cities that is in Polk County only

Table 3.72. Polk County Building Values In The 1-Percent Annual Chance Floodplain

Jurisdiction	Residential	Commercial	Government	School	Industrial	Agricultural	Total
Alleman	$1,263,400	$706,000	$0	$0	$0	$70,100	$2,039,500
Altoona	$2,476,400	$7,901,000	$194,000	$0	$650,000	$577,400	$11,798,800
Ankeny	$77,916,800	$11,894,600	$256,500	$0	$7,276,000	$609,100	$97,953,000
Bondurant	$4,473,100	$1,481,300	$0	$4,723,000	$109,000	$264,800	$11,051,200
Carlisle*	$0	$0	$0	$0	$0	$131,300	$131,300
Clive (Dallas)	$17,994,590	$0	$0	$0	$0	$0	$17,994,590
Clive (Polk)	$77,930,800	$92,135,200	$3,169,230	$0	$6,537,500	$0	$179,772,730
Des Moines (Polk)	$99,792,800	$169,228,650	$21,299,720	$0	$33,383,600	$286,300	$323,991,070
Des Moines (Warren)	$0	$0	$0	$0	$0	$0	$0
Elkhart	$0	$0	$0	$0	$0	$0	$0
Granger	$0	$0	$0	$0	$0	$0	$0
Grimes (Dallas)	$0	$0	$0	$0	$0	$0	$0
Grimes (Polk)	$34,936,600	$13,538,000	$0	$0	$192,000	$0	$48,666,600
Johnston	$14,360,200	$106,468,800	$1,150	$0	$662,500	$159,600	$121,652,250
Mitchellville	$0	$0	$0	$0	$0	$0	$0
Mitchellville (Jasper)	$0	$0	$0	$0	$0	$0	$0
Norwalk*	$0	$0	$0	$0	$0	$0	$0
Pleasant Hill	$1,531,300	$9,744,600	$0	$0	$3,921,500	$16,700	$15,214,100
Polk City	$3,020,900	$2,625,000	$0	$0	$0	$204,300	$5,850,200
Polk County Unincorporated	$102,849,800	$3,733,500	$2,374,250	$0	$15,000	$32,770,200	$141,742,750
Runnells	$0	$0	$0	$0	$0	$0	$0
Sheldahl*	$0	$0	$0	$0	$0	$0	$0
Urbandale (Dallas)	$32,686,590	$0	$0	$0	$0	$725,460	$33,412,050
Urbandale (Polk)	$126,293,400	$19,568,600	$6,730,000	$0	$0	$1,093,000	$153,685,000
West Des Moines (Dallas)	$4,579,110	$45,112,820	$0	$0	$0	$416,130	$50,108,060
West Des Moines (Madison)	$0	$0	$0	$0	$0	$0	$0
West Des Moines (Polk)	$50,793,400	$74,968,800	$0	$0	$12,764,300	$134,300	$138,660,800
West Des Moines (Warren)	$0	$0	$0	$0	$0	$0	$0
Windsor Heights	$11,406,400	$21,133,500	$0	$0	$0	$0	$32,539,900
Total	**$664,305,590**	**$580,240,370**	**$34,024,850**	**$4,723,000**	**$65,511,400**	**$37,458,690**	**$1,386,263,900**

Source: FEMA Preliminary DFIRM, Revised Approximate Study Areas from the Iowa Flood Center, Des Moines Area Regional GIS Partnership, 2013; * Data is for the portion of these cities that is in Polk County only

For the planning area ranking, the HMPC determined the magnitude of river flooding to be critical. Individual jurisdictional ratings are provided at the end of this hazard section.

Magnitude Score: 3—Critical

Potential Losses to Existing Development

The potential losses to existing development will be provided for the following categories of losses:

- Building Losses—this will include counts and values for buildings exposed to potential damage from the 1-percent annual chance flood for each jurisdictions in the planning area;
- Estimated Population Displaced;
- Agricultural Impacts; and
- Critical Facilities and Infrastructure at Risk.

Building Losses and Impacted Population

The result of the exposure analysis summarizes the values at risk in the floodplain. When a flood occurs, seldom does the event cause total destruction of an area. Potential losses from flooding are related to a variety of factors including flood depth, flood velocity, building type and construction. Based on FEMA Flood Insurance Administration (FIA) flood depth-damage curves, the percent of damage is directly related to the flood depth. FEMA's HAZUS flood loss estimation tool and the flood benefit/cost module both use this simplified approach to model flood damage based on building type and flood depth. A damage estimation of 20 percent of the total value was used based on FIA depth-damage curves for a one-story structure with no basement flooded to two feet. While there are several limitations to this model, it does present a methodology to estimate potential damages. This model may include structures within the 1-percent annual chance floodplain that may be elevated above the level of the base flood elevation, according to local floodplain development requirements, and thus mitigate the risk. Additionally, structures with finished basements and commercial properties would likely sustain a higher percentage of damage.

To determine the population that would be impacted and potentially displaced by a 1-percent annual chance flood event, the average household size, as determined by the 2010 census, was multiplied by the number of residential structures in the 1-percent annual chance floodplain for each jurisdiction. The population impacted is somewhat underestimated since some of the residential structures are multi-family structures. However, data was not available to determine the number of households in each multi-family structure.

Table 3.73 provides the summary of potential flood loss estimates and impacted population for the 1-percent annual chance flood by jurisdiction.

Table 3.73. Flood Loss Estimates For 1-Percent Annual Chance Flood

Jurisdiction	Total Building Value at Risk	Estimated Building Losses	Number of Residential Buildings	Average household Size	Estimated Impacted Population
Alleman	$2,039,500	$407,900	4	2.86	11
Altoona	$11,798,800	$2,359,760	32	2.64	84
Ankeny	$97,953,000	$19,590,600	395	2.58	1,019
Bondurant	$11,051,200	$2,210,240	52	2.83	147
Carlisle*	$131,300	$26,260	0	2.57	0
Clive (Dallas)	$17,994,590	$3,598,918	29	2.68	78
Clive (Polk)	$179,772,730	$35,954,546	451	2.68	1,209
Des Moines (Polk)	$323,991,070	$64,798,214	1,809	2.43	4,396
Des Moines (Warren)	$0	$0	0	2.43	0
Elkhart	$0	$0	0	2.67	0
Granger*	$0	$0	0	2.59	0
Grimes (Dallas)	$0	$0	0	2.65	0
Grimes (Polk)	$48,666,600	$9,733,320	284	2.65	753
Johnston	$121,652,250	$24,330,450	72	2.67	192
Mitchellville	$0	$0	0	2.53	0
Mitchellville (Jasper)	$0	$0	0	2.53	0
Norwalk*	$0	$0	0	2.53	0
Pleasant Hill	$15,214,100	$3,042,820	17	2.57	44
Polk City	$5,850,200	$1,170,040	22	2.73	60
Polk County Unincorporated	$141,742,750	$28,348,550	1,680	2.48	4,166
Runnells	$0	$0	0	2.83	0
Sheldahl*	$0	$0	0	2.57	0
Urbandale (Dallas)	$33,412,050	$6,682,410	97	2.52	244
Urbandale (Polk)	$153,685,000	$30,737,000	469	2.52	1,182
West Des Moines (Dallas)	$50,108,060	$10,021,612	8	2.32	19
West Des Moines (Madison)	$0	$0	0	2.32	0
West Des Moines (Polk)	$138,660,800	$27,732,160	423	2.32	981
West Des Moines (Warren)	$0	$0	0	2.32	0
Windsor Heights	$32,539,900	$6,507,980	128	2.24	287
Total	**$1,386,263,900**	**$277,252,780**	**5,972**	**N/A**	**14,872**

Source: FEMA Preliminary DFIRM, Revised Approximate Study Areas from the Iowa Flood Center, Des Moines Area Regional GIS Partnership, 2013; * Data is for the portion of these cities that is in Polk County only

The following two tables provide the loss ratio of potential loss estimates to buildings compared to the total building exposure. **Table 3.74** provides the loss ratio by jurisdiction and **Table 3.75** provides the loss by jurisdiction and county (for multi-county jurisdictions). These tables demonstrate that the highest loss ratio would occur in the City of Clive, followed by the City of Windsor Heights.

Table 3.74. Damage Loss Ratio (1-Percent Annual Chance Flood)-by Jurisdiction

Jurisdiction	Building Exposure ($)	Estimated Building Losses	Loss Ratio %
Alleman	$24,364,900	$407,900	1.7%
Altoona	$957,693,680	$2,359,760	0.2%
Ankeny	$2,936,209,050	$19,590,600	0.7%
Bondurant	$204,495,420	$2,210,240	1.1%
Carlisle*	$13,561,600	$26,260	0.2%
Clive	$1,427,445,690	$39,553,464	2.8%
Des Moines	$9,453,905,860	$64,798,214	0.7%
Elkhart	$23,919,600	$0	0.0%
Granger*	$15,440,500	$0	0.0%
Grimes	$544,058,200	$9,733,320	1.8%
Johnston	$1,473,397,350	$24,330,450	1.7%
Mitchellville	$59,238,800	$0	0.0%
Norwalk*	$0	$0	0.0%
Pleasant Hill	$524,475,690	$3,042,820	0.6%
Polk City	$216,399,800	$1,170,040	0.5%
Polk County Unincorporated	$1,820,273,890	$28,348,550	1.6%
Runnells	$18,350,900	$0	0.0%
Sheldahl*	$5,266,100	$0	0.0%
Urbandale	$3,039,647,700	$37,419,410	1.2%
West Des Moines	$4,707,775,460	$37,753,772	0.8%
Windsor Heights	$275,606,100	$6,507,980	2.4%

Source: FEMA Preliminary DFIRM, Revised Approximate Study Areas from the Iowa Flood Center, Des Moines Area Regional GIS Partnership, 2013; * Data is for the portion of these cities that is in Polk County only

Table 3.75. Damage Loss Ratio (1-Percent Annual Chance Flood)-by Jurisdiction and County

Jurisdiction	Building Exposure ($)	Estimated Building Losses	Loss Ratio %
Clive (Polk)	$982,393,130	$35,954,546	3.7%
Windsor Heights	$275,606,100	$6,507,980	2.4%
Grimes (Polk)	$542,973,990	$9,733,320	1.8%
Alleman	$24,364,900	$407,900	1.7%
Johnston	$1,473,397,350	$24,330,450	1.7%
Polk County Unincorporated	$1,820,273,890	$28,348,550	1.6%
Urbandale (Polk)	$2,368,099,500	$30,737,000	1.3%
Bondurant	$204,495,420	$2,210,240	1.1%
Urbandale (Dallas)	$671,548,200	$6,682,410	1.0%
West Des Moines (Polk)	$3,111,386,910	$27,732,160	0.9%
Clive (Dallas)	$445,052,560	$3,598,918	0.8%
Des Moines (Polk)	$9,450,540,160	$64,798,214	0.7%
Ankeny	$2,936,209,050	$19,590,600	0.7%
West Des Moines (Dallas)	$1,595,932,050	$10,021,612	0.6%
Pleasant Hill	$524,475,690	$3,042,820	0.6%
Polk City	$216,399,800	$1,170,040	0.5%

Jurisdiction	Building Exposure ($)	Estimated Building Losses	Loss Ratio %
Altoona	$957,693,680	$2,359,760	0.2%
Carlisle*	$13,561,600	$26,260	0.2%
Des Moines (Warren)	$3,365,700	$0	0.0%
Elkhart	$23,919,600	$0	0.0%
Granger*	$15,440,500	$0	0.0%
Grimes (Dallas)	$1,084,210	$0	0.0%
Mitchellville	$0	$0	0.0%
Mitchellville (Jasper)	$59,238,800	$0	0.0%
Norwalk*	$0	$0	0.0%
Runnells	$18,350,900	$0	0.0%
Sheldahl*	$5,266,100	$0	0.0%
West Des Moines (Madison)	$38,900	$0	0.0%
West Des Moines (Warren)	$417,600	$0	0.0%

Source: FEMA Preliminary DFIRM, Revised Approximate Study Areas from the Iowa Flood Center, Des Moines Area Regional GIS Partnership, 2013; * Data is for the portion of these cities that is in Polk County only

Agricultural Impacts

Additionally, USDA crop insurance claims for excess moisture/precipitation/rain and flood conditions for the ten-year period from 2002-2013 totaled $14,577,222. Considering that 88 percent of insurable crops are insured in Iowa (2012 Iowa Crop Insurance Profile, USDA, RMA), the adjusted losses calculate to $16,656,025 for all insurable crops for the period. This results in an average annual loss of $1,656,503 to insurable crops as a result of excess moisture/precipitation/rain and flood conditions affecting agriculture.

Critical Facilities and Infrastructure at Risk

To analyze critical facilities at risk in the planning area, the planning committee reviewed and updated the inventory of critical and essential facilities and infrastructure in the planning area that was compiled in 2011 as part of the HAZUS risk assessment study. After the critical facilities were validated and revised, a comparison was made with the Revised Preliminary DFIRM to determine those facilities that would be damaged in a 1-percent annual chance flood event. This analysis revealed 358 critical or essential facilities that are in the 1-percent annual chance floodplain. It should be noted that more than 1/3 of those in the floodplain are bridges. X provides the number of facilities in the floodplain based on facility type.

Table 3.76. Critical/Essential Facilities/Infrastructure in the 100-year Floodplain

Facility Type	# in 100-year Floodplain
Airport	1
Child Care	3
Communication Tower	44
Electric Power	2
Government / Housing / Shelters	2
Highway Bridge	243
Hospital and Clinic	1

Facility Type	# in 100-year Floodplain
Natural Gas	1
Nursing Homes	1
Police Station	1
Potable Water	1
Sanitary Pump Stations	9
Stormwater Pump Stations	13
Tier II Chemical Facility	35
Waste Water	1
Total	**358**

Source: Updated Critical Facility Inventory and Revised Preliminary DFIRM

Appendix E provides the list of critical facilities in the 1-percent annual chance floodplain that could be damaged in the event of a 1-percent annual chance flood This Appendix is “For Official Use Only”. To obtain access for official use, contact the Polk County Emergency Manager.

Future Development

Any future development in floodplains would increase risk in those areas. For those communities that participate in the National Flood Insurance Program, enforcement of the floodplain management regulations will ensure mitigation of future construction in those areas. However, even if structures are mitigated, evacuation may still be necessary due to rising waters. In addition, floods that exceed mitigated levels may still cause damages.

River Flooding Hazard Summary by Jurisdiction

To demonstrate how river flooding varies by jurisdiction, all jurisdictions that had any improvements in the 1-percent annual chance floodplain (including school districts) received a rating of 4 for probability since the planning area has historically seen a high probability of flooding in any given year. For those jurisdictions that did not have any 1-percent annual chance floodplain in the Revised Preliminary DFIRM (Elkhart) it was determined that the River Flood hazard does not apply. It should be noted that both Alleman and Mitchellville were determined by FEMA per the effective maps to have No Special Flood Hazard Areas. However, the Revised Preliminary DFIRM does show some floodplain in these jurisdictions.

To determine the magnitude rating, those jurisdictions with a loss ratio of 1 percent or higher were assigned a magnitude of 3 and those with a loss ratio less than 1 but 0.5 percent or higher were assigned a magnitude of 2. The exception of this is the city of Des Moines. Although the loss ratio is 0.7%, the estimated losses were in excess of $64 Million. As a result, Des Moines was assigned a magnitude of 3. For those jurisdictions with a loss ration less than 0.5 were assigned a magnitude of 1. The warning time and duration were considered to be 1 and 4 for all jurisdictions that have any properties in the floodplain. For those jurisdictions that do not have improvement exposures in the floodplain, all elements indicate Not Applicable (N/A). To determine the rankings for the school districts and DMWW, the critical facility layer of school buildings and facilities owned by DMWW was compared against the revised preliminary DFIRM. This analysis revealed no school buildings in the 100-year floodplain and 1 DMWW facility in the 100-year floodplain.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	4	3	1	4	3.25	High
Cities						
City of Alleman	4	3	1	4	3.25	High
City of Altoona	4	1	1	4	2.65	Moderate
City of Ankeny	4	2	1	4	2.95	Moderate
City of Bondurant	4	3	1	4	3.25	High
City of Clive	4	3	1	4	3.25	High
City of Des Moines	4	3	1	4	3.25	High
City of Elkhart	N/A	N/A	N/A	N/A	N/A	N/A
City of Grimes	4	3	1	4	3.25	High
City of Johnston	4	3	1	4	3.25	High
City of Mitchellville	4	1	1	4	2.65	Moderate
City of Pleasant Hill	4	2	1	4	2.95	Moderate
City of Polk City	4	2	1	4	2.95	Moderate
City of Runnells	4	1	1	4	2.65	Moderate
City of Urbandale	4	3	1	4	3.25	High
City of West Des Moines	4	2	1	4	2.95	Moderate
City of Windsor Heights	4	3	1	4	3.25	High
Des Moines Water Works	4	3	1	4	3.25	High
School Districts						
Ankeny, 261	N/A	N/A	N/A	N/A	N/A	N/A
Bondurant-Farrar, 720	N/A	N/A	N/A	N/A	N/A	N/A
Dallas Center-Grimes, 1576	N/A	N/A	N/A	N/A	N/A	N/A
Des Moines Independent, 1737	N/A	N/A	N/A	N/A	N/A	N/A
Johnston, 3231	N/A	N/A	N/A	N/A	N/A	N/A
North Polk, 4779	N/A	N/A	N/A	N/A	N/A	N/A
Saydel, 5805	N/A	N/A	N/A	N/A	N/A	N/A
Southeast Polk, 6101	N/A	N/A	N/A	N/A	N/A	N/A
Urbandale, 6579	N/A	N/A	N/A	N/A	N/A	N/A
West Des Moines	N/A	N/A	N/A	N/A	N/A	N/A

3.4.14 Sinkholes/Landslide

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
1	1	4	1	1.45	Low

Profile

Hazard Description

Sinkhole

Sinkholes are common where the rock below the land surface is limestone, carbonate rock, salt beds, or rocks that can naturally be dissolved by ground water circulating through them. As the rock dissolves, spaces and caverns develop underground. The sudden collapse of the land surface can be dramatic and range in size from broad, regional lowering of the land surface to localized collapse. The primary causes of most subsidence are human activities: underground mining of coal, groundwater or petroleum withdraw, and drainage of organic soils. In addition, sinkholes can develop as a result of subsurface void spaces created over time due to the erosion of subsurface limestone (karst).

Land subsidence occurs slowly and continuously over time or on occasion abruptly, as in the sudden formation of sinkholes. Sinkholes can be aggravated by flooding.

Landslide

A landslide is the downhill movement of masses of soil and rock by gravity. They are typically associated with mountainous regions, but they can also occur in areas of low relief. In these areas, the landslides are often the result of cut-and-fill failures (from roadway and building excavations), river bluff failures, lateral spreading, or mine collapse. The basic ingredients for landslides are gravity, susceptible soil or rock, sloping ground, and water. Landslides occur when susceptible rock, earth, or debris moves down a slope under the force of gravity and water. Landslides may be very small or very large, and can move at slow to very high speeds. New landslides can occur because of rainstorms, fires, earthquakes, and various human activities that modify slope and drainage.

Warning Time Score: 4—Minimal or no warning time

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

According to the Iowa Department of Natural Resources, Polk County is considered a low karst area. As a result, erosion of subsurface limestone resulting in sinkholes is not considered very likely.

Polk County is situated within a portion of the State underlain by abundant coal resources. Recorded production totaled over 50 billion tons when in production for over 100 years (1840 to 1947). Beginning in 1902, the state of Iowa required companies to document and map out the underground tunnels and veins for state records. Any mining activity that occurred prior to 1902 is typically not mapped.

In the city of Runnells, mining began in the 1880s so there are no detailed maps. The City also used to be a final coal stop for steam-paddled boats headed up the Des Moines River so several "mom and pop mines" operated within the community.

According to Iowa Department of Natural Resources, Mines and Minerals Bureau there are 187 closed-off underground mining locations in Polk County alone as listed in **Table 3.77**.

Table 3.77. List of Underground Mining Locations in Polk County

Mine Name	Acreage	First year of operation	Last year of operation	Data Type	Mining Method	Shaft Depth	No. maps
Acme Coal Co.	0	unknown	1895	Point location, ¼ section	unknown	unknown	0
Acme Coal Mine	38.5	1918	1926	Surveyed map	room and pillar	unknown	1
Adams And Hastie Mine	0	unknown	unknown	Point location, ¼ section	room and pillar	100	0
Altoona Mine	61.5	unknown	unknown	Unmapped, extent approx.	unknown	215	0
American Coal Mining Co.	91.2	1912	1919	Surveyed map	room and pillar	unknown	3
Anderson Coal Co.	34.5	1907	unknown	Unmapped, extent approx.	unknown	285	0
Anderson Mine	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
Atlas Mine	24	unknown	unknown	Unmapped, extent approx.	unknown	100	0
Avon Coal Co.	0	unknown	unknown	Point location, ¼ section	unknown	34	0
Beck Coal Co. (2nd Vein)	98.4	1908	1942	Surveyed map	room and pillar	unknown	4
Beck Coal Co. (3rd Vein)	24.1	1908	1922	Surveyed map	unknown	unknown	1
Beck Mine	0	unknown	unknown	Point location, w/in section	unknown	unknown	0
Bennett Brothers Coal Co. (3rd Vein)	42.8	1908	1914	Surveyed map	room and pillar	unknown	7
Bennett Brothers Coal Co. Mine No. 1	79.7	1903	1916	Surveyed map	room and pillar	125	2
Bennett Brothers Coal Co. Mine No. 2	120.3	1917	1936	Surveyed map	room and pillar	125	4
Bloomfield Coal Co. Marquisville Mine	410.8	1914	1927	Surveyed map	longwall, room and pillar	271	10
Bloomfield Coal Co. Mine No. 2	100.9	1896	1905	Surveyed map	room and pillar	102	1
Bloomfield Coal Co. Mine No. 6	58.6	1889	1895	Surveyed map	room and pillar	181	4
Blount And Evans Coal Co.	62.2	1908	unknown	Unmapped, extent approx.	unknown	218	0
Blount And Evans Coal Co.	51.2	1908	1913	Surveyed map	room and pillar	135	3
Caleb Johns Mine	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
Caleb Johns Mine	0	unknown	unknown	Point location, ¼	unknown	unknown	0

Mine Name	Acreage	First year of operation	Last year of operation	Data Type	Mining Method	Shaft Depth	No. maps
				section			
Camp Creek Coal Co.	0	1887	1894	Point location, w/in section	unknown	40	0
Campfield Coal Co.	21.1	unknown	1895	Unmapped, extent approx.	unknown	118	0
Capital City Coal Co. Mine No. 1	36.1	1930	1936	Surveyed map	room and pillar	unknown	3
Capital Coal Co. Mine No. 1	15.5	1903	1908	Surveyed map	room and pillar	unknown	3
Carbon Mining Co. Mine No. 9	78.5	1929	1941	Surveyed map	room and pillar	212	3
Carbondale Coal Co. Mine No. 1	28.9	1896	1897	Surveyed map	room and pillar	108	2
Center Coal And Mining Co.	78.4	1903	1908	Surveyed map	room and pillar	unknown	1
Central Service Coal Co. Mine No. 6	328.9	1930	1947	Surveyed map	longwall, room and pillar	225	14
Charles Reilley Mine	1	unknown	unknown	Surveyed map	room and pillar	unknown	1
Christy Coal Co. Mine No. 2	200.9	1892	1901	Surveyed map	room and pillar	115	2
Cliffton Heights Coal Co.	54.7	1895	1895	Surveyed map	room and pillar	120	2
Clover Leaf Mine	19	1929	1934	Surveyed map	longwall, room and pillar	unknown	4
Clover Leaf Mine Shaft	0	1911	1913	Point location, ¼ section	unknown	unknown	0
Coal Hill Coal And Mining Co.	46	1901	1901	Surveyed map	room and pillar	45	2
Coaldale Fuel Co.	136.4	1904	1910	Surveyed map	room and pillar	unknown	3
Cooperative Coal Co.	0	1901	1903	Point location, ¼ section	unknown	unknown	0
Cooperative Coal Co. Mine No. 1	0	unknown	unknown	Point location, ¼ section	unknown	125	0
Dahl Mine	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
Des Moines Coal Co.	0	1865	1873	Point location, ¼ section	unknown	unknown	0
Des Moines Coal Co. Iowa Mine	19.3	1913	1916	Surveyed map	room and pillar	150	1
Des Moines Coal Co. Iowa Mine	222	1913	1916	Surveyed map	room and pillar	150	2
Des Moines Coal Co. Marquisville Mine	457.1	1894	1907	Surveyed map	room and pillar	180	3
Des Moines Coal Co. Mine No. 1	0	unknown	1895	Point location, ¼ section	unknown	105	0
Des Moines Coal Co. Mine No. 4	83.8	1920	1936	Surveyed map	room and pillar	unknown	4
Des Moines Ice And Fuel Co.	66.1	1917	1925	Surveyed map	room and pillar	unknown	2
Diamond Jo Coal Mine	3.9	1901	1928	Surveyed map	room and pillar	unknown	1
Diamond Mine	25.3	unknown	1884	Unmapped, extent approx.	unknown	unknown	0
Eagle Coal Co. Mine	46.6	1908	1915	Surveyed map	room and	170	2

Mine Name	Acreage	First year of operation	Last year of operation	Data Type	Mining Method	Shaft Depth	No. maps
No. 2					pillar		
Eagle Mine No. 3	88.1	1910	1919	Surveyed map	room and pillar	unknown	2
Eclipse Coal Co.	60.3	1873	1885	Surveyed map	room and pillar	unknown	1
Economy Coal Co.	81.7	unknown	unknown	Surveyed map	unknown	unknown	1
Economy Coal Co. Mine No. 1	205.9	unknown	unknown	Surveyed map	room and pillar	110	2
Economy Coal Co. Mine No. 2	365.6	1924	1935	Surveyed map	room and pillar	unknown	10
Economy Coal Co. Mine No. 3	258.4	1932	1945	Surveyed map	room and pillar	220	3
Elko Coal Co.	36.6	1901	1907	Surveyed map	room and pillar	unknown	1
Enterprise Coal Co. No.3	0	unknown	unknown	Point location, w/in section	unknown	unknown	0
Enterprise Coal Mining Co. Mine No. 1	536.2	1903	1917	Surveyed map	room and pillar	212	1
Enterprise Coal Mining Co. Mine No. 2	503.4	1907	1917	Surveyed map	room and pillar	210	1
Eureka Coal Co. Mine No. 1	130.4	1874	1894	Unmapped, extent approx.	room and pillar	160	0
Eureka Coal Co. Mine No. 2	306.1	1896	unknown	Unmapped, extent approx.	room and pillar	107	0
Evergreen Coal Co.	0.8	1934	1936	Surveyed map	room and pillar	unknown	1
Extra Mine	0	1884	unknown	Point location, ¼ section	unknown	unknown	0
Flint Brick Co. Mine No. 1	37	1894	1901	Surveyed map	room and pillar	122	3
Flint Brick Co. Mine Shafts No. 2 And 3	90.5	unknown	unknown	Surveyed map	room and pillar	180	6
Flint Coal Co. Mine No. 4	86.3	1927	1928	Surveyed map	room and pillar	unknown	4
Flint Valley Mine	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
Fort Des Moines Mine	108.7	unknown	unknown	Unmapped, extent approx.	room and pillar	unknown	0
Four Mile Coal Co.	86.5	1928	1931	Surveyed map	room and pillar	unknown	6
Fuller And Coggshell Coal Co.	5.2	1882	1885	Surveyed map	room and pillar	unknown	1
Giant Coal Co. Mine No. 1	166.4	unknown	1894	Unmapped, extent approx.	room and pillar	unknown	0
Giant Coal Co. Mine No. 2	54.4	unknown	unknown	Unmapped, extent approx.	unknown	145	0
Giant Coal Co. Mine No. 3	47.6	1885	unknown	Unmapped, extent approx.	unknown	unknown	0
Gibson Coal Co. Mine No. 4	86.4	1903	1909	Surveyed map	room and pillar	190	1
Gibson Coal Co. Mine No.1	66.4	1889	1895	Unmapped, extent approx.	unknown	105	0
Gibson Coal Mining Co. Mine No. 2	42.3	1895	1899	Surveyed map	room and pillar	unknown	2
Gibson Coal Mining Co. Mine No. 5	126.7	1908	1918	Surveyed map	room and pillar	160	2
Gibson Mine No. 3	0	1901	1903	Point location, ¼ section	room and pillar	unknown	0

Mine Name	Acreage	First year of operation	Last year of operation	Data Type	Mining Method	Shaft Depth	No. maps
Glenwood Coal Co. Mine No. 2	61.7	1901	1914	Surveyed map	room and pillar	unknown	1
Glenwood Coal Co. Mine No. 3	0	unknown	unknown	Point location, ¼ section	room and pillar	110	0
Glenwood Mine	10.5	1899	1901	Surveyed map	room and pillar	unknown	1
Gross Coal Mine	1.8	1928	1936	Surveyed map	room and pillar	unknown	3
Hall's Bank	0	1850	unknown	Point location, w/in section	room and pillar	unknown	0
Highland Park Mine	168.2	unknown	unknown	Unmapped, extent approx.	unknown	unknown	0
Hollingsworth Coal Co.	15	1905	1912	Surveyed map	room and pillar	156	5
Hulme Mine	26.7	unknown	unknown	Unmapped, extent approx.	longwall	95	0
Independent Coal Co.	96.4	1927	1945	Surveyed map	room and pillar	60	11
Interurban Coal Co.	17.8	1919	1920	Surveyed map	room and pillar	unknown	1
Iowa Central Mine	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
Iowa Coal And Mining Co.	127.9	unknown	unknown	Unmapped, extent approx.	unknown	65	0
J. M. Christy Mine	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
James Kyle Coal Co.	0	1891	1895	Point location, w/in section	unknown	unknown	0
Johns Coal Co.	17.8	1907	1913	Surveyed map	room and pillar	unknown	3
Joplin Coal Company #3	6	1930	1941	Surveyed map	room and pillar	90	1
Keating – Stanford Coal Co.	28.8	1934	1938	Surveyed map	room and pillar	unknown	5
Keystone Coal Co. Mine	193.9	1908	1922	Surveyed map	room and pillar	165	1
Keystone Coal Co. Mine No. 1	40.3	1894	1908	Surveyed map	room and pillar	142	1
Keystone Coal Co. Mine No. 2	49.1	1894	1908	Unmapped, extent approx.	unknown	unknown	0
Kring Coal Co.	1	1937	1943	Surveyed map, poor location	longwall	58	1
Lake Park Mine	0	1895	unknown	Point location, ¼ section	unknown	unknown	0
Levey Coal Co.	2.2	1936	1941	Surveyed map	room and pillar	90	1
Levey Coal Co.	1.8	1941	1941	Surveyed map	longwall	unknown	1
Logan Mine	0	1891	1893	Point location, ¼ section	room and pillar	40	0
M. Quinn Mine	0	1893	unknown	Point location, ¼ section	unknown	unknown	0
Madison Coal Co.	103.9	1908	1916	Surveyed map	room and pillar	165	1
Maple Block Coal Co. Mine No. 1	297.9	1906	1917	Surveyed map	room and pillar	168	2
Maple Block Coal Co. Mine No. 2	48	1905	1922	Surveyed map	room and pillar	unknown	1
Maple Grove Mine Shaft	23.1	1891	1903	Surveyed map	room and	105	3

Mine Name	Acreage	First year of operation	Last year of operation	Data Type	Mining Method	Shaft Depth	No. maps
No. 1					pillar		
Maple Grove Mine Shaft No. 2	40.8	1891	1903	Surveyed map	room and pillar	105	2
Merchants Mine	0	unknown	unknown	Point location, ¼ section	longwall	unknown	0
Merle Hay Coal Co.	191.2	1942	1947	Surveyed map	room and pillar	200	10
Midland Coal And Mining Co.	0	1891	1896	Point location, ¼ section	unknown	45	0
Midway Coal Co. Shaw Mine	0	unknown	unknown	Point location, ¼ section	unknown	140	0
Miller Mine	15.9	1882	1883	Unmapped, extent approx.	unknown	unknown	0
Moore Coal Co.	3.2	unknown	1926	Surveyed map	longwall	unknown	1
no name	0.7	unknown	unknown	Surveyed map, poor location	unknown	unknown	1
None	7.5	unknown	unknown	Surface	surface	unknown	0
Norris Brothers Coal Co.	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
Norris Coal Company	1.1	unknown	unknown	Surveyed map	room and pillar	unknown	1
Norwood Coal And Mining Co. No.1	0	1901	1903	Point location, ¼ section	room and pillar	unknown	0
Norwood-White Coal Co. Mine No. 1	321.7	1908	1911	Surveyed map	room and pillar	215	1
Norwood-White Coal Co. Mine No. 2	105.8	1908	1912	Surveyed map	room and pillar	unknown	1
Norwood-White Coal Co. Mine No. 3	292.8	1919	1926	Surveyed map	room and pillar	unknown	1
Norwood-White Coal Co. Mine No. 4	393.2	1911	1918	Surveyed map	room and pillar	170	2
Norwood-White Coal Co. Mine No. 5	186.7	1914	1920	Surveyed map	room and pillar	unknown	1
Norwood-White Coal Co. Mine No. 6	93.7	1919	1924	Surveyed map	room and pillar	unknown	1
Norwood-White Coal Co. Mine No. 8	2.7	1922	1943	Surveyed map	room and pillar	210	1
Norwood-White Coal Co. Mine No. 8	636.3	1922	1943	Surveyed map	room and pillar	210	1
O. K. Coal Co.	9.3	1903	1906	Surveyed map	room and pillar	unknown	1
Old Clover Leaf Mine	3.9	1923	1925	Surveyed map	room and pillar	unknown	1
Pennsylvania Mine	0	1869	1896	Point location, ¼ section	room and pillar	unknown	0
Pioneer Coal Co.	114.8	1876	1896	Surveyed map	room and pillar	150	2
Pioneer Coal Co.	31.8	1940	1941	Surveyed map	room and pillar	100	7
Pittsburg Mine	0	unknown	1885	Point location, ¼ section	unknown	unknown	0
Pleasant Hill Coal Co.	0	unknown	unknown	Point location, ¼ section	unknown	68	0
Polk City Mine	0	1887	1897	Point location, w/in section	unknown	238	0
Preston Coal Co. (Schulz lease)	2.2	unknown	unknown	Surveyed map	room and pillar	unknown	1
Preston Coal Co. (seam	1.5	1926	1929	Surveyed map	room and	unknown	8

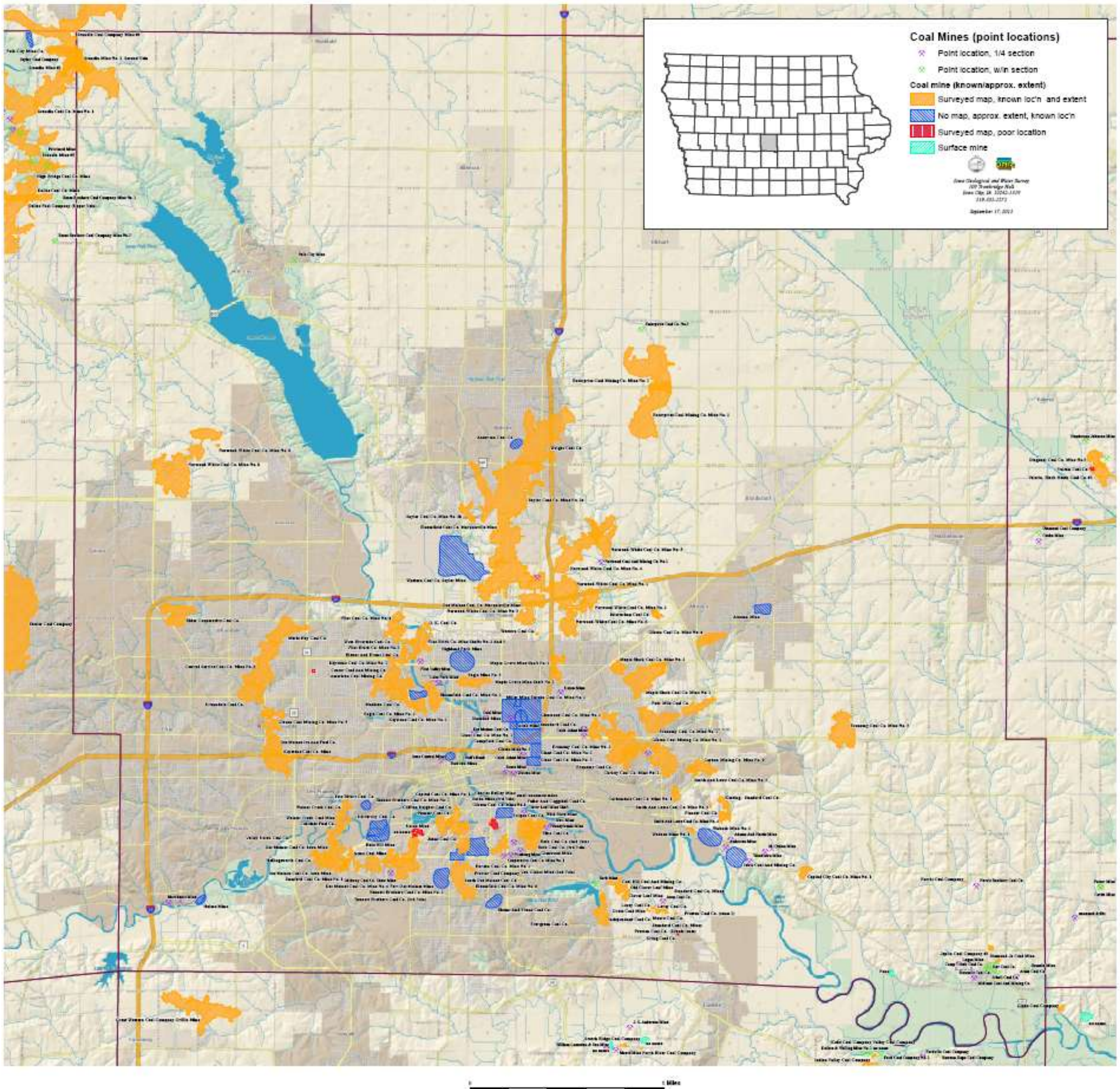
Mine Name	Acreage	First year of operation	Last year of operation	Data Type	Mining Method	Shaft Depth	No. maps
1)					pillar		
Proctor Coal Company	55.7	unknown	unknown	Unmapped, extent approx.	unknown	197	0
Ramsey Mine No. 2	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
Rawson Mine	24.6	unknown	unknown	Unmapped, extent approx.	unknown	unknown	0
Reese Mine	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
Rider Cooperative Coal Co.	186	1931	1939	Surveyed map	room and pillar	365	5
Rose Hill Mine	62	1889	1896	Unmapped, extent approx.	unknown	90	0
Runnells Coal Co.	0	1939	1942	Point location, w/in section	room and pillar	20	0
Samuel Dale Mine	0	1889	1893	Point location, ¼ section	unknown	100	0
Saylor Coal Co. Mine No. 2a	884.5	1906	1928	Surveyed map	room and pillar	unknown	1
Saylor Coal Co. Mine No. 2b	54.5	1906	1928	Surveyed map	room and pillar	unknown	1
Scandia Coal Company Mine #4	1470	unknown	unknown	Surveyed map	room and pillar	unknown	30
Scandia Mine #2	510.8	1912	1926	Surveyed map	room and pillar	unknown	1
Scandia Mine No. 2 Second Vein	136.3	1912	1926	Surveyed map	room and pillar	unknown	1
Schell Coal Co.	0	1939	1944	Point location, w/in section	room and pillar	20	0
Scott Mine	0	1908	unknown	Point location, ¼ section	unknown	unknown	0
Skandia Mine	0	unknown	unknown	Point location, w/in section	unknown	unknown	0
small unnamed mine	1	unknown	unknown	unknown	unknown	unknown	1
Smith And Lowe Coal Co. Mine No. 2	1.4	1902	1908	Surveyed map	room and pillar	110	1
Smith And Lowe Coal Co. Mine No. 3	18.3	1902	1908	Surveyed map	room and pillar	unknown	2
Smith And Lowe Coal Co. Mine No. 4	0	1903	1905	Point location, ¼ section	room and pillar	unknown	0
South Des Moines Coal Co.	203.7	1912	1922	Surveyed map	longwall, room and pillar	unknown	6
Standard Coal Co.	73.1	unknown	unknown	Unmapped, extent approx.	unknown	unknown	0
Standard Coal Co. Mines	1.3	1933	1936	Surveyed map	room and pillar	unknown	1
Standard Coal Co. Mines	2.2	1929	1933	Surveyed map	room and pillar	unknown	1
Stanford Coal Co. Mine No. 1	15.1	1931	1932	Surveyed map	room and pillar	unknown	3
Star Coal Co.	0	unknown	unknown	Point location, w/in section	unknown	unknown	0
Swanwood Coal Co.	0	1908	1910	Point location, ¼ section	room and pillar	unknown	0
Two Rivers Coal Co.	29.5	unknown	unknown	Unmapped, extent approx.	unknown	unknown	0
Union Mine	18.4	1894	1894	Surveyed map,	room and	unknown	2

Mine Name	Acreage	First year of operation	Last year of operation	Data Type	Mining Method	Shaft Depth	No. maps
				poor location	pillar		
Union Mine	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
Union Mine (3rd Vein)	20.7	1887	1894	Surveyed map, poor location	room and pillar	150	1
University Coal Co.	86.9	unknown	unknown	Unmapped, extent approx.	room and pillar	unknown	0
unnamed	1	unknown	unknown	unknown	unknown	unknown	0
Urbandale Coal Co.	146.4	1920	1942	Surveyed map	room and pillar	180	2
Valley-Union Coal Co.	0.6	1906	1912	Surveyed map	room and pillar	150	3
Van Ginkel Mine (2nd Vein)	57.5	1885	1897	Surveyed map	room and pillar	75	3
W. V. Stoughtenberg Mine	0	1889	1894	Point location, w/in section	unknown	unknown	0
Wabash Mine No. 1	6.8	unknown	unknown	Surveyed map	room and pillar	unknown	1
Wabash Mine No. 2	129.5	1886	unknown	Unmapped, extent approx.	unknown	100	0
Walnut Creek Coal Co.	2	1905	1910	Surveyed map	room and pillar	150	2
Walnut Creek Coal Mine	5.1	1885	1894	Surveyed map	longwall, room and pillar	140	1
Watson Mine	0	1866	1876	Point location, ¼ section	unknown	40	0
West Riverside Coal Co.	52.7	1894	1911	Surveyed map	room and pillar	160	2
Western Coal Co.	1.8	1896	1902	Surveyed map	room and pillar	unknown	1
Western Coal Co. Saylor Mine	587.6	1898	1910	Unmapped, extent approx.	room and pillar	216	1
Wild Rose Mine	18.8	1899	1899	Surveyed map	room and pillar	unknown	1
Woodlawn Mine	0	unknown	unknown	Point location, ¼ section	unknown	unknown	0
Wright Coal Co.	703.4	1910	1924	Surveyed map	room and pillar	unknown	1

Source: Iowa Department of Natural Resources

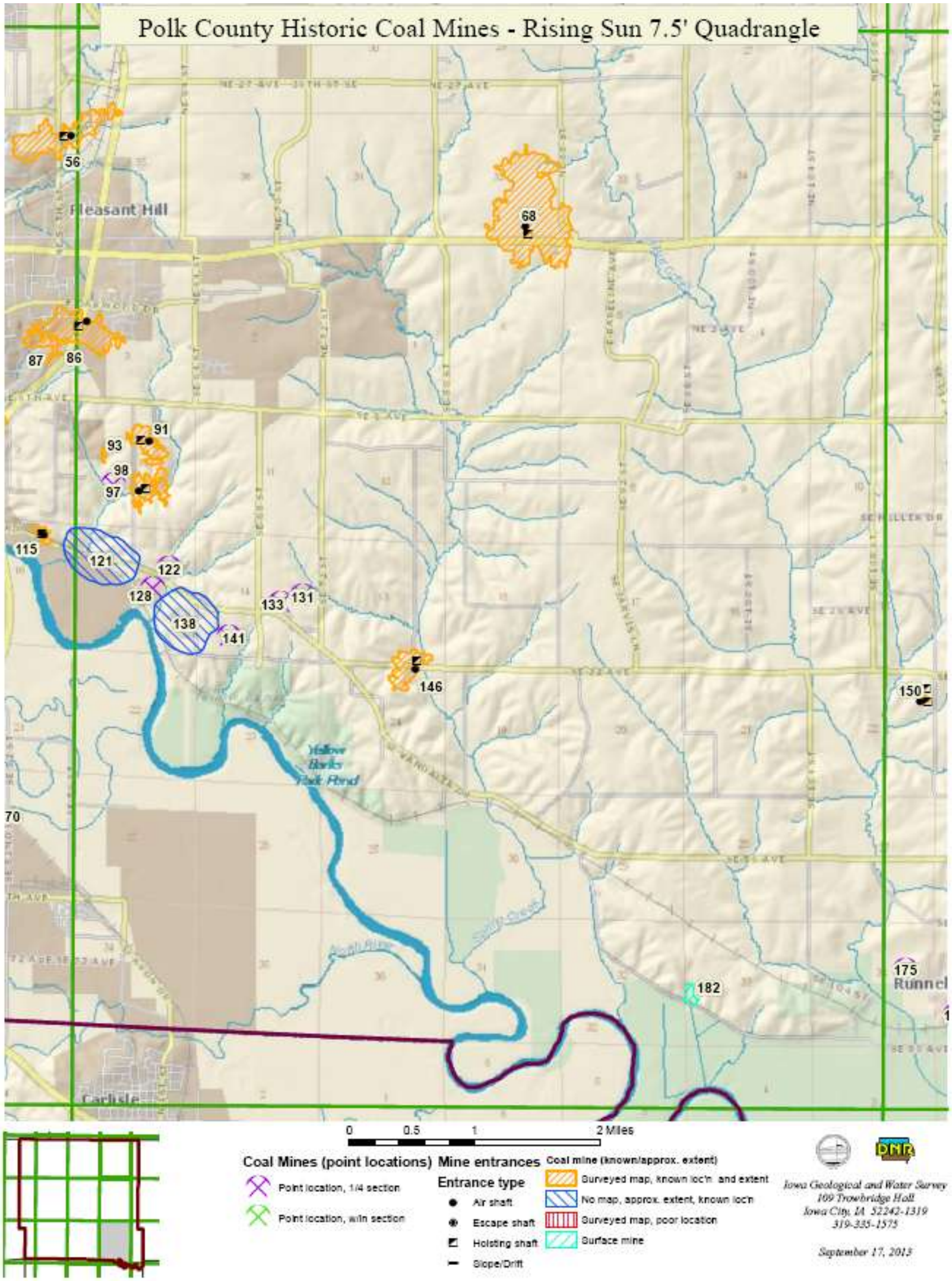
The map in **Figure 3.87** shows all the specific historic coal mining areas that are listed in **Table 3.77** that could potentially be susceptible to sinkhole. **Figure 3.88**, **Figure 3.89**, **Figure 3.90**, **Figure 3.91**, and **Figure 3.92** that follow are detailed quadrangle maps with the specific mining areas identified.

Figure 3.87. Polk Countywide Map of Historic Coal Mines



Source: Iowa Department of Natural Resources,

Figure 3.88. Polk County Historic Coal Mines – Rising Sun Quadrangle



Source: Iowa Department of Natural Resources

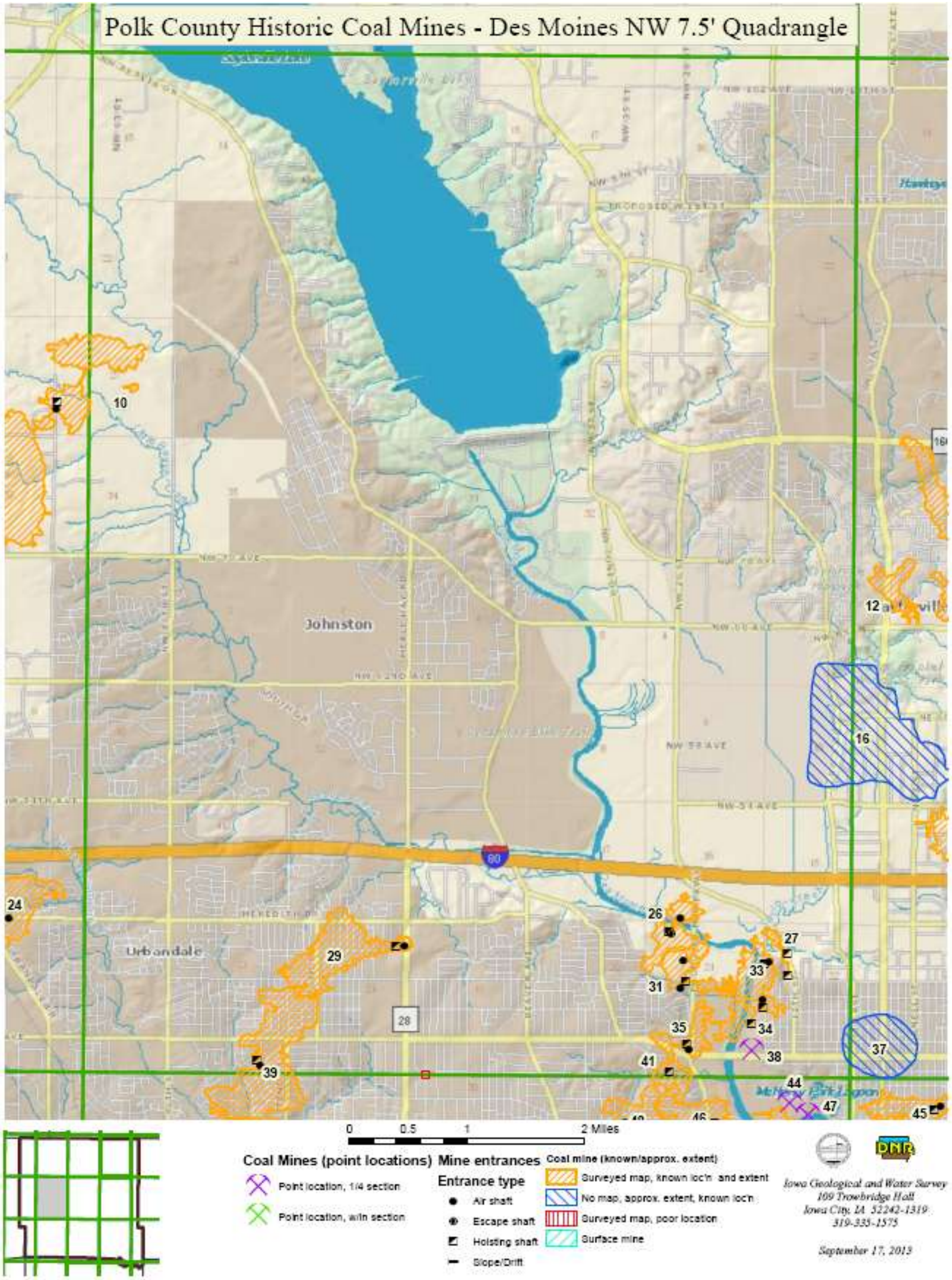
Table 3.78 lists the corresponding coal mine number from the Rising Sun Quadrangle Map above.

Table 3.78. Corresponding Coal Mine Number on Rising Sun Quadrangle Map

Map No.	Mine Name	Acreage
146	Capital City Coal Co. Mine No. 1	35.4
56	Four Mile Coal Co.	86.3
68	Economy Coal Co. Mine No. 3	277.8
86	Carbon Mining Co. Mine No. 9	88.2
91	Keating - Stanford Coal Co.	29.4
93	Smith And Lowe Coal Co. Mine No. 2	1.3
97	Smith And Lowe Coal Co. Mine No. 4	unknown
98	Pioneer Coal Co.	31.4
121	Wabash Mine No. 2	129.5
122	Adams And Hastie Mine	unknown
128	Anderson Mine	unknown
131	J. M. Christy Mine	unknown
133	M. Quinn Mine	unknown
138	Iowa Coal And Mining Co.	127.9
141	Woodlawn Mine	unknown
182	None	7.5

Source: Iowa Department of Natural Resources

Figure 3.89. Polk County Historical Mines – Des Moines NW Quadrangle



Source: Iowa Department of Natural Resources

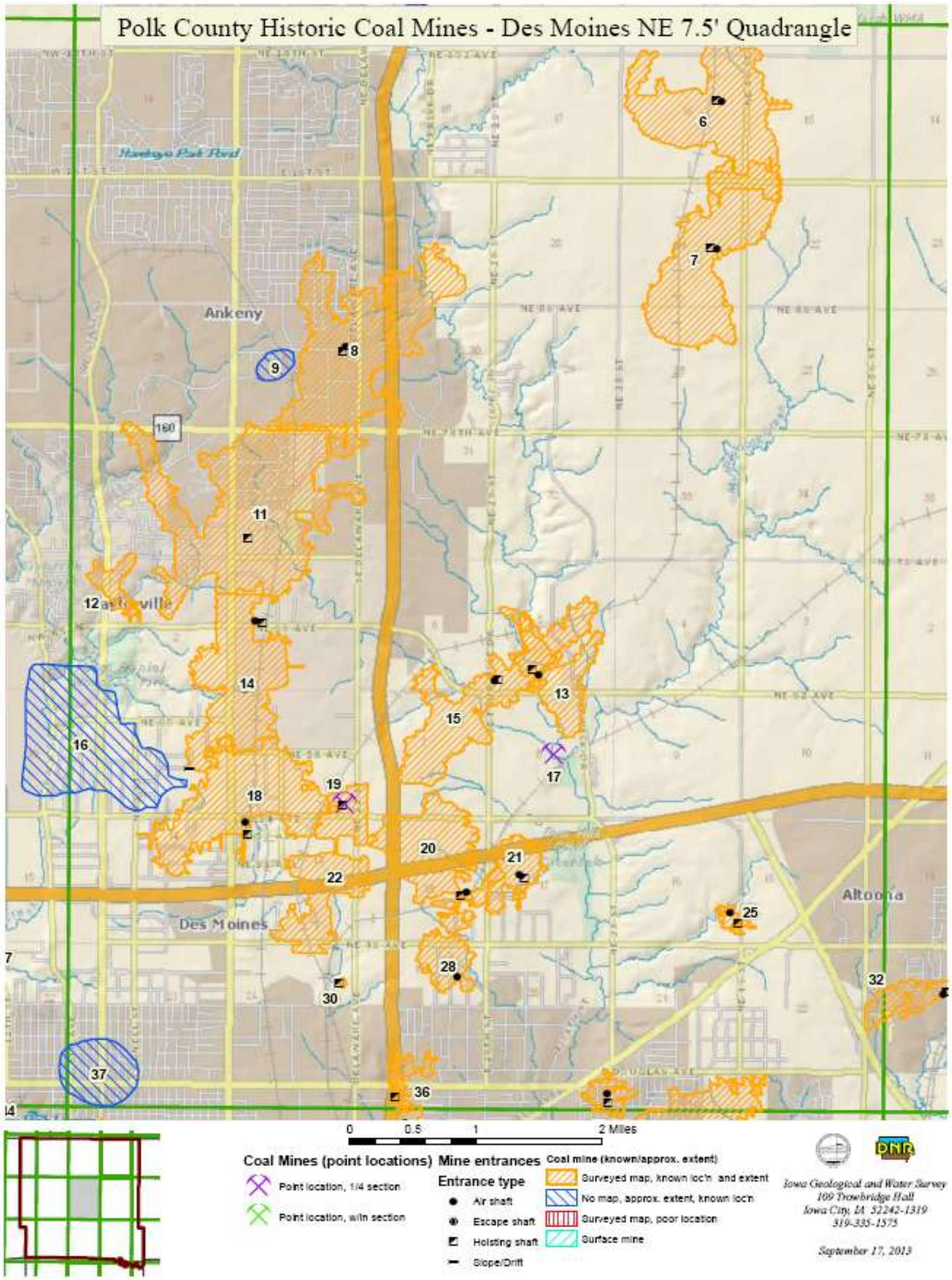
Table 3.79 lists the corresponding coal mine number from the Des Moines NW Quadrangle Map above.

Table 3.79. Corresponding Coal Mine Number from Des Moines NW Quadrangle Map

Map No.	Mine Name	Acreage
10	Norwood-White Coal Co. Mine No. 8	690.3
10	Norwood-White Coal Co. Mine No. 8	690.3
16	Western Coal Co. Saylor Mine	587.4
26	Flint Coal Co. Mine No. 4	88
27	O. K. Coal Co.	8.4
29	Merle Hay Coal Co.	188.9
31	West Riverside Coal Co.	53
33	Flint Brick Co. Mine Shafts No. 2 And 3	90.2
34	Flint Brick Co. Mine No. 1	37
35	Blount And Evans Coal Co.	51.9
37	Highland Park Mine	168.1
38	Flint Valley Mine	1
39	Central Service Coal Co. Mine No. 6	365.4
41	Keystone Coal Co. Mine No. 1	31

Source: Iowa Department of Natural Resources

Figure 3.90. Polk County Historical Mines – Des Moines NE Quadrangle



Source: Iowa Department of Natural Resources

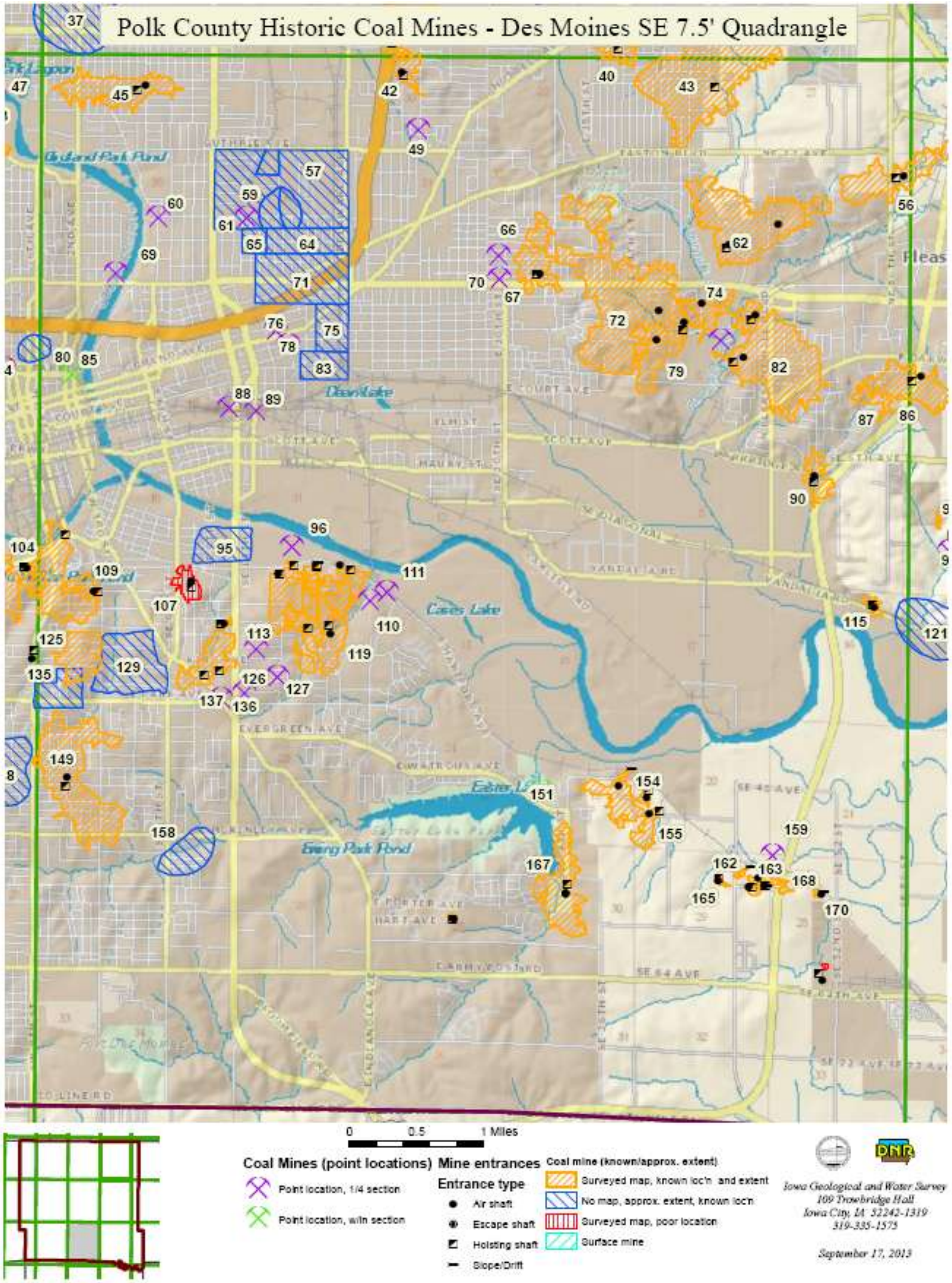
Table 3.80 lists the corresponding coal mine number from the Des Moines NE Quadrangle Map above.

Table 3.80. Corresponding Coal Mine Number from Des Moines NE Quadrangle Map

Map No.	Mine Name	Acreage
6	Enterprise Coal Mining Co. Mine No. 1	568.3
7	Enterprise Coal Mining Co. Mine No. 2	446.2
8	Wright Coal Co.	723.6
9	Anderson Coal Co.	34.5
11	Saylor Coal Co. Mine No. 2a	955.4
12	Saylor Coal Co. Mine No. 2b	65.0
13	Norwood-White Coal Co. Mine No. 5	216.8
14	Bloomfield Coal Co. Marquisville Mine	195.8
15	Norwood-White Coal Co. Mine No. 4	443.9
16	Western Coal Co. Saylor Mine	587.4
17	Norwood Coal And Mining Co. No.1	unknown
18	Des Moines Coal Co. Marquisville Mine	474.7
19	Swanwood Coal Co.	unknown
20	Norwood-White Coal Co. Mine No. 1	311.7
21	Norwood-White Coal Co. Mine No. 2	109.6
22	Norwood-White Coal Co. Mine No. 3	302.3
25	Interurban Coal Co.	18.2
28	Norwood-White Coal Co. Mine No. 6	107.9
30	Western Coal Co.	1.8
32	Gibson Coal Co. Mine No. 4	88.2
36	Maple Grove Mine Shaft No. 2	34.8
37	Highland Park Mine	168.1
40	Maple Block Coal Co. Mine No. 2	52.2
42	Maple Grove Mine Shaft No. 1	34.7
43	Maple Block Coal Co. Mine No. 1	331.2

Source: Iowa Department of Natural Resources

Figure 3.91. Polk County Historical Mines – Des Moines SE Quadrangle



Source: Iowa Department of Natural Resources

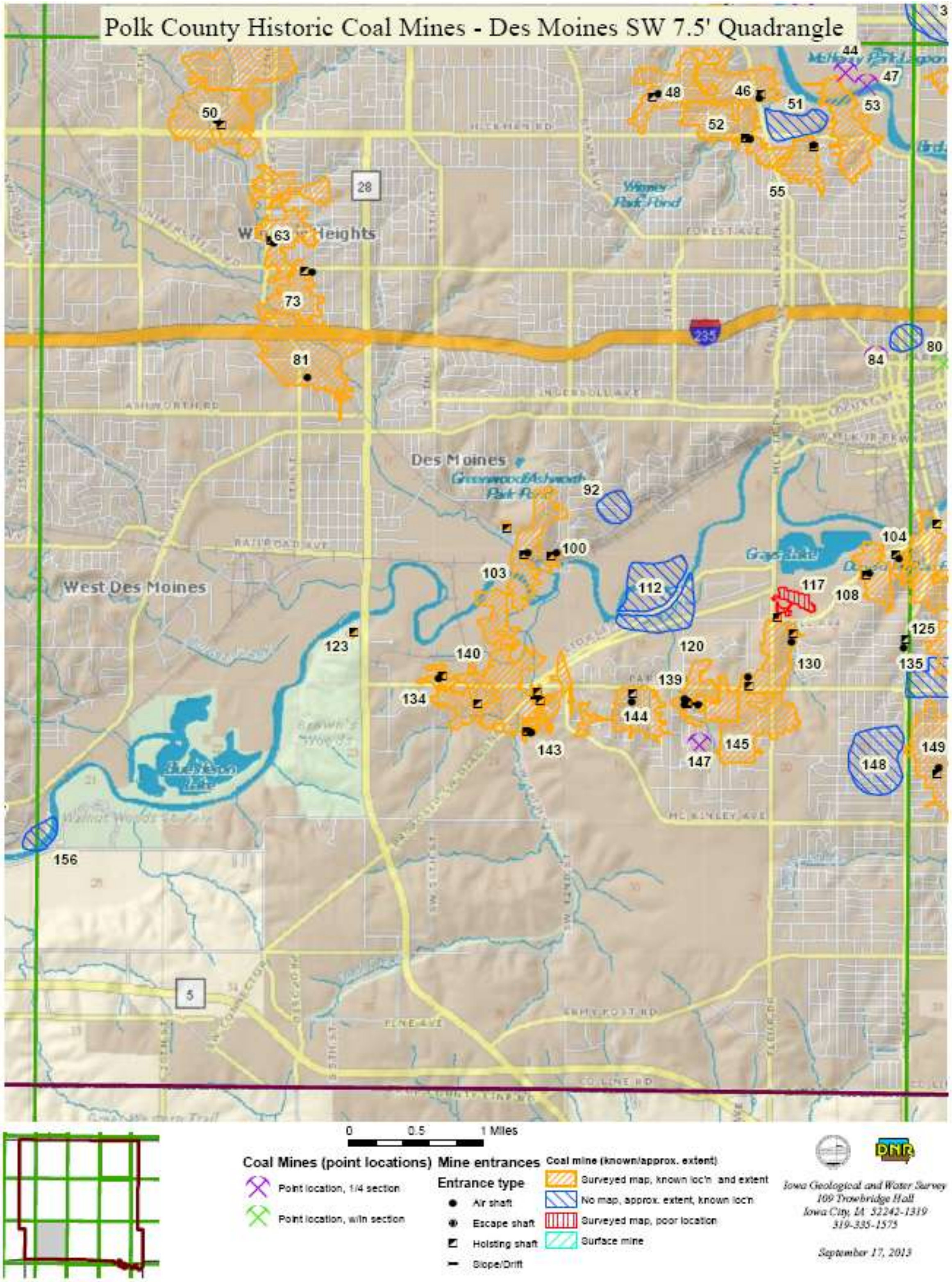
Table 3.81 lists the corresponding coal mine number from the Des Moines SE Quadrangle Map above.

Table 3.81. Corresponding Coal Mine Number from Des Moines SE Quadrangle Map

Map No.	Mine Name	Acreage
40	Maple Block Coal Co. Mine No. 2	52.2
42	Maple Grove Mine Shaft No. 1	34.7
43	Maple Block Coal Co. Mine No. 1	331.2
45	Eagle Mine No. 3	83.3
49	Union Mine	unknown
54	Miller Mine	15.9
56	Four Mile Coal Co.	86.3
57	Eureka Coal Co. Mine No. 2	306.0
58	Atlas Mine	24.0
59	Diamond Mine	25.3
60	Dahl Mine	unknown
61	Extra Mine	unknown
62	Economy Coal Co. Mine No. 1	212.2
64	Standard Coal Co.	73.1
65	Campfield Coal Co.	21.1
66	Glenwood Coal Co. Mine No. 3	unknown
67	Glenwood Coal Co. Mine No. 2	58.9
69	Des Moines Coal Co.	unknown
70	Caleb Johns Mine	unknown
71	Giant Coal Co. Mine No. 1	166.4
72	Economy Coal Co. Mine No. 2	371.5
74	Gibson Coal Mining Co. Mine No. 2	42.0
75	Giant Coal Co. Mine No. 2	54.4
76	Caleb Johns Mine	unknown
77	Ramsey Mine No. 2	unknown
78	Gibson Mine No. 3	unknown
79	Economy Coal Co.	76.6
80	Rawson Mine	24.6
82	Christy Coal Co. Mine No. 2	191.3
83	Giant Coal Co. Mine No. 3	47.6
85	Hall's Bank	0.0
86	Carbon Mining Co. Mine No. 9	88.2
87	Smith And Lowe Coal Co. Mine No. 3	18.5
88	Reese Mine	unknown
89	Watson Mine	unknown
90	Carbondale Coal Co. Mine No. 1	27.8
95	Gibson Coal Co. Mine No.1	66.4
96	Clover Leaf Mine Shaft	unknown
99	Charles Reilley Mine	unknown
101	small unnamed mine	unknown
102	Fuller And Coggshell Coal Co.	7.2
104	Pioneer Coal Co.	120.1
105	Johns Coal Co.	18.3
106	Wild Rose Mine	20.1
107	Union Mine (3rd Vein)	21.6
109	Capital Coal Co. Mine No. 1	13.1
110	Elko Coal Co.	37.5
111	Scott Mine	unknown
113	Eclipse Coal Co.	62.0
114	Pennsylvania Mine	unknown
115	Wabash Mine No. 1	6.7
118	Beck Coal Co. (3rd Vein)	24.7
119	Beck Coal Co. (2nd Vein)	77.4
121	Wabash Mine No. 2	129.5
124	Des Moines Coal Co. Mine No. 1	unknown
125	Bloomfield Coal Co. Mine No. 6	58.2
126	Van Ginkel Mine (2nd Vein)	54.3
127	Glenwood Mine	10.7
129	Eureka Coal Co. Mine No. 1	130.4
132	Pleasant Hill Coal Co.	unknown
135	Proctor Coal Company	55.7
136	Pittsburg Mine	unknown
137	Cooperative Coal Co. Mine No. 1	unknown
149	South Des Moines Coal Co.	220.4
151	Beck Mine	unknown
152	Old Clover Leaf Mine	3.9
154	Coal Hill Coal And Mining Co.	42.0
155	Clover Leaf Mine	17.9
158	Blount And Evans Coal Co.	62.2
159	Avon Coal Co.	unknown
162	Levey Coal Co.	1.7
163	Levey Coal Co.	2.0
164	Standard Coal Co. Mines	2.1
165	Gross Coal Mine	1.6
166	Standard Coal Co. Mines	1.3
167	Independant Coal Co.	101.3
168	Preston Coal Co. (Schulz lease)	0.0
169	Moore Coal Co.	3.1
170	Preston Coal Co. (seam 1)	1.4
171	Evergreen Coal Co.	3.2
172	Kring Coal Co.	0.3

Source: Iowa Department of Natural Resources

Figure 3.92. Polk County Historical Mines – Des Moines SW Quadrangle



Source: Iowa Department of Natural Resources

Table 3.82 lists the corresponding coal mine number from the Des Moines SW Quadrangle Map above.

Table 3.82. Corresponding Coal Mine Number on Des Moines SW Quadrangle Map

Map No.	Mine Name	Acreage
39	Central Service Coal Co. Mine No. 6	365.4
41	Keystone Coal Co. Mine No. 1	31.0
44	Cooperative Coal Co.	unkn
46	Center Coal And Mining Co.	82.6
47	Lake Park Mine	unkn
48	American Coal Mining Co.	86.2
50	Urbandale Coal Co.	136.1
51	Keystone Coal Co. Mine No. 2	49.1
52	Madison Coal Co.	100.9
53	Bloomfield Coal Co. Mine No. 2	105.1
55	Eagle Coal Co. Mine No. 2	45.3
63	Gibson Coal Mining Co. Mine No. 5	126.7
73	Des Moines Ice And Fuel Co.	66.1
80	Rawson Mine	24.6
81	Keystone Coal Co. Mine	200.4
84	Iowa Central Mine	unkn
92	Two Rivers Coal Co.	29.5
94	Walnut Creek Coal Co.	1.8
100	Walnut Creek Coal Mine	13.2
103	Coaldale Fuel Co.	136.3
104	Pioneer Coal Co.	120.1
105	Johns Coal Co.	18.3
108	Cliffton Heights Coal Co.	55.6
112	University Coal Co.	86.8
116	no name	0.7
117	Union Mine	15.1
120	Rose Hill Mine	62.0
123	Valley-Union Coal Co.	0.2
130	Bennett Brothers Coal Co. Mine No. 1	79.5
134	Hollingsworth Coal Co.	5.5
135	Proctor Coal Company	55.7
139	Bennett Brothers Coal Co. (3rd Vein)	41.6
140	Des Moines Coal Co. Iowa Mine	224.1
142	Acme Coal Mine	34.2
143	Stanford Coal Co. Mine No. 1	14.6
144	Des Moines Coal Co. Mine No. 4	90.0
145	Bennett Brothers Coal Co. Mine No. 2	114.5
147	Midway Coal Co. Shaw Mine	unkn
148	Fort Des Moines Mine	108.7
149	South Des Moines Coal Co.	220.4
156	Hulme Mine	26.7

Source: Iowa Department of Natural Resources

The map in **Figure 3.93** depicts landslide susceptibility and incidents rates in Iowa according to the Iowa Department of Natural Resources. This shows that all of Polk County has a moderate susceptibility and moderate incident rate of landslide.

Figure 3.93. Landslide Susceptibility and Incident Rates in Iowa

Source: Iowa Department of Natural Resources

Previous Occurrences

According to the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation (DSC—IDALS) they have had a total of eight investigations of sinkholes in Polk County with only two being related to underground coal mining.

In the city of Runnells, the Mayor stated that over the last 20 years, multiple sinkholes have appeared in a field on the east side of town where two entrances to mines were located.

May 30, 2013—Sinkhole in Runnells in a residential front yard was 10 feet deep and 10 feet wide eroded around a power pole. The sinkhole was caused by an old septic tank.

July 28, 2010—Sinkhole on property near Runnells see **Figure 3.94.**

Figure 3.94. Photo of Sinkhole Near Runnells, July 28, 2010

Source: Photo courtesy of DSC—IDALS

1980s—Sinkhole in east side of Runnells that was 25 feet in diameter and it caved in a portion of two residential roads. No homes were impacted in the incident.

Probability of Future Occurrence
Historically, there have only been eight documented investigations of sinkholes in the planning area.

The HMPC determined the probability of future occurrence of sinkholes and landslide in the planning area to be less than 10 percent.

Probability Score: 1—Unlikely

Vulnerability

Vulnerability Overview
There will be sinkholes that continue to be found in the planning area, but the damages have been relatively minimal.

Intense rainfall events may cause landslides in the planning area, but the damages are again minimal and not widespread.

Magnitude Score: 1—Negligible

Potential Losses to Existing Development
Since Polk County is considered a low karst area according to Iowa Department of Natural Resources, sinkholes are not prevalent from erosion of subsurface limestone, but are possible from the extensive abandoned coal mines to affect existing development.

Due to the lack of information regarding previous occurrences of this hazard, it is not possible to estimate potential losses.

Future Development

Future development over abandoned coal mines will increase vulnerability to this hazard. The probability for Runnells was rated higher as an Occasional because of the sinkholes in the past.

Table 3.83. Sinkhole and Landslide Hazard Summary by Jurisdiction

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	1	1	4	1	1.45	Low
Cities						
City of Alleman	1	1	4	1	1.45	Low
City of Altoona	1	1	4	1	1.45	Low
City of Ankeny	1	1	4	1	1.45	Low
City of Bondurant	1	1	4	1	1.45	Low
City of Clive	1	1	4	1	1.45	Low
City of Des Moines	1	1	4	1	1.45	Low
City of Elkhart	1	1	4	1	1.45	Low
City of Grimes	1	1	4	1	1.45	Low
City of Johnston	1	1	4	1	1.45	Low
City of Mitchellville	1	1	4	1	1.45	Low
City of Pleasant Hill	1	1	4	1	1.45	Low
City of Polk City	1	1	4	1	1.45	Low
City of Runnells	2	1	4	1	1.90	Low
City of Urbandale	1	1	4	1	1.45	Low
City of West Des Moines	1	1	4	1	1.45	Low
City of Windsor Heights	1	1	4	1	1.45	Low
Des Moines Water Works	1	1	4	1	1.45	Low
School Districts						
Ankeny, 261	1	1	4	1	1.45	Low
Bondurant-Farrar, 720	1	1	4	1	1.45	Low
Dallas Center-Grimes, 1576	1	1	4	1	1.45	Low
Des Moines Independent, 1737	1	1	4	1	1.45	Low
Johnston, 3231	1	1	4	1	1.45	Low
North Polk, 4779	1	1	4	1	1.45	Low
Saydel, 5805	1	1	4	1	1.45	Low
Southeast Polk, 6101	1	1	4	1	1.45	Low
Urbandale, 6579	1	1	4	1	1.45	Low
West Des Moines	1	1	4	1	1.45	Low

3.4.15 Structural Fire

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	2	4	1	3.10	Moderate

Profile

Hazard Description

A structural or urban fire is an uncontrolled fire in populated area that threatens life and property and is beyond normal day-to-day response capabilities. Modern fire codes and fire suppression requirements in new construction and building renovations, coupled with improved firefighting equipment, training, and techniques, lessen the chance and impact of a major urban fire. Structures in areas served by older, smaller, or otherwise inadequate water distribution infrastructure such as water mains and hydrants are also at significant risk.

Warning Time Score: 4—Minimal or no warning

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

With modern training, equipment, fire detection devices, and building regulations and inspections, most fires are quickly contained and limited to the immediate structure involved. Certain circumstances, such as the involvement of highly combustible materials or high winds, can threaten a larger area. The age and density of a particular neighborhood can also make it more vulnerable to fire due to the spreading of fire from neighboring structures. Most urban fires occur in residential structures, but the occurrence of a fire in a commercial or industrial facility could affect more people and pose a greater threat to those near the fire or fighting the fire because of the size or contents of the structures involved.

Figure 3.56 in Grass and Wildland Fire Section shows the boundaries of Polk County Fire Agencies.

Previous Occurrences

Structural fires are almost a daily occurrence in some of the jurisdictions. Dozens are major fires totally destroying the structures in which they occur.

The National Fire Incident Reporting System (NFIRS) is a repository of statistical data submitted by reporting fire departments. **Table 3.84**, **Table 3.85**, and **Table 3.86** below show the number of fire reports received, the number of structure fires, total incident property loss, incident content loss, civilian injury and deaths from 2012 – 2010 submitted by reporting fire departments located in Polk County. It is unknown, based on the statistical data available if any of these structural fires were beyond normal day-to-day response capabilities.

Several of the fire departments located in Polk County have jurisdictional boundaries outside Polk County (Clive, Des Moines, Grimes, Mitchellville, Urbandale, and West Des Moines) and the NFIRS data includes fires reported by fire departments that occurred in their entire jurisdictional area. In addition, there is the opposite situation where fire departments are based in neighboring counties and have portions of their jurisdictional boundaries that overlap into Polk County. Fire departments with this situation include: Madrid, Slater, Maxwell, Granger, Carlisle, Northern Warren, and Norwalk Fire Departments. Their NFIRS data is not included in this analysis since the majority of their coverage areas are in adjacent counties.

Table 3.84. NFIRS Historical Data for Polk County Fire Departments, 2012

FDID	Fire Departments	2012 Total Reports Received	2012 Total Structure Fires Reported	Total Incident Property Loss	Total Incident Content Loss	Incident Civilian Injury	Incident Civilian Death
77002	Altoona Fire Department	1,699	35	$27,000	$38,450	0	0
77003	Ankeny Fire Department	3,304	61	$488,099	$241,999	1	0
77005	Bondurant Fire Department	323	10	$0	$0	0	0
77006	Clive Fire Department	1,046	27	$9,643	$500	0	0
77007	Delaware Twp Fire Department	432	31	$107,656	$20,100	0	0
77008	Des Moines Fire Department	20,164	335	$3,666,563	$1,158,072	21	3
77009	Elkhart Fire Department	87	9	$7,000	$45,000	0	0
77010	Grimes Fire Department	740	15	$210,750	$81,200	1	0
77011	Johnston Fire Department	1,099	31	$256,000	$151,000	0	0
77012	Mitchellville Fire Department	0	0	$0	$0	0	0
77013	Pleasant Hill Fire Department	829	28	$54,400	$36,000	1	0
77014	Polk City Fire Department	363	12	$0	$1,000	0	0
77015	Runnells Fire Department	0	0	$0	$0	0	0
77016	Saylor Twp Fire Department	735	25	$173,000	$82,500	0	0
77018	Urbandale Fire Department	2,605	53	$452,921	$111,945	0	0
77019	West Des Moines Fire Department	2,467	70	$1,441,400	$193,660	1	0
77020	Windsor Heights Fire Department	0	0	$0	$0	0	0
	Total	**35,927**	**742**	**$6,894,432**	**$2,161,426**	**25**	**3**

Source: NFIRS data from the Iowa Fire Marshal Division. Note: “0” reflects that the Fire Department did not report to NFIRS.

Table 3.85. NFIRS Data from Polk County Fire Department, 2011

FDID	Fire Departments	2011 Total Reports Received	2011 Total Structure Fires Reported	Total Incident Property Loss	Total Incident Content Loss	Incident Civilian Injury	Incident Civilian Death
77002	Altoona Fire Department	1,593	44	$790,500	$321,179	0	0
77003	Ankeny Fire Department	2,430	47	$129,502	$30,802	0	0
77005	Bondurant Fire Department	0	0	$0	$0	0	0
77006	Clive Fire Department	1,355	43	$783,750	$256,000	0	0
77007	Delaware Twp Fire Department	322	13	$168,500	$11,500	1	0
77008	Des Moines Fire Department	19,748	332	$9,384,256	$3,941,975	26	0
77009	Elkhart Fire Department	102	4	$0	$0	0	0
77010	Grimes Fire Department	498	20	$45,000	$20,100	0	0
77011	Johnston Fire Department	1,154	34	$417,200	$55,750	0	0
77012	Mitchellville Fire Department	0	0	$0	$0	0	0

FDID	Fire Departments	2011 Total Reports Received	2011 Total Structure Fires Reported	Total Incident Property Loss	Total Incident Content Loss	Incident Civilian Injury	Incident Civilian Death
77013	Pleasant Hill Fire Department	738	24	$0	$0	0	0
77014	Polk City Fire Department	154	13	$75,200	$25,000	0	0
77015	Runnells Fire Department	166	11	$476,800	$106,000	0	0
77016	Saylor Twp Fire Department	802	13	$100,000	$0	0	0
77018	Urbandale Fire Department	2,489	60	$839,158	$353,674	2	1
77019	West Des Moines Fire Department	2,593	81	$1,486,400	$324,050	0	0
77020	Windsor Heights Fire Department	0	0	$0	$0	0	0
	Total	**34,144**	**739**	**$14,696,266**	**$5,446,030**	**29**	**1**

Source: NFIRS data from the Iowa Fire Marshal Division. Note: “0” reflects that the Fire Department did not report to NFIRS.

Table 3.86. NFIRS Data from Polk County Fire Department, 2010

FDID	Fire Departments	2010 Total Reports Received	2010 Total Structure Fires Reported	Total Incident Property Loss	Total Incident Content Loss	Incident Civilian Injury	Incident Civilian Death
77002	Altoona Fire Department	1,417	57	$1,017,000	$1,536,000	0	0
77003	Ankeny Fire Department	2,339	48	$372,500	$265,450	0	1
77005	Bondurant Fire Department	0	0	$0	$0	0	0
77006	Clive Fire Department	2	0	$0	$0	0	0
77007	Delaware Twp Fire Department	29	1	$0	$0	0	0
77008	Des Moines Fire Department	15,516	245	$4,624,300	$1,820,630	19	1
77009	Elkhart Fire Department	73	3	$0	$0	0	0
77010	Grimes Fire Department	555	13	$33,700	$0	0	0
77011	Johnston Fire Department	933	23	$27,750	$20,200	0	0
77012	Mitchellville Fire Department	0	0	$0	$0	0	0
77013	Pleasant Hill Fire Department	862	25	$275,000	$25,000	0	0
77014	Polk City Fire Department	91	9	$0	$0	0	0
77015	Runnells Fire Department	0	0	$0	$0	0	0
77016	Saylor Twp Fire Department	647	11	$0	$0	0	0
77018	Urbandale Fire Department	2,179	33	$118,502	$45,935	0	0
77019	West Des Moines Fire Department	2,307	70	$876,400	$65,000	1	0
77020	Windsor Heights Fire Department	462	14	$0	$0	0	0
	Total	**27,413**	**552**	**$7,345,152**	**$3,778,215**	**20**	**2**

Source: NFIRS data from the Iowa Fire Marshal Division. Note: “0” reflects that the Fire Department did not report to NFIRS.

Figure 3.95. Structure Fire in Pleasant Hill, IA on May 28, 2010

Source: Polk County Emergency Management, 2013

Probability of Future Occurrence

Much of the fire prevention efforts by the municipalities participating in this plan have gone into prevention of nonresidential fires and the results have been highly effective. However, even with an increase in the prevention efforts in residential fires, both residential and nonresidential fires will continue to occur. During colder months, clogged chimneys and faulty furnaces and fire places can increase the probability of structural fires. Based on previous occurrences, there is a 100 percent chance that there will be structural fires in Polk County in any given year.

Probability Score: — 4 “Highly Likely”

Vulnerability

Overview

All Fire Departments respond to structural fires on a regular basis.

Iowa is a home rule state. As a result, cities and counties may enact any law governing their local affairs unless such law is inconsistent with a state law. The State Fire Code with amendments is based on the International Fire Code (IFC) Chapters 2-7 and the 2009 International Building Code (IBC). The following jurisdictions in the planning area have adopted the IFC and IBC thus reducing structural vulnerability and susceptibility to fire.

Table 3.87. Polk County Jurisdictions Adoption of IFC and IBC

Jurisdictions	Adopted IFC	Adopted IBC
Polk County	✓	✓
City of Alleman		
City of Altoona	✓	✓
City of Ankeny	✓	✓
City of Bondurant	✓	✓
City of Clive	✓	✓
City of Des Moines	✓	✓
City of Elkhart		
City of Grimes	✓	✓
City of Johnston		

Jurisdictions	Adopted IFC	Adopted IBC
City of Mitchellville		
City of Pleasant Hill		
City of Polk City		
City of Runnells		
City of Urbandale	✓	✓
City of West Des Moines	✓	✓
City of Windsor Heights	✓	✓

Magnitude Score: 2—Limited

Potential Losses to Existing Development

NFIRS categorizes reported structure fires by property type. **Table 3.88** lists the property types of the structure fires from 2012-2010. There were a total of 2,033 fires over this three year timeframe with an average of 678 fires per year. The majority of the fires were to residential structures, storage facilities, businesses and assembly locations. There were fewer structure fires reported in 2010. This may be due to less data reported, not actually less structure fires.

Table 3.88. Polk County Fire Department Responses to Number of Structure Fires Reported by Property Types, 2012-2010.

NFIRS Category	NFIRS Property Type	2012	2011	2010
100	Assembly	21	22	21
200	Educational	13	14	13
300	Health Care, Detention, & Correction	10	6	6
400	Residential	421	437	285
500	Mercantile, Business	24	21	20
600	Industrial, Utility, Defense, Agriculture, Mining	2	1	3
700	Manufacturing, Processing	9	9	5
800	*Storage*	28	35	20
900	Outside or Special Property	15	12	8
NNN	Unknown/Undetermined/NA	199	182	171
	Total	**742**	**739**	**552**

Source: NFIRS data from the Iowa Fire Marshal Division

The total estimated property and contents damage reported to NFIRS from 2012-2010 is $40,321,521 which averages to $13,440,507 in damages each year. There were six civilian deaths and 74 civilian injuries reported during this timeframe. Thus there is the potential for structure fire damages, deaths and injuries in the future based on this historical NFIRS data.

Structural Fire Hazard Summary by Jurisdiction
All jurisdictions within the planning area are at risk to structural fire.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	4	2	4	1	3.10	High
Cities						
City of Alleman	4	2	4	1	3.10	High
City of Altoona	4	2	4	1	3.10	High
City of Ankeny	4	2	4	1	3.10	High
City of Bondurant	4	2	4	1	3.10	High
City of Clive	4	2	4	1	3.10	High
City of Des Moines	4	2	4	1	3.10	High
City of Elkhart	4	2	4	1	3.10	High
City of Grimes	4	2	4	1	3.10	High
City of Johnston	4	2	4	1	3.10	High
City of Mitchellville	4	2	4	1	3.10	High
City of Pleasant Hill	4	2	4	1	3.10	High
City of Polk City	4	2	4	1	3.10	High
City of Runnells	4	2	4	1	3.10	High
City of Urbandale	4	2	4	1	3.10	High
City of West Des Moines	4	2	4	1	3.10	High
City of Windsor Heights	4	2	4	1	3.10	High
Des Moines Water Works	4	2	4	1	3.10	High
School Districts						
Ankeny, 261	4	2	4	1	3.10	High
Bondurant-Farrar, 720	4	2	4	1	3.10	High
Dallas Center-Grimes, 1576	4	2	4	1	3.10	High
Des Moines Independent, 1737	4	2	4	1	3.10	High
Johnston, 3231	4	2	4	1	3.10	High
North Polk, 4779	4	2	4	1	3.10	High
Saydel, 5805	4	2	4	1	3.10	High
Southeast Polk, 6101	4	2	4	1	3.10	High
Urbandale, 6579	4	2	4	1	3.10	High
West Des Moines	4	2	4	1	3.10	High

3.4.16 Thunderstorm with Lightning and Hail

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	1	3	1	2.65	Moderate

Profile

Hazard Description
A thunderstorm is defined as a storm that contains lightning and thunder which is caused by unstable atmospheric conditions. When the upper air which is cold sinks and the warm moist air rises, storm clouds or 'thunderheads' develop resulting in thunderstorms. This can occur singularly, in clusters or in lines. At any given moment across the world, there are about 1,800 thunderstorms occurring. Severe thunderstorms most often occur in Iowa in the spring and summer, during the afternoon and evenings, but can occur at any time. The entire State of Iowa is at risk to the damaging effects of Thunderstorms, Hail, and Lightning. Other hazards associated with thunderstorms and lightning include: heavy rains causing flash flooding (discussed separately in **Section3.4.7**), tornadoes (discussed separately in **Section 3.4.17**), and windstorm (discussed further in **Section 3.4.18**).

Lightning

All thunderstorms produce lightning which often strikes outside of the area where it is raining and is known to fall more than 10 miles away from the rainfall area. Thunder is simply the sound that lightning makes. Lightning is a huge discharge of electricity. When lightning strikes, electricity shoots through the air causing vibrations and creating the sound of thunder. Nationwide, lightning kills 75 to 100 people each year. Lightning strikes can also start building fires, wildland fires, and damage electrical systems and equipment.

Hail

According to the National Oceanic and Atmospheric Administration (NOAA), hail is precipitation that is formed when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere causing them to freeze. The raindrops form into small frozen droplets and then continue to grow as they come into contact with super-cooled water which will freeze on contact with the frozen rain droplet. This frozen rain droplet can continue to grow and form hail. As long as the updraft forces can support or suspend the weight of the hailstone, hail can continue to grow.

At the time when the updraft can no longer support the hailstone, it will fall down to the earth. For example, a ¼" diameter or pea sized hail requires updrafts of 24 mph, while a 2 ¾" diameter or baseball sized hail requires an updraft of 81 mph. The largest hailstone recorded in the United States was found in Vivian, South Dakota on July 23, 2010, measuring eight inches in diameter, almost the size of a soccer ball. Soccer-ball-sized hail is the exception, but even small pea sized hail can do damage.

Hailstorms in Iowa cause damage to property, crops, and the environment and kill and injure livestock. In the United States, hail causes more than $1 billion in damage to property and crops each year. Much of the damage inflicted by hail is to crops. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are the other things most commonly damaged by hail. Hail has been known to cause injury to humans, occasionally fatal injury.

Based on information provided by the Tornado and Storm Research Organization, **Table 3.89** below describes typical damage impacts of the various sizes of hail.

Table 3.89. Tornado and Storm Research Organization Hailstorm Intensity Scale

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
Hard Hail	5-9	0.2-0.4	Pea	No damage
Potentially Damaging	10-15	0.4-0.6	Mothball	Slight general damage to plants, crops
Significant	16-20	0.6-0.8	Marble, grape	Significant damage to fruit, crops, vegetation
Severe	21-30	0.8-1.2	Walnut	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
Severe	31-40	1.2-1.6	Pigeon's egg > squash ball	Widespread glass damage, vehicle bodywork damage
Destructive	41-50	1.6-2.0	Golf ball > Pullet's egg	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
Destructive	51-60	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick walls pitted
Destructive	61-75	2.4-3.0	Tennis ball > cricket ball	Severe roof damage, risk of serious injuries
Destructive	76-90	3.0-3.5	Large orange > Soft ball	Severe damage to aircraft bodywork
Super Hailstorms	91-100	3.6-3.9	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
Super Hailstorms	>100	4.0+	Melon	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: Tornado and Storm Research Organization (TORRO), Department of Geography, Oxford Brookes University
Notes: In addition to hail diameter, factors including number and density of hailstones, hail fall speed and surface wind speeds affect severity.

The onset of thunderstorms with lightning and hail is generally rapid. Duration is less than 6 hours and warning time is generally 6 to 12 hours.

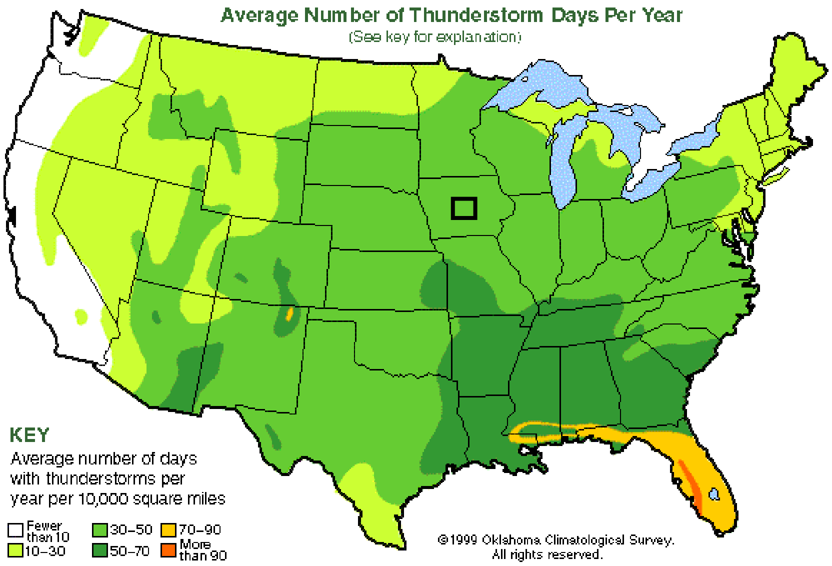
<u>Warning Time Score:</u> 3—6 — 12 hours

<u>Duration Score:</u> 1—less than 6 hours

Geographic Location/Extent

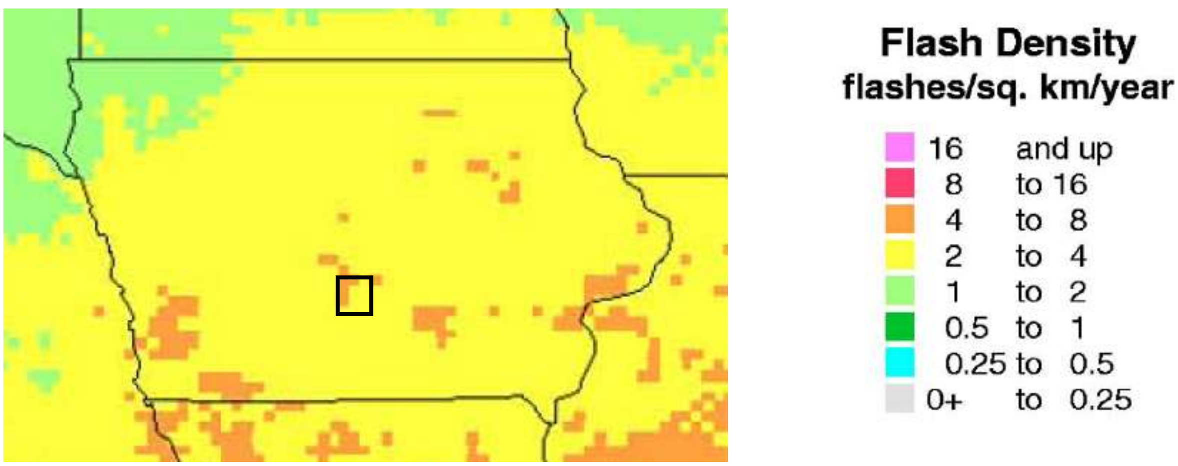
Thunderstorms and the associated hail and lightning impact the entire County with relatively similar frequency. Although, these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas. In addition, damages are more likely to occur in more densely developed urban areas. **Figure 3.96** provides the distribution and frequency of thunderstorms in the U.S. The entire state of Iowa has an average of 30-50 days with thunderstorms per year. **Figure 3.97** shows 2 to 8 lightning strikes per square kilometer per year with both yellow and orange shaded areas.

Figure 3.96. Distribution and Frequency of Thunderstorms



Note: Black Square indicates approximate location of Polk County

Figure 3.97. Location and Frequency of Lightning in Iowa



Source: National Weather Service, www.lightningsafety.noaa.gov/lightning_map.htm
Note: Black Square indicates approximate location of Polk County

Previous Occurrences

Since 1965, Polk County has been included in seven presidential disaster declarations for severe storms/severe weather (see **Table 3.90**). Some of the damages that resulted in the declarations were from windstorms that accompanied the severe weather.

Table 3.90. Presidential Disaster Declarations for Severe Storms/Severe Weather that included Polk County (2012-1965)

Disaster Number	Description	Declaration Date (Incident Period)	Individual Assistance (IA) Public Assistance (PA)
DR-1930	Severe Storms, Flooding, & Tornadoes	7-29-2010 (6-1-2010 to 8-31-3010)	IA & PA
DR-1763	Severe Storms, Tornadoes, & Flooding	5-27-2008 (5-25-2008 to 8-13-2008)	IA & PA
DR-1518	Severe Storms, Tornadoes, & Flooding	5-25-2004 (5-19-2004 to 6-24-2004)	IA & PA
DR-1230	Severe Weather, Tornadoes, & Flooding	7-2-1998 (6-13-1998 to 7-15-1998)	IA & PA
DR-996	Flooding, Severe Storm	7-9-1993 (4-13-1993 to 10-1-1993)	IA & PA
DR-868	Flooding, Severe Storm	5-26-1990 (5-18-1990 to 7-6-1990)	IA & PA
DR-443	Flooding, Severe Storm	6-24-1974 (6-24-1974)	IA & PA

Source: FEMA

Lightning

Lightning events from 1996 to April 2013, Polk County experienced 9 reported damaging lightning events. During this 17.3 year time period there were no lightning-caused deaths and six lightning-related injuries. Reported property damages were $957,000 mainly due to lightning-caused fires.

Some of the more notable damaging lightning events are described in additional detail below. Information on these events is from NCDC:

- **June 11, 2012**—As the thunderstorms moved through Bondurant, lightning struck a house setting it on fire.
- **August 18, 2010**—Lightning caused a house fire in Ankeny.
- **June 12, 2010**—Lightning struck a business in Runnells. Bakeris Roofing was struck and set on fire. The fire took eight fire departments two hours to put out the fire and the business was destroyed.
- **February 26, 2009**—Lightning struck an overpass along Interstate 80/35 along the north side of the Des Moines metro area and knocked a chunk of concrete off of it. The concrete fell onto the windshield of a moving van, smashing through the glass. The driver was injured and admitted to the hospital with minor injuries.
- **August 7, 2007**—Lighting struck a house in Urbandale causing damage.
- **April 20, 2004**—Lightning struck a large multi-bay garage at a condominium complex in West Des Moines that caused $15,000 in estimated damages.
- **April 8, 2001**—Lightning caused a house fire in Johnston and it was completely burned to the ground.
- **August 8, 2000**—Lightning struck a clubhouse at a recreational facility in Grimes. The clubhouse was set on fire and was a total loss.

Hail

The NCDC reports 373 hail events in Polk County between 1996 and April 2013 causing $13 million in property damages and $720,000 in crop damages. Resulting in annualized property damages of $75,144 and annualized crop damages of $41,618. Of these 373 events, 192 included hail 0.75 inches in diameter and larger. When excluding events that were reported on the same day, there were 93 events during this 17.3 year time period. **Table 3.91** shows the number of hail events 0.75 inches and larger by the size of the hail.

Table 3.91. Hail Events Summarized by Hail Size

Hail Size (inches)	# of Events 1996- 2012
3.00	2
2.75	1
2.50	1
2.00	4
1.75	20
1.50	9
1.25	8
1.00	52
0.88	47
0.80	1
0.75	47
Totals	**192**

Source: National Climatic Data Center;

Some of the more notable damaging hail events are described in additional detail below. Information on these events is from NCDC:

- **June 9, 2011**—Polk County experienced hail ranging in sizes from 1.75 to .88 inch in diameter causing an estimated $211,000 in property damages.
- **July 14, 2009**—The cities of Johnston, Grimes, Polk City and Des Moines experienced hail ranging in sizes from 3.00 to 1.00 inch in diameter causing an estimated $351,000 in property damages. The 3.00 inch diameter hail is the largest size hail recorded for Polk County during this timeframe.
- **May 25, 2008**—The cities of Ankeny, Des Moines, and Bondurant experienced hail ranging in sizes from 1.75 to .88 inch in diameter causing an estimated $56,000 in property damages.
- **March 30, 2006**—The Des Moines metropolitan area experienced an early spring thunderstorm with hail ranging in sizes from 2.00 to .88 inch in diameter causing an estimated $145,000 in property damages.
- **June 12, 2001**—On this day, the Des Moines metropolitan area got hit with record hail ranging in sizes from 2.75 to 1.00 inch in diameter causing over $10 million in property damages.
- **May 19, 1998**—The cities of Runnells, Ankeny, Johnston, and Clive reported hail ranging in size from 1.75 to .75 inch in diameter causing an estimated $408,050 in property damages.

Thunderstorm Winds

The NCDC reports 331 thunderstorm wind events in Polk County between 1996 and April 2013 causing $72 million in property damages, $1.7 million in crop damages, no fatalities, and 43 injuries. This results in annualized property damages of $4.1 million and annualized crop damages of $98,266. When excluding events that were reported on the same day, there were 85 events during this 17.3 year time period. Information concerning wind storms, separate from thunderstorms, can be found in **Section 3.4.18**.

Some of the more notable damaging thunderstorm wind events are described in additional detail below. Information on these events is from NCDC:

- **September 19, 2013**—Numerous reports of high winds were received with wind speeds of 60 to 80 MPH. In the Des Moines metropolitan area, 40,000 customers were reportedly out of power at the peak of the storm. After 12 hours, nearly one quarter of those still remained without power. Tree and power line damage was widespread along the line. Scattered roof damage was reported in the Des Moines metropolitan area as well. Roof damage reported at South Prairie Elementary School in Grimes
- **April 14, 2012—**The Des Moines metro area was hard hit with winds of up to 65 MPH causing considerable tree damage. At one time, 20,000 customers were reported without power.
- **July 11, 2011—**Two radio towers were downed, one in central Tama County, the other in northern Polk County. A local television station's weather radar was destroyed near Alleman, also in Polk County. Local wind speeds in these areas were estimated as high as 115 MPH. Widespread power outages were reported.
- **July 18, 2010**—A measured wind gust of 84 MPH was recorded on the northwest side of the Des Moines Metro area. Power was knocked out to nearly 40,000 customers in central Iowa by the storms. Damage reports from along the path of the derecho were widespread. Grain bins were destroyed as well as numerous out buildings. Tree and power line damage was extensive all the way from the Minnesota border through south central Iowa.
- **July 21, 2008**—In Polk County, in Ankeny, 20 t o 30 Black Locust trees of 1 to 2 feet in diameter were snapped or uprooted near the intersection of 35th street and Highway 415.
- **August 22, 2002**—Heavy wind damage occurred in eastern Dallas and Polk Counties. Winds gusted as high as 80 MPH as the storm roared through Des Moines. At one point, near 50,000 customers were without electricity in the metro Des Moines area. By the evening of the 23rd, power was restored to all but 13,000 to 15,000 customers. Some of the harder hit areas were without power for 2 to 3 days. Damage to trees and power lines was extensive. There were several reports of semi-tractor-trailer trucks being blown over by the high winds and structural damage occurred to a few homes.
- **July 21, 2001**—Sixty five MPH winds swept into the town of Bondurant causing power line damage and downed trees. There were several waves of wind as cells developed rapidly in the same area as the entire area sank southeast around 5 MPH. Structural damage was reported in Bondurant as the last cell moved through. This cell produced winds around 80 MPH, damaging roofs in the area. One bar and grill in town sustained $85,000 in damage.
- **June 29, 1998**—The worst affected metro areas were the Granger area, Johnston, and the northeast side of Des Moines proper. A duplex in Granger was flattened by the winds. There were several reports of roofs being ripped off of stores and houses in the metropolitan Des Moines area. Several small private planes were flipped at a small air field north of Des Moines. There were also several reports of semi-tractor-trailer trucks being blown over on Interstate 35. Heavy construction equipment was overturned on Interstate

35/80 just north of Des Moines. Damage was extensive to the east side of Des Moines proper. Estimates from Polk County alone are near $100 million in damage including cleanup. Damages were estimated at $11 million from initial claims in Johnston and $726,000 from West Des Moines just to city buildings and systems. West Des Moines was on the far west edge of the major damage however. In addition to the property damage, at least 125 people were injured during the storm. Most of the injuries were caused by flying debris and many were not serious. Fortunately there were no fatalities. Heavy damage was reported by MidAmerica Energy. On a state wide report, they indicated 200,000 homes were without electricity, effecting over 500,000 people, at one time during the storm. In the metropolitan Des Moines area, 100,000 homes were without electricity at the height of the storm. That number was reduced to around 25,000 36 hours later. The worst damaged areas were without power for 5 to 6 days. Heavy damage was also reported by local telephone and cable systems. In Polk County, the worst damage extended from the Camp Dodge area into the northeast parts of Des Moines. At least 462 homes in the metro Des Moines area sustained significant damage. Statewide, 80 homes were destroyed, 559 sustained severe damage, with 1416 others receiving moderate damage. In the Camp Dodge area, 80 to 90 percent of the brick buildings were damaged with the roofs removed from many of them

Figure 3.98. Severe Thunderstorm Caused Grain Bin Collapse, July 11, 2011

Source: Polk County Emergency Management, 2013

The National Weather Service (NWS) will issue a Severe Thunderstorm Warning whenever a thunderstorm is forecasted to produce wind gusts to 58 miles per hour (50 knots) or greater and/or hail size one inch (quarter-size) diameter which can produce significant damage (source: http://www.nws.noaa.gov/oneinchhail/). **Table 3.92** shows the number of Severe Thunderstorm Watches and Warnings issued by NOAA's National Weather Service Des Moines Weather Forecast Office.

Table 3.92. National Weather Service Severe Thunderstorm Watch and Warning Issuance in Polk County, IA, 2005-May 2013

Year	Severe Thunderstorm Watch	Severe Thunderstorm Warning
2013	9	8
2012	5	19
2011	9	30
2010	23	25
2009	13	22
2008	15	54
2007	15	18
2006	12	15
2005	0	17
Total	**101**	**208**

Source: NOAA's National Weather Service Des Moines Weather Forecast Office

Although NCDC provides estimates of crop losses, crop insurance payment statistics are considered a more accurate resource for this data. According to the USDA Risk Management Agency, insured crop losses in Polk County as a result of hail from 2003 to 2012 totaled $267,431 (see **Table 3.93**) and $803,271 from windstorms (see **Table 3.94**).

Table 3.93. Crop Insurance Claims Paid in Polk County from Hailstorms, 2003-2012.

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2003	Corn	Hail	$4,564
2003	Soybeans	Hail	$8,026
2004	Soybeans	Hail	$202
2005	Corn	Hail	$9,735
2005	Soybeans	Hail	$19,930
2008	Corn	Hail	$26,829
2008	Soybeans	Hail	$143,253
2009	Soybeans	Hail	$8,164
2011	Corn	Hail	$9,971
2011	Soybeans	Hail	$36,758
Total			**$267,431**

Source: USDA Risk Management Agency Crop Insurance Payment FOIA Request; USDA Risk Management Agency Iowa Crop Insurance Profile, http://www.rma.usda.gov/pubs/2012/stateprofiles/iowa11.pdf

Table 3.94. Crop Insurance Claims Paid in Polk County from Windstorms, 2003-2012.

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2004	Corn	Wind/Excess Wind	$8,839
2008	Corn	Wind/Excess Wind	$160,409
2009	Hybrid Corn	Wind/Excess Wind	$4,854
2011	Corn	Wind/Excess Wind	$33,107
2011	Hybrid Corn	Wind/Excess Wind	$593,887
2012	Corn	Wind/Excess Wind	$2,176
Total			**$803,271**

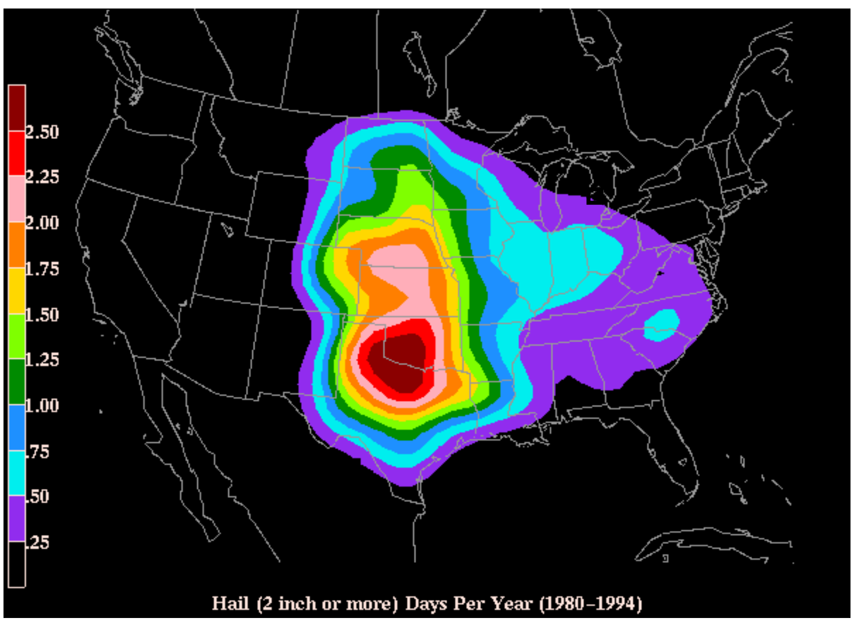
Probability of Future Occurrence

NCDC-reported damaging lightning events occurred 9 times from 1996 to April 2013. Since lightning accompanies thunderstorms, it can be assumed that lightning occurs more often than damages are reported. These rates of occurrence are expected to continue in the future.

Based on NCDC data, there have been 93 separate hail events in a 17.3 year period, producing an average of 5.3 hail events each year in Polk County. When limiting the probability analysis to hail events producing hail 1.75 inches and larger, there have been 28 separate events (separate days) in a 17.3 year period. Based on this history, the probability of a destructive hail event in any given year is 61 percent, making the probability for damaging hail "highly likely" in any given year.

Figure 3.99 is based on hailstorm data from 1980-1994. It shows the probability of hailstorm occurrence (2" diameter or larger) based on number of days per year. Polk County is located in the area shown to have approximately 1 to 1.25 days annually with hail 2 inches in diameter or larger.

Figure 3.99. Annual Hailstorm Probability (2'' diameter or larger), United States 1980-1994



Source: NSSL, http://www.nssl.noaa.gov/users/brooks/public_html/bighail.gif
Note: Black square indicates approximate location of Polk County

Probability Score: 4—Highly Likely

Vulnerability

Overview

In general, assets in the County are vulnerable to thunderstorms with lightning and hail including people, crops, vehicles, and built structures. According to the 2013 Iowa Hazard Mitigation Plan, of the 8 hazards for which data was available to estimate annualized losses, thunderstorm with lightning and hail ranked 4th with $30 million in annualized losses based on data spanning a 17-year period. Although this hazard results in high annual losses, generally private property insurance and crop insurance cover the majority of losses. Considering insurance coverage as a recovery capability and therefore mitigation of devastating impacts to the economy, the overall impact on jurisdictions is reduced; therefore, this hazard's magnitude score to the planning area is "negligible".

Potential Losses to Existing Development

Most lightning damages occur to electronic equipment located inside buildings. But structural damage can also occur when a lightning strike causes a building fire. In addition, lightning strikes can cause damages to crops if fields light on fire. Communications equipment and warning transmitters and receivers can also be knocked out by lightning strikes. There have not been any fatalities in Polk County from lightning strikes.

Thunderstorm winds and hail can cause damage to property, vehicles, trees, and crops.

Property and Crop Losses

Table 3.95 provides the estimated annualized property damages resulting from Thunderstorms, including lightning, hail and wind. This annualized damage has been compared to the total building exposure for Polk County and the level of damage is minimal compared to the value of building exposure. Building Exposure values are based on parcel data provided by the City of Des Moines GIS Department.

Table 3.95. Estimated Annualized Property Damages Resulting from Severe Thunderstorms (Hail/Lightning/Wind, 1996-April 2013)

Building Exposure	Hail/Lightning/Thunderstorm Wind Property Damages	Annualized Property Damages
$27,741,526,290	Hail - $13,000,000 Lightning - $957,000 Wind - $ 72,000,000 Total $85,957,000	$4,968,612

Source: Building Exposure, City of Des Moines GIS Department, 2013; Hail, Lightning, & Thunderstorm Wind Property Damage from NCDC records

Table 3.96 provides the insured crop losses for resulting from hail and wind. The insured loss has been adjusted to estimate losses to all insurable crops by considering that 88 percent of insurable crops in the State were insured (2012 Iowa Crop Insurance Profile from USDA's Risk Management Agency).

Table 3.96. Estimated Insurable Annualized Crop Damages Resulting from Severe Thunderstorms (Hail//Wind)

Crop Exposure (2007)	Insurance Paid (2003-2012)	Adjusted Crop Damages	Annualized Adjusted Crop Damages
$105,403,000	Hail -$267,431 Wind -$803,271 Total -$1,070,702	$1,216,707	$121,670

Source: Crop Exposure is from Iowa State University, University Extension, 2007; Insurance paid is from USDA's RMA; Statewide Crop insurance Coverage is from USDA's RMA Iowa Crop Insurance Profile.
Note: This includes insurable crops that are insured.

Future Development

Current development trends for Polk County are likely to increase vulnerability to wind, lightning and hail. Additional development means more households and businesses vulnerable to damages from severe thunderstorms, lightning and hail.

Thunderstorm, Lightning and Hail Hazard Summary by Jurisdiction

The following hazard summary table shows how this hazard varies by jurisdiction. Although thunderstorms and with lightning and hail occur at similar rates in all parts of the planning area, damages are more likely in the incorporated areas that are more densely developed.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	4	1	3	1	2.65	Moderate
Cities						
City of Alleman	4	2	3	1	2.95	Moderate
City of Altoona	4	2	3	1	2.95	Moderate
City of Ankeny	4	2	3	1	2.95	Moderate
City of Bondurant	4	2	3	1	2.95	Moderate
City of Clive	4	2	3	1	2.95	Moderate
City of Des Moines	4	2	3	1	2.95	Moderate
City of Elkhart	4	2	3	1	2.95	Moderate
City of Grimes	4	2	3	1	2.95	Moderate
City of Johnston	4	2	3	1	2.95	Moderate
City of Mitchellville	4	2	3	1	2.95	Moderate
City of Pleasant Hill	4	2	3	1	2.95	Moderate
City of Polk City	4	2	3	1	2.95	Moderate
City of Runnells	4	2	3	1	2.95	Moderate
City of Urbandale	4	2	3	1	2.95	Moderate
City of West Des Moines	4	2	3	1	2.95	Moderate
City of Windsor Heights	4	2	3	1	2.95	Moderate
Des Moines Water Works	4	2	3	1	2.95	Moderate
School Districts						
Ankeny, 261	4	2	3	1	2.95	Moderate
Bondurant-Farrar, 720	4	2	3	1	2.95	Moderate
Dallas Center-Grimes, 1576	4	2	3	1	2.95	Moderate
Des Moines Independent, 1737	4	2	3	1	2.95	Moderate
Johnston, 3231	4	2	3	1	2.95	Moderate
North Polk, 4779	4	2	3	1	2.95	Moderate
Saydel, 5805	4	2	3	1	2.95	Moderate
Southeast Polk, 6101	4	2	3	1	2.95	Moderate
Urbandale, 6579	4	2	3	1	2.95	Moderate
West Des Moines	4	2	3	1	2.95	Moderate

3.4.17 Tornado

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	2	3	1	2.95	Moderate

Profile

Hazard Description

The NWS defines a tornado as “a violently rotating column of air extending from a thunderstorm to the ground.” It is usually spawned by a thunderstorm and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. Often, vortices remain suspended in the atmosphere as funnel clouds. When the lower tip of a vortex touches the ground, it becomes a tornado and a force of destruction.

Tornadoes are the most violent of all atmospheric storms and are capable of tremendous destruction. Wind speeds can exceed 250 miles per hour and damage paths can be more than one mile wide and 50 miles long. Tornadoes have been known to lift and move objects weighing more than 300 tons a distance of 30 feet, toss homes more than 300 feet from their foundations, and siphon millions of tons of water from water bodies. Tornadoes also generate a tremendous amount of flying debris or “missiles,” which often become airborne shrapnel that causes additional damage. If wind speeds are high enough, missiles can be thrown at a building with enough force to penetrate windows, roofs, and walls. However, the less spectacular damage is much more common.

High winds not associated with tornadoes are profiled separately in this document in **Section 3.4.19**, Windstorm.

Iowa is located in a part of the United States where tornadoes are a common occurrence. Iowa has experienced 1,517 tornadoes from 1980 through 2011 (32 year period) with 86 percent of them being rated F0 and F1, 14 percent rated F2 through F5. Only one F5 rated tornadoes have occurred in Iowa during this timeframe (Parkersburg in 2008). Since 1980, there have been on average 47 tornadoes per year in Iowa. Most tornadoes occurred in May and June but can occur during any month. Also mid afternoon until around sunset is the peak time of day for tornado activity. There have been 763 injuries and 26 deaths attributable to tornadoes (source: National Weather Service, Iowa Tornado Climatology Report 1980-2011).

Tornadoes are classified according to the EF- Scale (the original F – Scale was developed by Dr. Theodore Fujita, a renowned severe storm researcher). The Enhanced F- Scale (see **Table 3.97**) attempts to rank tornadoes according to wind speed based on the damage caused. This update to the original F scale was implemented in the U.S. on February 1, 2007.

Table 3.97. Enhanced F Scale for Tornado Damage

FUJITA SCALE			DERIVED EF SCALE		OPERATIONAL EF SCALE	
F Number	Fastest ¼-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Source: The National Weather Service, www.spc.noaa.gov/faq/tornado/ef-scale.html

The wind speeds for the EF scale and damage descriptions are based on information on the NOAA Storm Prediction Center as listed in **Table 3.98**. The damage descriptions are summaries. For the actual EF scale it is necessary to look up the damage indicator (type of structure damaged) and refer to the degrees of damage associated with that indicator. Information on the Enhanced Fujita Scale's damage indicators and degrees or damage is located online at www.spc.noaa.gov/efscale/ef-scale.html.

Table 3.98. Enhanced Fujita Scale with Potential Damage

Enhanced Fujita Scale			
Scale	Wind Speed (mph)	Relative Frequency	Potential Damage
EF0	65-85	53.5%	Light. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e. those that remain in open fields) are always rated EF0).
EF1	86-110	31.6%	Moderate. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	10.7%	Considerable. Roofs torn off well constructed houses; foundations of frame homes shifted; mobile homes complete destroyed; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	3.4%	Severe. Entire stores of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	0.7%	Devastating. Well-constructed houses and whole frame houses completely levelled; cars thrown and small missiles generated.
EF5	>200	<0.1%	Explosive. Strong frame houses levelled off foundations and swept away; automobile-sized missiles fly through the air in excess of 300 ft.; steel reinforced concrete structure badly damaged; high rise buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA Storm Prediction Center

The advancement in weather forecasting has provided for the ability to predict severe weather that is likely to produce tornadoes days in advance. Tornado watches can be delivered to those in the path of these storms several hours in advance. Lead time for actual tornado warnings is about 30 minutes. Tornadoes have been known to change paths very rapidly, thus limiting the time in which to take shelter. Tornadoes may not be visible on the ground if they occur after sundown or due to blowing dust or driving rain and hail.

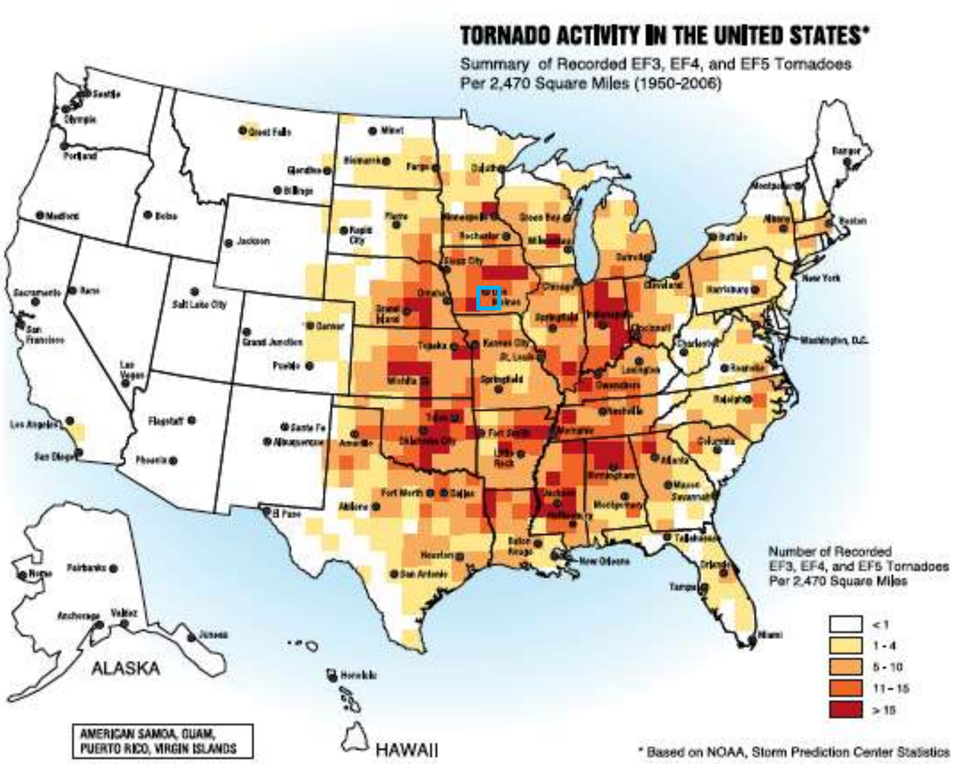
Warning Time Score: 3—6 to 12 hours

Duration Score: 1—less than 6 hours

Geographic Location/Extent

Tornadoes can occur in the entire planning area. **Figure 3.100** illustrates the number of F3, F4, and F5 tornadoes recorded in the United States per 3,700 square miles between 1950 and 2006. Polk County is in the section with orange shading, indicating 5 to 15 tornadoes of this magnitude during this 57-year period.

Figure 3.100. Tornado Activity in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition
Note: Blue square is approximate location of Polk County

Previous Occurrences

According to statistics reported by the National Climatic Data Center, Polk County had 27 recorded tornado events from 1980 to April 2013. Of these, 1 was F4, 4 were F2, 10 were F1 and EF1, and 12 were F0. These tornadoes caused no fatalities, a combined 99 injuries, over $13 million in property damages, and $97,500 in crop damages. **Table 3.99** summarizes these events.

Table 3.99. Recorded Tornadoes in Polk County, 1980 – April 2013

Date	Beginning Location	Ending Location	Length (miles)	Width (yards)	F/EF Rating	Death	Injury	Property Damage	Crop Damages
6/6/1980	Des Moines	Des Moines	1	40	F1	0	0	$50,000	0
6/15/1982	Des Moines	Des Moines	0	50	F1	0	0	$50,000	0
5/6/1983	Unincorporated	Unincorporated	0	20	F1	0	0	$50,000	0
5/6/1983	Des Moines	Des Moines	1	60	F2	0	0	$500,000	0
6/11/1984	West Des Moines	Wes Des Moines	0	10	F0	0	0	$500,000	0
9/9/1984	Polk City	Polk City	2	50	F1	0	0	$5,000	0
5/11/1985	Unincorporated	Unincorporated	1	50	F0	0	0	$5,000	0
6/29/1986	West Des Moines	Des Moines	5	50	F2	0	0	$500,000	0
9/28/1986	Unincorporated	Unincorporated	20	250	F4	0	0	$1,000,000	0
3/13/1990	Ankeny	Unincorporated	15	60	F2	0	15	$500,000	0
5/12/1997	Bondurant	Mitchellville	6.7	15	F0	0	0	0	0
5/19/1998	Runnells	Runnells	0.2	25	F0	0	0	0	$500
6/29/1998	Grimes	Des Moines	18.3	150	F2	0	83	$10,000,000	$75,000
4/8/1999	Des Moines	Des Moines	0.2	30	F0	0	0	$43,000	0
4/8/1999	Runnells	Runnells	7	75	F1	0	0	$50,000	0
5/18/2000	Runnells	Runnells	0.2	25	F0	0	0	$1,000	0
5/30/2000	Des Moines	Altoona	8	40	F1	0	0	$100,000	$5,000
4/11/2001	Saylorville	Saylorville	0.5	35	F0	0	0	0	0
7/24/2001	West Des Moines	West Des Moines	0.2	25	F0	0	0	0	$1,000
9/6/2001	West Des Moines	West Des Moines	2.8	50	F1	0	1	$500,000	$5,000
4/18/2002	Altoona	Altoona	0.3	30	F0	0	0	$1,000	0
4/18/2002	Bondurant	Mitchellville	8.5	60	F1	0	0	$15,000	0
5/22/2004	Alleman	Alleman	2	50	F0	0	0	0	0
9/5/2004	Elkhart	Elkhart	0.5	25	F0	0	0	$5,000	$1,000
4/2/2006	Runnells	Runnells	0.2	30	F0	0	0	0	0
10/2/2007	Des Moines	Des Moines	0.44	20	EF1	0	0	$75,000	0
7/27/2008	Farrar	Elkhart	0.29	100	EF1	0	0	$50,000	$10,000
	Total							**$14,000,000**	**$97,500**

Source: National Climatic Data Center

According to NOAA's National Weather Service Des Moines Weather Forecast Office, they have issued 64 Tornado Warnings between 1985 and May 2013. The only years that warnings have not been issues are 1988, 1992, 1994, 1995, 1996, 2003, 2005, and 2012.

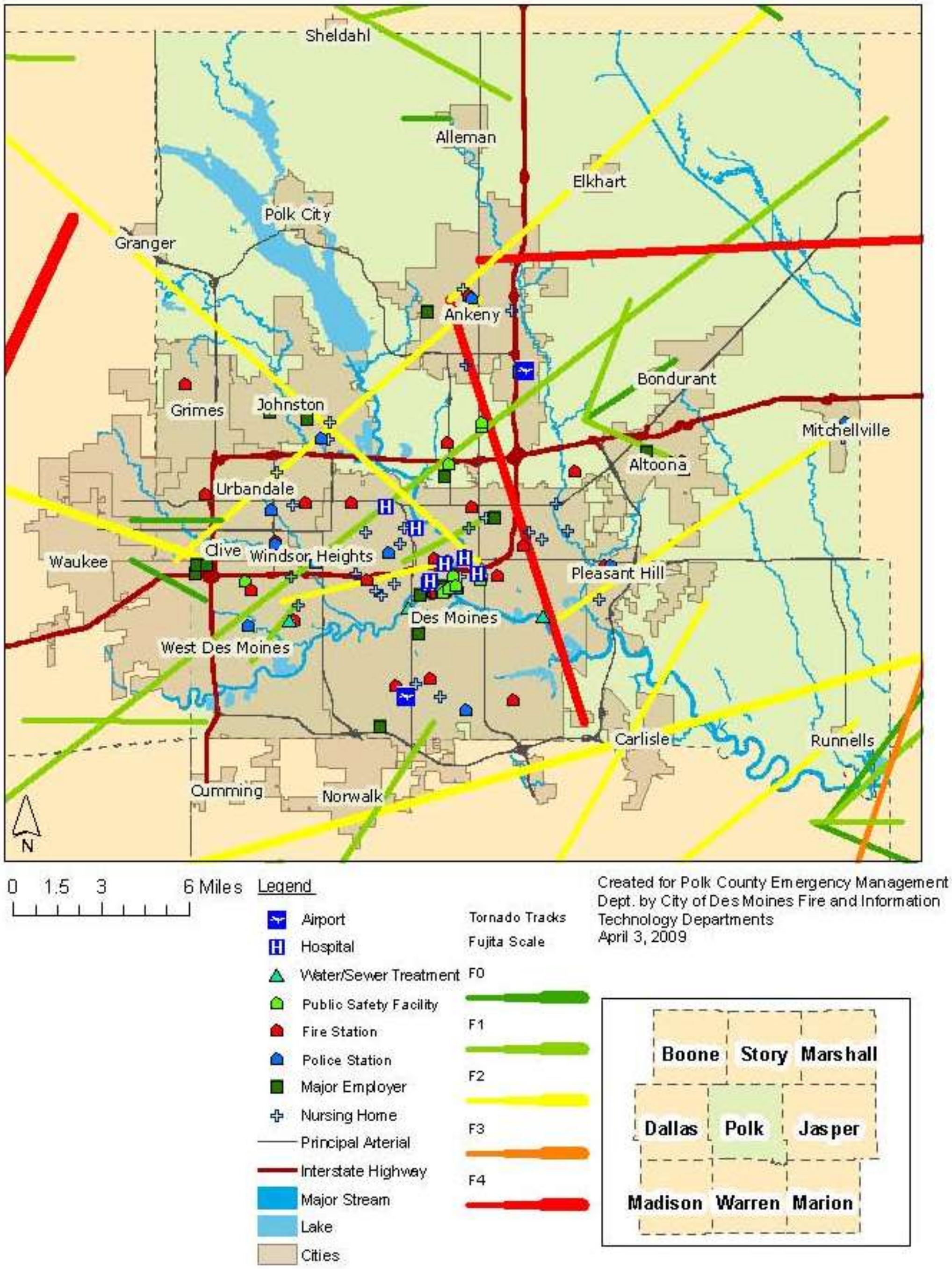
Polk County has been included in four presidential disaster declarations that involved tornadoes since 1965. Descriptions of notable previous tornado events are provided below:

- ***FEMA-1930-DR-IA—Severe Storms, Flooding, & Tornadoes***, *Declared July 29, 2010; Incident Period June 1 to August 31, 2010*. The damages in Polk County associated with this declaration were for severe storms and flooding.
  FEMA-*1763-DR-IA—Severe Storms, Tornadoes, & Flooding*, *Declared May 27, 2008; Incident Period May 25 to August 13, 2008*. The primary damages in Polk County associated with this declaration were for severe storms and flooding. However, an EF1

tornado touched down southwest of Elkhart on July 27th. The tornado damaged two houses and caused considerable tree damage. Parts of the house were blown up into the trees.

- **October 2, 2007**—EF1 Tornado: Des Moines. The storms raced east across Iowa and they produced gusty winds and very heavy rainfall. The storms produced a small, but intense, tornado in downtown Des Moines. Two power poles snapped and power lines down at 13th and Mulberry. At 6th and Mulberry, two vehicles were flipped including one SUV that was likely flipped nose down due to engine weight. The SUV slid about 30 feet. Eyewitness saw a small 10 foot tree lifted into the circulation and rotating around briefly. Media reported some roof debris on the SW 9th overpass at Martin Luther King Parkway, but no building damage is evident at this time. Some buildings were damaged in the area. The tornado was rated an EF1 with 110 mph winds. This was the first tornado to touchdown in the Des Moines city limits since May 30, 2000.
- ***FEMA-1518-DR-IA—Severe Storms, Tornadoes, & Flooding****, Declared May 25, 2004; Incident Period May 19 to June 24, 2004*. The primary damages in Polk County associated with this declaration were for severe storms and flooding. However, on May 22, 2004, a F0 tornado touched down in Alleman. No damages were reported.
- **FEMA-1230-DR-IA—Severe Weather, Tornadoes, & Flooding**, Declared on July 2, 1998; Incident Period from June 13 to July 15, 1998. On June 29th, a complex weather situation occurred over much of central and southern Iowa. Many places reported winds over 80 mph with incredible tree damage and numerous buildings damaged or destroyed. At least 38 counties were declared disaster areas by the Federal Government due to the severe damage and flooding. An F2 tornado touched down in Grimes. But most of the damage appeared to be from straight line winds based on a storm survey that was done following the event.
- **September 28, 1986—**F4 Tornado touched down at 5:40pm near the unincorporated community of Farrar then moved northeastward to Jasper County destroying 7 homes and 65 farm buildings.

Figure 3.101. Polk County Map of Historic Tornado Events



According to the USDA Risk Management Agency, insurance payments in Polk County for corn crop damages as a result of tornadoes occurred in 2008 for $19,858 during the 2003-2012 timeframe.

Probability of Future Occurrence
The National Climatic Data Center reported 27 tornadoes in Polk County in a 34.3 year time period, which calculates to 78 percent chance of a tornado in any given year. Even if the analysis only takes into consideration the F1-F4 events, the number of tornadoes would be 15 in a 34.3 year time period which equates to a 43 percent chance of a tornado in any given year.

With the 64 NWS tornado warnings issued for Polk County from 1985 thru May 2013 there have been an average of two tornado warnings per year during this 27.4years of data.

Therefore, it is a high probability that some portion of Polk County will experience tornado activity in any given year.

<u>Probability Score</u>: 4—Highly Likely

Vulnerability

Overview
Polk County is located in a region of the U.S. with high frequency of dangerous and destructive tornadoes and is referred to as "Tornado Alley". **Figure 3.102** is based on areas where dangerous tornadoes are most likely to take place.

Figure 3.102. Tornado Alley in the U.S.

Source: http://www.tornadochaser.net/tornalley.html

Light frame structures, such as mobile homes, outbuildings and sheds are considered especially vulnerable to damage from tornadoes. **Table 3.100** shows the number vulnerable light frame structures in each jurisdiction in the planning area. There are 103,093 light frame structures listed in these jurisdictions. The data is from the Des Moines Area Regional GIS Partnership GIS data.

Table 3.100. Number of Light Frame Structures in Polk County, IA

Jurisdiction	Mobile Homes	Outbuildings	Sheds
Polk County	1,174	8,671	6,691
City of Alleman	2	74	65
City of Altoona	373	1,516	1,126
City of Ankeny	556	3,434	2,125
City of Bondurant	3	469	358
City of Carlisle*	0	34	19
City of Clive	2	444	505
City of Des Moines	2,157	38,274	15,523
City of Elkhart	8	75	68
City of Granger*	0	0	1
City of Grimes	496	718	565
City of Johnston	110	734	659
City of Mitchellville	40	414	312
City of Norwalk*	0	0	0
City of Pleasant Hill	12	714	605
City of Polk City	7	439	259
City of Runnells	4	118	65
City of Sheldahl*	0	60	23
City of Urbandale	76	2,673	2,220
City of West Des Moines	432	4,059	2,473
City of Windsor Heights	4	601	454
Total	**5,456**	**63,521**	**34,116**

Source: Des Moines Area Regional GIS Partnership, http://arcgis.dmgov.org/EXTmapcenter/GetDSMData.aspx: *Data is for Polk County portions of these cities only

According to the 2013 Iowa Hazard Mitigation Plan, of the 8 hazards for which date was available to estimate annualized losses, tornadoes ranked 3rd with $36 million in annualized losses based on data spanning a 63-year period.

Magnitude Score: 2—Limited

Potential Losses to Existing Development

In Polk County, the NCDC estimate for past property damages from 1980 – April 2013 is $14,000,000. This translates to a conservative amount of $408,163 in annualized losses over the 34.3 year timeframe based on the NDCD property damage conservative estimates.

To estimate vulnerability to tornadoes, a potential tornado scenario was analyzed for each jurisdiction in the planning area. The scenario chosen was an F1/EF1 tornado with wind speed of approximately 100 mph. From the NCDC reports, it was determined that there have been 10 F1 tornadoes in Polk County since 1980. Of these 10 reported tornadoes, the average width was 50 yards and the average length was 3 miles.

To provide estimated damage results from an F1/EF1 tornado with these dimensions, a hypothetical tornado track was considered at a 45 degree angle running through the approximate center of each jurisdiction in the planning area. For Unincorporated Polk County and the incorporated cities, the parcel data provided by the Des Moines Area Regional GIS Partnership was utilized as the basis for determining damage estimates. Separate analyses were not conducted for the public school districts. Since the public school districts have a relatively small number of buildings, it was not possible to apply this same type of random tornado path scenario to provide meaningful results.

With the infinite variables associated with tornado occurrences such as wind speed, direction, length, width, time on the ground, etc., it is not possible to accurately estimate future losses. However, this methodology provides loss estimates for a defined scenario. Utilizing GIS data with associated building values considers variations in density of the built environment as well as variations in values. Although it is not possible to accurately predict tornado losses, this analysis demonstrates how the impacts of specific tornado scenario would vary among jurisdictions in Polk County.

Once the number and values of buildings within the hypothetical tornado track were determined, a 10 percent damage calculation was made. This damage percent is based on information from the NOAA Storm Prediction Center, which estimates that a F1/EF1 tornado of this magnitude would severely strip roofs; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.

Table 3.101 provides the results of the analysis in terms of the number and value of buildings in the scenario tornado path and estimated losses in Polk County. A planning area total was not calculated as this scenario is not meant to indicate that these damages would occur simultaneously.

Table 3.101. F/EF 1 Tornado Scenario Loss Estimates for Jurisdictions in Polk County

Jurisdiction	# of Buildings in Path	Total Building Values in Path	10% Loss Estimate
Polk County	36	$1,140,200	$114,020
City of Alleman	2	$199,700	$19,970
City of Altoona	134	$11,194,600	$1,119,460
City of Ankeny	164	$15,011,800	$1,501,180
City of Bondurant	41	$3,018,260	$301,826
City of Carlisle*	10	$268,600	$26,860
City of Clive	8	$5,412,200	$541,220
City of Des Moines	266	$11,714,330	$1,171,433
City of Elkhart	19	$2,004,000	$200,400
City of Granger*	6	$1,281,300	$128,130
City of Grimes	34	$3,370,900	$337,090
City of Johnston	19	$4,957,500	$495,750
City of Mitchellville	37	$1,089,400	$108,940
City of Norwalk*	0	$0	$0
City of Pleasant Hill	69	$6,240,690	$624,069
City of Polk City	46	$2,603,800	$260,380

Jurisdiction	# of Buildings in Path	Total Building Values in Path	10% Loss Estimate
City of Runnells	29	$1,953,100	$195,310
City of Sheldahl*	12	$627,700	$62,770
City of Urbandale	55	$10,619,100	$1,061,910
City of West Des Moines	119	$51,459,450	$5,145,945
City of Windsor Heights	68	$5,391,100	$539,110

Source: Des Moines Area Regional GIS Partnership, http://arcgis.dmgov.org/EXTmapcenter/GetDSMData.aspx; *Data is for Polk County portions of these cities only

The City of Des Moines would have the highest number of buildings impacted and the third highest dollar losses. The City of West Des Moines has the highest total building values in this scenario path. This is expected due to the high building density in City of West Des Moines and it being one of wealthiest cities in Iowa.

Future Development

Due to the increase in population and urban sprawl in the planning area vulnerability to tornados will increase in the planning area. Public buildings such as schools, government offices, as well as other buildings with a high occupancy and mobile home parks should consider inclusion of a tornado saferoom to shelter occupants in the event of a tornado.

Tornado Hazard Summary by Jurisdiction

The magnitude was rated as a level 2 for all the participating jurisdictions as they are all vulnerable to tornado damage. The factors of probability, warning time, and duration are also equal across the planning area. This hazard does not substantially vary by jurisdiction.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	4	2	3	1	2.95	Moderate
Cities						
City of Alleman	4	2	3	1	2.95	Moderate
City of Altoona	4	2	3	1	2.95	Moderate
City of Ankeny	4	2	3	1	2.95	Moderate
City of Bondurant	4	2	3	1	2.95	Moderate
City of Clive	4	2	3	1	2.95	Moderate
City of Des Moines	4	2	3	1	2.95	Moderate
City of Elkhart	4	2	3	1	2.95	Moderate
City of Grimes	4	2	3	1	2.95	Moderate
City of Johnston	4	2	3	1	2.95	Moderate
City of Mitchellville	4	2	3	1	2.95	Moderate
City of Pleasant Hill	4	2	3	1	2.95	Moderate
City of Polk City	4	2	3	1	2.95	Moderate
City of Runnells	4	2	3	1	2.95	Moderate
City of Urbandale	4	2	3	1	2.95	Moderate
City of West Des Moines	4	2	3	1	2.95	Moderate
City of Windsor Heights	4	2	3	1	2.95	Moderate
Des Moines Water Works	4	2	3	1	2.95	Moderate
School Districts						
Ankeny, 261	4	2	3	1	2.95	Moderate
Bondurant-Farrar, 720	4	2	3	1	2.95	Moderate
Dallas Center-Grimes, 1576	4	2	3	1	2.95	Moderate
Des Moines Independent, 1737	4	2	3	1	2.95	Moderate
Johnston, 3231	4	2	3	1	2.95	Moderate
North Polk, 4779	4	2	3	1	2.95	Moderate
Saydel, 5805	4	2	3	1	2.95	Moderate
Southeast Polk, 6101	4	2	3	1	2.95	Moderate
Urbandale, 6579	4	2	3	1	2.95	Moderate
West Des Moines	4	2	3	1	2.95	Moderate

3.4.18 Transportation Incident

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	2	4	1	3.10	High

Profile

Hazard Description

This hazard encompasses the following: air transportation, highway transportation, railway transportation, and waterway transportation incidents. The transportation incidents can involve any mode of transportation that directly threatens life and which results in property damage and/or death(s)/injury(s) and/or adversely impact a community's capabilities to provide emergency services.

An air transportation incident may involve a military, commercial or private aircraft. Air transportation is playing a more prominent role in transportation as a whole. Airplanes and helicopters are used to transport passengers for business and recreation as well as thousands of tons of cargo. A variety of circumstances can result in an air transportation incident; mechanical failure, pilot error, enemy attack, terrorism, weather conditions and on-board fire can all lead to an air transportation incident.

Highway transportation incidents are very complex. Contributing factors can include a roadway's design and/or pavement conditions (e.g. rain, snow and ice), a vehicle's mechanical condition (e.g. tires, brakes, lights), a driver's behavior (e.g. speeding, inattentiveness and seat belt usage), as well as the driver's condition (e.g. alcohol use, age-related conditions, physical impairment). In fact, the driver's behavior and condition factors are the primary cause in an estimated 67 percent of highway crashes and a contributing factor in an estimated 95 percent of all crashes.

As such, highway safety needs go beyond just physical improvements to a specific roadway or intersection, and include changes to driver behavior. These are best addressed with a multi-disciplinary approach using engineering, enforcement, emergency response, and education strategies. According to the U.S. Department of Transportation, Iowa's transportation safety needs are based on an analysis of fatal and major injury crashes in Iowa from 2001–2009 and are related to crashes involving:

- single vehicles running off the road;
- vehicles crossing the centerline on two-lane highways
- vehicles crossing the medians on freeways;
- horizontal curves
- intersections
- unbelted drivers and passengers;
- impaired drivers; and
- speeding.

U.S. Department of Transportation, http://safety.fhwa.dot.gov/hsip/fivepercent/2010/index.cfm?state=ia)

A railway transportation incident is a train accident that directly threatens life and/or property, or adversely impacts a community's capabilities to provide emergency services. Railway incidents may include derailments, collisions and highway/rail crossing accidents. Train incidents can result from a variety of causes; human error, mechanical failure, faulty signals, and/or problems with the track. Results of an incident can range from minor "track hops" to catastrophic hazardous material incidents and even human/animal casualties. With so many miles of track in Iowa, vehicles must cross the railroad tracks at numerous at-grade crossings.

A waterway incident is an accident involving any water vessel that threatens life and/or adversely affects a community's capability to provide emergency services. Waterway incidents primarily involve pleasure crafts on rivers and lakes.

Warning Time Score: 4—Minimal or no warning

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

The entire planning area is subject to transportation incidents and all participating jurisdictions are affected. The transportation routes include Interstates 35 and 80, US Highways 6, 65 and 69, Iowa State Highways 5, 17, 141, 44, 415, and 163. According to the Iowa Department of Transportation (DOT), Polk County is one of 12 counties included in DOT District 1 that maintains 770 bridges and 1,781 centerline miles (4,561 lane miles) within the District.

The Des Moines International Airport serves as the major air passenger and airfreight center for central Iowa. There are two other public airports in the County: Ankeny Regional Airport and Morningstar Field and nine other private airports.The Des Moines General Hospital, the Iowa Lutheran Hospital, the Iowa Methodist Medical Center, the Mercy Hospital Medical Center, and Polk County Hospital all maintain heliports for medical helicopters.

There is a military installation called Camp Dodge in Johnston, although the Department of Defense classifies it as a major training center.

Polk County has three Class I railroad companies: the Union Pacific (UP) Railroad Company, the Burlington Northern Santa Fe (BNSF), and the Norfold Southern (NS) Railroad and one Class II railroad company serving the area is Iowa interstate Railroad (IAIS).

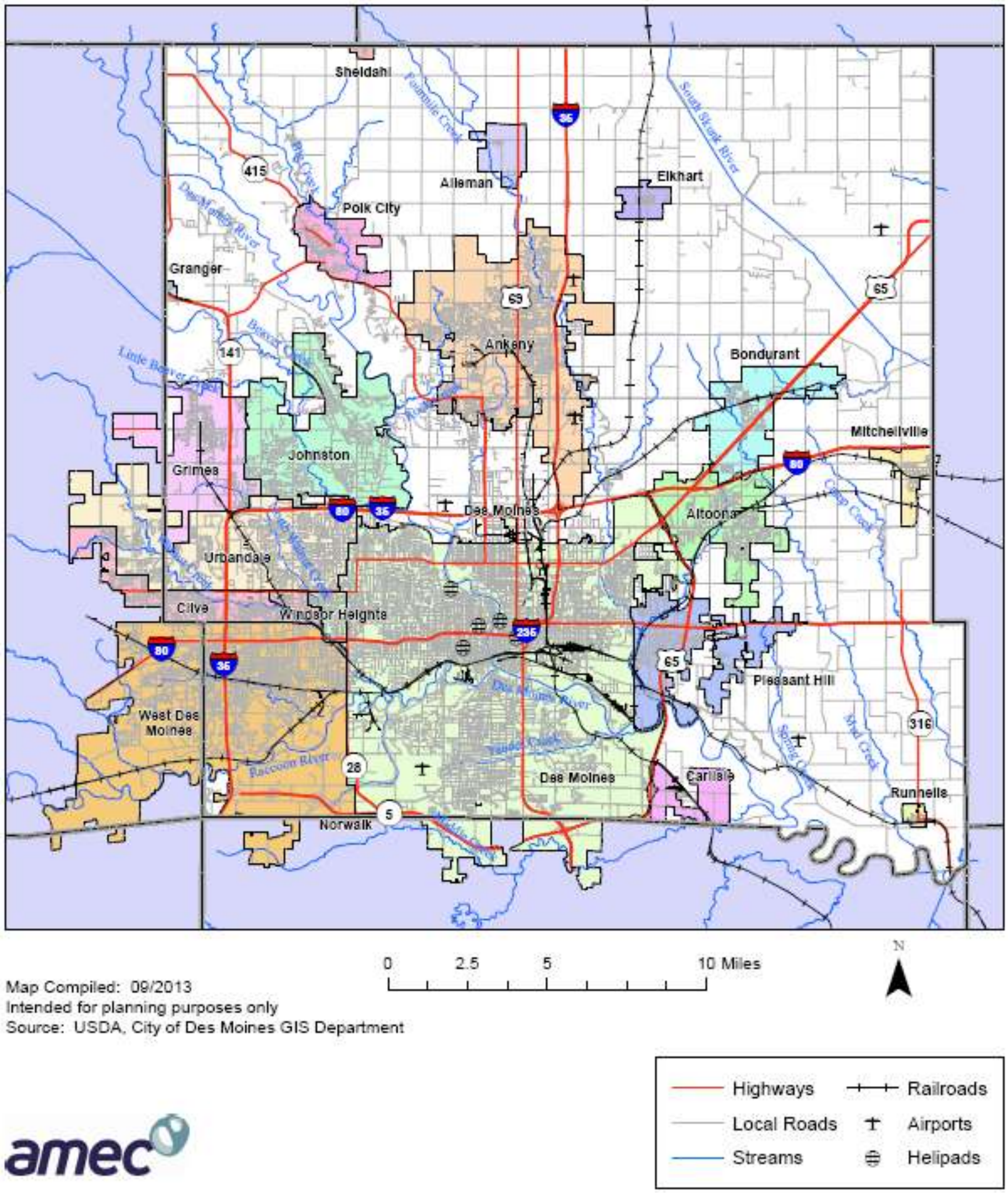
Polk County does not have navigable waterways for commercial purposes but has the following recreational boating lakes (see **Table 3.102**).

Table 3.102. Recreational Boating Lakes/Rivers in Polk County, IA

Lake	Location
Saylorville Reservoir	North edge of Des Moines
Big Creek Lake	2 miles north of Polk City
Blue Heron Lake (Raccoon River Park)	Southwest of West Des Moines; Raccoon River Park
Dale Maffitt Reservoir	6 miles southwest of Des Moines
Easter Lake	Southeast edge of Des Moines
Grays Lake	Fleur Drive, Des Moines
Des Moines River	Stratford to Saylorville
Lake Petoka	Northeast edge of Bondurant

Figure 3.103 shows all the transportation routes in Polk County.

Figure 3.103. Polk County Transportation Routes, Airports, and Helipads



Previous Occurrences
Air Transportation Incidents:

There have not been any Polk County aviation incidents reported to the National Transportation Safety Board (NTSB) during the period from January 1, 2002 to September 30, 2013.

For information and details about other air transportation incidents in Iowa, see http://planecrashmap.com/list/ia/.

Highway Transportation Incidents:

- July 18, 2011—Tanker Truck Rollover occurred on I80/35 East Mixmaster (see **Figure 3.104**). Tank was full of hot tar. The driver was taking the southbound I235 ramp to westbound 80/35. As the driver took the ramp he dropped his cell phone, bent down to pick it up and rolled the rig. Hot tar leaked out and was headed for a storm water intake. No fatalities.

Figure 3.104. Tanker Truck Rollover on I80/35 East Mixmaster, July 18, 2011

Source: Polk County Emergency Management, 2013

The Iowa Department of Transportation's Office of Traffic and Safety maintains traffic crash statistics and location maps by county and large cities in Iowa. **Table 3.103** shows the most recent available number of crashes categorized by the following: fatal, major, minor, possibility unknown, property damage only. The data is reported for Polk County unincorporated and for the cities of Altoona, Ankeny, Clive, Des Moines, Grimes, Johnston, Pleasant Hill, Urbandale, West Des Moines, and Windsor Heights.

Table 3.103. All Crashes in Polk County, 2003-2012

Crashes					
Crashes	**Fatal**	**Major**	**Minor**	**Possibility Unknown**	**Property Damage Only**
Polk County (unincorporated)					
9,155	77	264	800	1,435	6,579
City of Altoona					
2,083	7	28	146	391	1,511
City of Ankeny					
6,925	22	133	680	1,205	4,885
City of Clive					
4,181	5	70	312	852	2,942
City of Des Moines					
55,067	117	1,240	4,764	11,287	37,659
City of Grimes					
916	4	13	60	122	717
City of Johnston					
1,549	5	20	97	226	1,201
City of Pleasant Hill					
1,160	7	28	98	231	796
City of Urbandale					
7,861	14	116	446	1,371	5,914
City of West Des Moines					
9,486	27	189	852	1,750	6,668
City of Windsor Heights					
2,044	5	31	130	405	1,473
Totals					
100,427	290	2,132	8,385	19,275	70,345

Source: Iowa Department of Transportation's Office of Traffic and Safety

Railway Transportation Incidents

According to the Federal Railroad Administration's Office of Safety Analysis, **Table 3.104** shows the train derailments in Polk County from 2008-2012. Photos in **Figure 3.105** show one of these train derailments from March 2009. Throughout Iowa, rail car traffic has increased but the number of derailments in relationship to the traffic is trending downward according to the Iowa Department of Transportation (see **Figure 3.106**).

Table 3.104. Train Derailments in Polk County, 2008-2012

Year	Number of Derailments	Cars Derailed Per Year	Equipment Damages	Track Damages	Injuries
2012	3	6	$11,350	$53,007	0
2011	7	18	$93,311	$61,584	0
2010	5	20	$155,030	$187,652	0
2009	3	19	$945,437	$400,076	0
2008	none	0	$0	$0	0
5-yr average	3.6	9.2	$241,026	$140,464	0

Source: Iowa Department of Transportation

Figure 3.105. Train Derailment near Pleasant Hill, March 2009

Source: Polk County Emergency Management, 2013

Figure 3.106. Derailments in Iowa per Million Rail Car Miles, 1991-2011.

Source: Iowa Department of Transportation, http://www.iowadot.gov/about/Derailments.html

As of 2013, Iowa has 5,157 highway-rail crossings in the State. In 2012, there were 41 highway-rail crossing crashes at public crossings. None of the 2012 incidents occurred in Polk County. **Table 3.105** shows the highway–railroad grade crossing accidents that occurred at public crossings in Polk County from 2008-2012

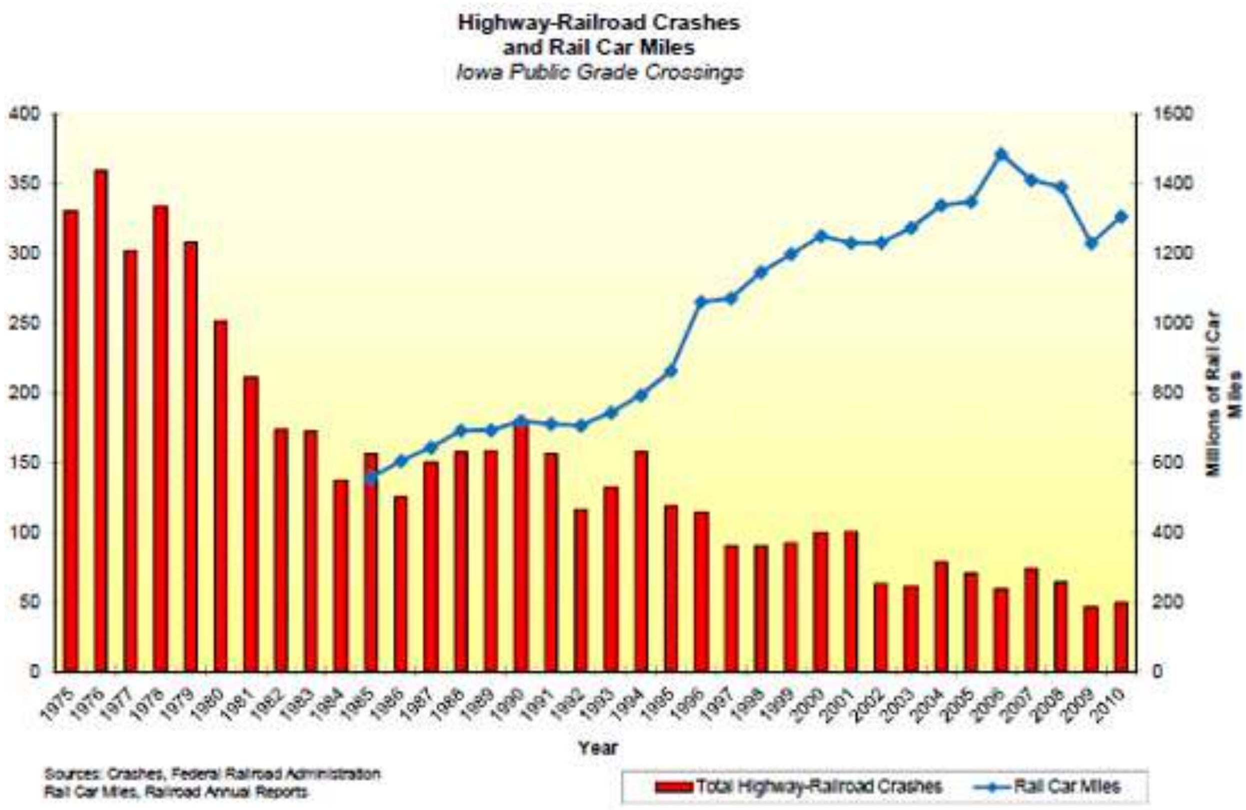
Table 3.105. Highway-Railroad Grade Crossing Accidents in Polk County, 2008-2012

Year	# of Accidents	Injuries
2012	0	0
2011	3	1
2010	3	0
2009	2	0
2008	1	0
5-yr average	1.8	.2

Source: Iowa Department of Transportation

Figure 3.107 shows the significant decline in highway-railroad crashes from 1975 to 2010 compared to the increased miles that rail cars are traveling.

Figure 3.107. Highway-Railroad crashes in Iowa, 1975-2010



Source: Iowa Department of Transportation, http://www.iowadot.gov/about/RailHighwayCrossing.html

Waterway Incidents

There have been few significant waterway incidents in Iowa and even less in Polk County. According to the Iowa Department of Natural Resources, there have been no recreational boating incidents in Polk County from 2008-2012.

Probability of Future Occurrence

A major transportation incident can occur at any time, even though traffic engineering, inspection of traffic facilities, and land use management of areas adjacent to roads and highways has increased, incidents continue to occur. As the volume of traffic on the county streets, highways and interstates increases, the number of traffic accidents will likely also increase. The combination of large numbers of people on the road, wildlife, unpredictable weather conditions, potential mechanical problems and human error always leaves the potential for a transportation accident

Based on the available information, the probability of air transportation, highway, railway or waterway incident that directly threatens life and which results in property damage and/or death(s)/injury(s) and/or adversely impact a community's capabilities to provide emergency services is **"Highly Likely"** with greater than 33 percent likelihood to occur in any given year.

Probability Score: 4—Highly Likely

Vulnerability

Overview

Transportation incidents can almost always be expected to occur in specific areas, on or near airports, roadways, railroads, lakes, rivers or other transportation infrastructure. The exception is air transportation incidents can occur anywhere. However, it is difficult to predict the magnitude of any specific event because these types of events are accidental and the circumstances surrounding these events will impact the extent of damage or injuries that occur. Highway transportation incidents, which are the most comment, generally involve isolated impacts to a few vehicles and persons per incident.

Magnitude Score: 2—Limited

Potential Losses to Existing Development

The U.S. Department of Transportation Federal Highway Administration issued a technical advisory in 1994 providing suggested estimated of the cost of traffic crashes to be used for planning purposes. These figures were converted from 1994 dollars to 2013 dollars using an annual inflation rate of 2.46 percent. The costs are listed below in **Table 3.106.**

Table 3.106. Costs of a Traffic Crash

Severity	Cost per injury (in 2013 dollars $)
Fatal	$4,099,402
Incapacitating Injury	$283,804
Evident Injury	$56,760
Possible Injury	$29,958
Property Damage Only	$3,154

Source: U.S. Department of Transportation Federal Highway Administration Technical Advisory T 7570.2, 1994. Adjusted to 2013 dollars.

Using the traffic crash costs per type of severity from **Table 3.106**, the total costs of traffic crashes is figured in **Table 3.107** for Polk County and several incorporated cities from 2003-2012.

Table 3.107. Costs of Traffic Crashes in Polk County, 2003-2012

	Fatal Crash	Major Crash (Evident Injury)	Minor Crash (Possible Injury)	Crash with Property Damage Only
Polk County (unincorporated)				
Number of incidents	77	264	800	6,579
Total Cost	$315,653,954	$14,984,640	$23,966,400	$20,750,166
Average Annual Cost	$31,565,395	$1,498,464	$2,396,640	$2,075,017
City of Altoona				
Number of incidents	7	28	146	1,511
Total Cost	$28,695,814	$1,589,280	$4,373,868	$4,765,694
Average Annual Cost	$2,869,581	$158,928	$437,387	$476,569
City of Ankeny				
Number of incidents	22	133	680	1,205
Total Cost	$90,186,844	$7,549,080	$20,371,440	$15,407,290
Average Annual Cost	$9,018,684	$754,908	$2,037,144	$1,540,729
City of Clive				
Number of incidents	5	70	312	2,942

	Fatal Crash	Major Crash (Evident Injury)	Minor Crash (Possible Injury)	Crash with Property Damage Only
Total Cost	$20,497,010	$3,973,200	$9,346,896	$9,279,068
Average Annual Cost	$2,049,701	$397,320	$934,690	$927,907
City of Des Moines				
Number of incidents	117	1,240	4,764	37,659
Total Cost	$479,630,034	$70,382,400	$142,719,912	$118,776,486
Average Annual Cost	$47,963,003	$7,038,240	$14,271,991	$11,877,649
City of Grimes				
Number of incidents	4	13	60	717
Total Cost	$16,397,608	$737,880	$1,797,480	$2,261,418
Average Annual Cost	$1,639,761	$73,788	$179,748	$226,142
City of Johnston				
Number of incidents	5	20	97	1,201
Total Cost	$20,497,010	$1,135,200	$2,905,926	$3,787,954
Average Annual Cost	$2,049,701	$113,520	$290,593	$378,795
City of Pleasant Hill				
Number of incidents	7	28	98	796
Total Cost	$28,695,814.00	$1,589,280.00	$2,935,884.00	$2,510,584.00
Average Annual Cost	$2,869,581	$158,928	$293,588	$251,058
City of Urbandale				
Number of incidents	14	116	446	5,914
Total Cost	$57,391,628	$6,584,160	$13,361,268	$18,652,756
Average Annual Cost	$5,739,163	$658,416	$1,336,127	$1,865,276
City of West Des Moines				
Number of incidents	27	189	852	6,668
Total Cost	$110,683,854	$10,727,640	$25,524,216	$21,030,872
Average Annual Cost	$11,068,385	$1,072,764	$2,552,422	$2,103,087
City of Windsor Heights				
Number of incidents	5	31	130	1,473
Total Cost	$20,497,010	$1,759,560	$3,894,540	$4,645,842
Average Annual Cost	$2,049,701	$175,956	$389,454	$464,584

Sources: U.S. Department of Transportation Federal Highway Administration Technical Advisory T 7570.2, 1994. Adjusted to 2013 dollars and Iowa Department of Transportation's Office of Traffic and Safety, http://www.iowadot.gov/crashanalysis/index.htm?

Estimated losses as a result of air transportation, railway transportation and waterway are not available for this analysis.

Future Development

The Iowa Department of Transportation, Office of Aviation, has an Aviation System Plan 2010-2030 that makes recommendations for future development of the air transportation system until 2030. The plan describes the role of air transportation for Iowans for moving people and goods. A 2009 Iowa Department of Transportation study determined that the Iowa air transportation system contributes about $5.4 billion a year to Iowa's economy and supports an estimated 47,034 jobs (source: http://www.iowadot.gov/aviation/studiesreports/systemplanreports.html)

According to the Iowa Department of Transportation, there are no major federal interstate or state highway projects scheduled in Polk County at the time of this planning effort.

The Des Moines Area Metropolitan Planning Organization's *Year 2030 Long-Range Transportation Plan* to address its growing population and employment that are supplemented with increased transportation needs. This plan includes roadways, pedestrian, bicycle and transit system of the Des Moines area and makes recommendations for future transportation needs.

Transportation Hazard Summary by Jurisdiction

All jurisdictions within the planning area are at risk to some kind of transportation incident. Most cities have railroad and highways crossing their city and all jurisdictions are susceptible to airplane crashes.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	4	2	4	1	3.10	High
Cities						
City of Alleman	4	2	4	1	3.10	High
City of Altoona	4	2	4	1	3.10	High
City of Ankeny	4	2	4	1	3.10	High
City of Bondurant	4	2	4	1	3.10	High
City of Clive	4	2	4	1	3.10	High
City of Des Moines	4	2	4	1	3.10	High
City of Elkhart	4	2	4	1	3.10	High
City of Grimes	4	2	4	1	3.10	High
City of Johnston	4	2	4	1	3.10	High
City of Mitchellville	4	2	4	1	3.10	High
City of Pleasant Hill	4	2	4	1	3.10	High
City of Polk City	4	2	4	1	3.10	High
City of Runnells	4	2	4	1	3.10	High
City of Urbandale	4	2	4	1	3.10	High
City of West Des Moines	4	2	4	1	3.10	High
City of Windsor Heights	4	2	4	1	3.10	High
Des Moines Water Works	4	2	4	1	3.10	High
School Districts						
Ankeny, 261	4	2	4	1	3.10	High
Bondurant-Farrar, 720	4	2	4	1	3.10	High
Dallas Center-Grimes, 1576	4	2	4	1	3.10	High
Des Moines Independent, 1737	4	2	4	1	3.10	High
Johnston, 3231	4	2	4	1	3.10	High
North Polk, 4779	4	2	4	1	3.10	High
Saydel, 5805	4	2	4	1	3.10	High
Southeast Polk, 6101	4	2	4	1	3.10	High
Urbandale, 6579	4	2	4	1	3.10	High
West Des Moines	4	2	4	1	3.10	High

3.4.19 Windstorm

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	1	3	2	2.75	Moderate

Profile

Hazard Description

Strong winds can occur year-round in Iowa. These winds typically develop with strong pressure gradients and gusty frontal passages. The closer and stronger two systems are, (one high pressure, one low pressure) the stronger the pressure gradient, and therefore, the stronger the winds are. Objects such as trees, barns, outbuildings, high-profile vehicles, and power line/poles can be toppled or destroyed, and roofs, windows, and homes can be damaged as wind speeds increase. Downbursts can be particularly dangerous to aviation.

The National Weather Service can issue High Wind Watch, High Wind Warning, and Wind Advisory to the public. The following are the definitions of these issuances:

- High Wind Watch—This is issued when there is the potential of high wind speeds developing that may pose a hazard or is are life-threatening.
- High Wind Warning—The 1-minute surface winds of 35 knots (40 mph) or greater lasting for one hour or longer, or winds gusting to 50 knots (58 mph) or greater, regardless of duration, that are either expected or observed over land.
- High Wind Advisory—This is issued when high wind speeds may pose a hazard. Sustained winds 25 to 39 mph and/or gusts to 57 mph.

High winds, often accompanying severe thunderstorms, can cause significant property and crop damage, threaten public safety, and have adverse economic impacts as a result of business closures and power loss.

The damaging winds of thunderstorms include downbursts, microbursts, and straight-line winds. Downbursts are localized currents of air blasting down from a thunderstorm, which induce an outward burst of damaging wind on or near the ground. Microbursts are minimized downbursts covering an area of less than 2.5 miles across. They include a strong wind shear (a rapid change in the direction of wind over a short distance) near the surface. Microbursts may or may not include precipitation and can produce winds at speeds of more than 150 miles per hour. Straight-line winds are generally any thunderstorm wind that is not associated with rotation (i.e., is not a tornado). It is these winds, which can exceed 100 mph, which represent the most common type of severe weather and are responsible for most wind damage related to thunderstorms. Since thunderstorms do not have narrow tracks like tornadoes, the associated wind damage can be extensive and affect entire (and multiple) counties. Objects like trees, barns, outbuildings, high-profile vehicles, and power lines/poles can be toppled or destroyed, and roofs, windows, and homes can be damaged as wind speeds increase.

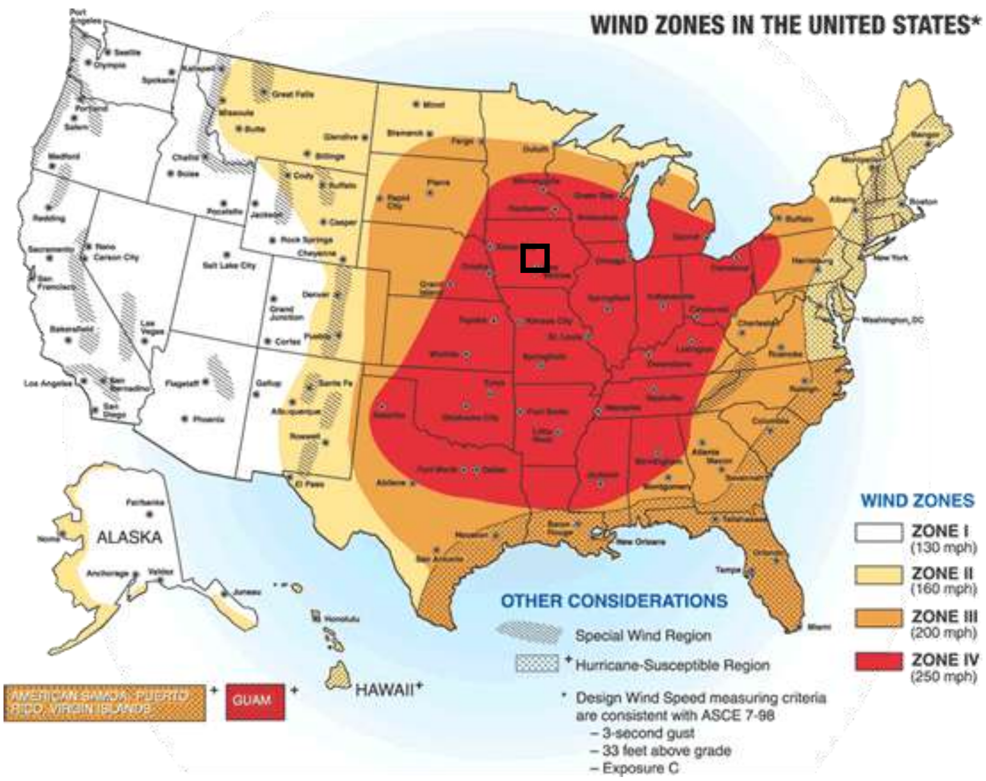
Warning Time: 2—less than one day

Duration: 2—less than 1 day

Geographic Location/Extent

All of Polk County is susceptible to high wind events. The County is located in Wind Zone IV, which is susceptible to winds up to 250 mph. All of the participating jurisdictions are vulnerable to this hazard. **Figure 3.108** shows the wind zones of the United States based on maximum wind speeds; the entire state of Iowa is located within wind zone IV, the highest inland category.

Figure 3.108. Wind Zones in the United States



Source: FEMA; http://www.fema.gov/plan/prevent/saferoom/tsfs02_wind_zones.shtm
Note: Black square indicates approximate location of Polk County

Previous Occurrences

According to the NCDC database, there were 31 high wind events and 331 thunderstorm wind events for a total of 362 events in Polk County between 1996 and April 2013. During this time period there were no reported deaths, 46 injuries causing an estimated $74.6 million in damages. Recorded wind gusts ranged from a high of 104 knots to a low of 36 knots. **Table 3.108** provides a summary of the wind speeds reported for the wind events above 50 knots. Many of the 362 wind events occurred on the same day. When counting only events that occurred on different days, there were 246 separate events in this 17.3 year period.

Table 3.108. Reported Wind Speeds, NCDC Events from 1996 to April 2013

Wind Speed (Knots)	Number of Events
Above 100	1
100-96	1
95-91	0
90-86	1
85-81	1
80-76	1
75-71	5
70-66	13
65-61	45
60-56	42
55-50	136
Total	**246**

Source: NCDC

Table 3.109 shows the number of High Wind Watches, Warnings, and Advisories issued by NOAA's National Weather Service Des Moines Weather Forecast Office. High Wind Advisories are issued every year for the planning area notifying the public that high winds may pose a hazard threat to the community.

Table 3.109. National Weather Service High Wind Watch, Warning, & Advisory Issuance in Polk County, IA, 2005-May 2013

Year	High Wind Watch	High Wind Warning	High Wind Advisory
2013		1	3
2012		3	7
2011			6
2010	2	1	7
2009			3
2008	1	2	10
2007			8
2006		4	8
2005			2
Total	**3**	**11**	**54**

Source: NOAA's National Weather Service Des Moines Weather Forecast Office

Summaries of some of the more damaging events since 1996 are described below. These descriptions are from NCDC and Data Collection Guides completed by participating jurisdictions:

- **April 14, 2012—**Numerous reports of 60 to 70 mph winds were received all along the path. Numerous reports of tree and power line damage were received. The Des Moines metro area was hard hit with winds of up to 65 mph causing considerable tree damage. At one time, 20,000 customers were reported without power.
- **July 18, 2010—**A wide spread thunderstorm produced hail and high winds. Winds of 60 to 75 mph were common causing tree damage. One report stated that a large 3 to 4 foot

diameter White Pine was snapped at the base and another tree fell onto a garage and through a rood in Windsor Heights.

- **July 27, 2008**—There were numerous reports of winds to around 70 mph as the storm moved south across the east side of Des Moines, and on southeast into southeast Iowa.
- **September 8, 2005—**The storm and high winds resulted in power outages to 8,700 customers in the Des Moines area. The high winds caused a semi-tractor trailer and a camper to overturn on Interstate 80 in Polk County.
- **August 22, 2002**—Heavy wind damage occurred in eastern Dallas and Polk Counties. Winds gusted as high as 80 mph as the storm roared through Des Moines. At one point, nearly 50,000 customers were without electricity in the metro Des Moines area. By the evening of the 23rd, power was restored to all but 13,000 to 15,000 customers. Some of the harder hit areas were without power for 2 to 3 days. Damage to trees and power lines was extensive. There were several reports of semi-tractor trailer trucks being blown over by the high winds and structural damage occurred to a few homes.
- **June 29, 1998**—A complex weather situation set up over the central U.S. as a mesoscale convective system passed to the south of Iowa during the overnight hours and early morning of the 29th. The storms produced a variety of severe weather across Iowa. The system initially moved east across the northern and central counties, but then began sinking southeast. The dominant severe weather with the storms was extremely high winds. Winds in excess of 100 mph were reported. At least 38 counties were declared disaster areas by FEMA due to the severe damage and flooding. One of the hardest hit counties was Polk County. Damage appeared to be from straight line winds based on a storm survey that was done following the event. The worst affected metro areas were the Granger area, Johnston, and the northeast side of Des Moines proper. A duplex in Granger was flattened by the winds. There were several reports of roofs being ripped off of stores and houses in the metropolitan Des Moines area. Several small private planes were flipped at a small air field north of Des Moines. There were also several reports of semi-tractor trailer trucks being blown over on Interstate 35. Heavy construction equipment was overturned on Interstate 35/80 just north of Des Moines. Damage was extensive to the east side of Des Moines proper. To make matters worse, following the passage of the main line of thunderstorms, a second line of severe thunderstorms developed and moved across the same areas already hit. Estimates from Polk County alone were $100 million in damage including cleanup. Initial claims estimated over $11 million in damage in Johnston and $726,000 from West Des Moines just to city buildings and systems. West Des Moines was on the far west edge of the major damage, however. Heavy damage was reported by MidAmerica Energy. In the metropolitan Des Moines area, 100,000 homes were without electricity at the height of the storm. That number was reduced to around 25,000 36 hours later. The worst damaged areas were without power for 5 to 6 days. Heavy damage was also reported by local telephone and cable systems. In Polk County, the worst damage extended from the Camp Dodge area into the northeast parts of Des Moines. At least 462 homes in the metro Des Moines area sustained significant damage. In the Camp Dodge area, 80 to 90 percent of the brick buildings were damaged with the roofs removed from many of them. Lightning from the storms struck the WSR-88D in the midst of the storm. The radar was taken out of service for more than 24 hours because of this. Countless reports of parts of crop fields being flattened were received.

According to the USDA Risk Management Agency, insurance payments in Polk County for damages to crops as a result of wind and excessive wind during 2003-2012 totaled $803,271. **Table 3.110** shows the insurable crop insurance claims paid in Polk County as a result of windstorms.

Table 3.110. Crop Insurance Claims Paid in Polk County from Windstorms, 2003-2012.

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2004	Corn	Wind/Excess Wind	$8,839
2008	Corn	Wind/Excess Wind	$160,409
2009	Hybrid Corn	Wind/Excess Wind	$4,854
2011	Corn	Wind/Excess Wind	$33,107
2011	Hybrid Corn	Wind/Excess Wind	$593,887
2012	Corn	Wind/Excess Wind	$2,176
Total			**$803,271**

Source: USDA Risk Management Agency Crop Insurance Payment FOIA Request; USDA Risk Management Agency Iowa Crop Insurance Profile, http://www.rma.usda.gov/pubs/2012/stateprofiles/iowa11.pdf

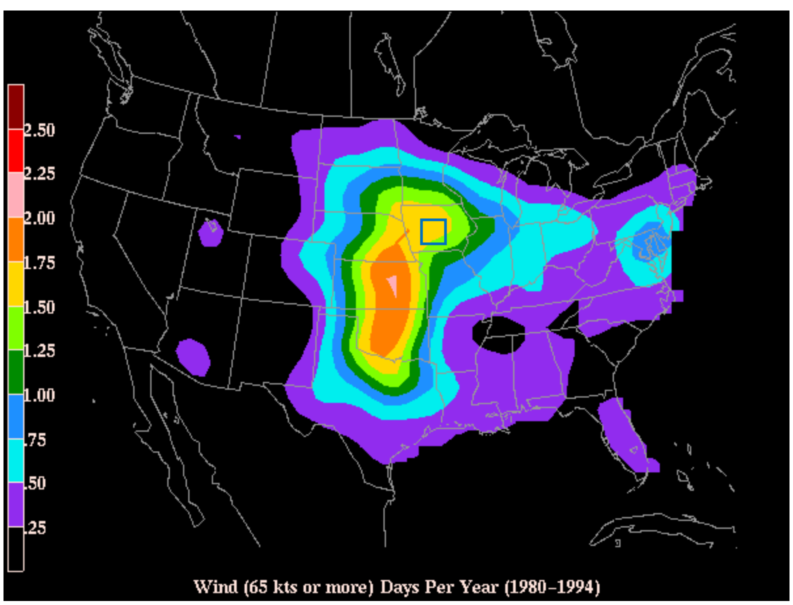
Probability of Future Occurrences

According to NCDC, there were 246 separate events from 1996 to April 2013 (17.3 year period) in Polk County. Based on this data, an average of 14 high wind events occur in Polk County each year.

Probability Score: 4—Highly Likely

Figure 3.109 below shows the probability of a windstorm event (65 knots or greater) in the U.S. The Polk County planning area is colored yellow showing that 65+ knot wind is probable to occur 1.50 to 1.75 times a year.

Figure 3.109. Annual Windstorm Probability (65+ knots), United States 1980-1994



Source: NSSL, http://www.nssl.noaa.gov/users/brooks/public_html/bigwind.gif;
Note: Blue square indicates approximate location of Polk County

Vulnerability

Overview

Windstorm is primarily a public safety and economic concern, and the planning area is located in a region with very high frequency of occurrence. Windstorm can cause damage to structures and power lines which in turn create hazardous conditions for people. Debris flying from high wind events can shatter windows in structures and vehicles and can harm people that are not adequately sheltered.

Although windstorms occur frequently in the planning area and damages to property occur, much of the damage is generally covered by private insurance. This results in less impact to individuals and the community since recovery is facilitated by insurance.

Magnitude Score: 1 — Negligible

Potential Losses to Existing Development

Campers, construction trailers, mobile homes, outbuildings, barns, and sheds and other dwellings without secure foundations or basements their occupants are particularly vulnerable as windstorm events in Polk County can be sufficient in magnitude to overturn these lighter structures.

Loss of Use

Overhead power lines and infrastructure are also vulnerable to damages from windstorms. Potential losses would include cost of repair or replacement of damaged facilities, and lost economic opportunities for businesses. Public safety hazards include risk of electrocution from downed power lines. Specific amounts of estimated losses are not available due to the complexity and multiple variables associated with this hazard. The electric power loss of use estimates provided in **Table 3.111** below were calculated using FEMA's Standard Values for Loss of Service for Utilities published in the June 2009 *BCA Reference Guide*. These figures are used to provide estimated costs associated with the loss of power in relation to the populations in Polk County's jurisdictions. The loss of use estimates for power failure associated with windstorms is provided as the loss of use cost per person, per day of loss. The estimated loss of use provided for each jurisdiction represents the loss of service of the indicated utility for one day for 10 percent of the population. It is understood that in rural areas, the typical loss of use may be for a larger percentage of the population for a longer time during weather extremes. These figures do not take into account physical damages to utility equipment and infrastructure.

Table 3.111. Loss of Use Estimates for Power Failure

Jurisdiction	County	Population	Estimated Affected Population 10%	Electric Loss of Use Estimate ($126 per person per day)
City of Alleman	Polk	432	43	$5,443
City of Altoona	Polk	14,541	1,454	$183,217
City of Ankeny	Polk	45,580	4,558	$574,308
City of Bondurant	Polk	3,860	386	$48,636
City of Carlisle	Polk	82	8	$1,033
City of Clive	Dallas	4,713	471	$59,384
City of Clive	Polk	10,728	1,073	$135,173

Jurisdiction	County	Population	Estimated Affected Population 10%	Electric Loss of Use Estimate ($126 per person per day)
City of Des Moines	Polk	204,122	20,412	$2,571,937
City of Des Moines	Warren	625	63	$7,875
City of Elkhart	Polk	683	68	$8,606
City of Granger	Polk	212	21	$2,671
City of Grimes	Dallas	14	1	$176
City of Grimes	Polk	8,232	823	$103,723
City of Johnston	Polk	17,278	1,728	$217,703
City of Mitchellville	Jasper	26	3	$328
City of Mitchellville	Polk	2,228	223	$28,073
City of Norwalk	Polk	0	0	$0
City of Pleasant Hill	Polk	9,009	901	$113,513
City of Polk City	Polk	3,416	342	$43,042
Polk County	Polk	26,581	2,658	$335,462
City of Runnells	Polk	507	51	$6,388
City of Sheldahl	Polk	134	13	$1,688
City of Urbandale	Dallas	6,339	634	$79,871
City of Urbandale	Polk	33,070	3,307	$416,682
City of West Des Moines	Dallas	11,764	1,176	$148,226
City of West Des Moines	Madison	3	0	$38
City of West Des Moines	Polk	44,999	4,500	$566,987
City of West Des Moines	Warren	41	4	$517
City of Windsor Heights	Polk	4,860	486	$61,236
Total		454,165	45,417	$5,722,479

Source: Population, U.S. Census Bureau, 2010; Loss of Use Estimates from FEMA BCA Reference Guide, 2009

Property and Crop Losses

Property damage estimates from NCDC from 1996 to April 2013 were $74.6 million. This translates to an annual average of $4,312,138. Additionally crop insurance payments for the period from 2003-2012 were $803,271 for wind damage. This was adjusted to $912,808 to account for uninsured crops (see **Table 3.112**) based on the 2012 Iowa Crop Insurance Profile from USDA, 88 percent of insurable crops are insured in the State.

Considering the value of crops from the 2007 Census of Agriculture as baseline crop exposure, the estimated annual losses from high winds was determined minimal compared to the value of the insurable crops.

Table 3.112. Estimated Insurable Annual Crops Lost Resulting From High Winds

10-Year High Wind Insurance Paid	Adjusted 10-Year High Wind Losses (considering 88% insured)	Estimated Annualized Losses*	2007 Value of Crops
$803,271	$912,808	$91,280	$105,403,000

Source: Crop value is from USDA 2007 Census of Agriculture; Crop Insurance Paid is from the USDA's Risk Management Agency for 2003-2012.*Note: This includes insurable crops that are insured

Future Development

The entire planning area is at risk to damage from high wind and thunderstorm wind events, thus additional development will increase the exposure of the built environment to damage from wind. Future development projects should consider windstorm hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability.

Windstorm Hazard Summary by Jurisdiction

The following hazard summary table demonstrates that the windstorm hazard does not vary among the jurisdictions in the planning area.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	4	1	3	2	2.75	Moderate
Cities						
City of Alleman	4	1	3	2	2.75	Moderate
City of Altoona	4	1	3	2	2.75	Moderate
City of Ankeny	4	1	3	2	2.75	Moderate
City of Bondurant	4	1	3	2	2.75	Moderate
City of Clive	4	1	3	2	2.75	Moderate
City of Des Moines	4	1	3	2	2.75	Moderate
City of Elkhart	4	1	3	2	2.75	Moderate
City of Grimes	4	1	3	2	2.75	Moderate
City of Johnston	4	1	3	2	2.75	Moderate
City of Mitchellville	4	1	3	2	2.75	Moderate
City of Pleasant Hill	4	1	3	2	2.75	Moderate
City of Polk City	4	1	3	2	2.75	Moderate
City of Runnells	4	1	3	2	2.75	Moderate
City of Urbandale	4	1	3	2	2.75	Moderate
City of West Des Moines	4	1	3	2	2.75	Moderate
City of Windsor Heights	4	1	3	2	2.75	Moderate
Des Moines Water Works	4	1	3	2	2.75	Moderate
School Districts						
Ankeny, 261	4	1	3	2	2.75	Moderate
Bondurant-Farrar, 720	4	1	3	2	2.75	Moderate
Dallas Center-Grimes, 1576	4	1	3	2	2.75	Moderate
Des Moines Independent, 1737	4	1	3	2	2.75	Moderate
Johnston, 3231	4	1	3	2	2.75	Moderate
North Polk, 4779	4	1	3	2	2.75	Moderate
Saydel, 5805	4	1	3	2	2.75	Moderate
Southeast Polk, 6101	4	1	3	2	2.75	Moderate
Urbandale, 6579	4	1	3	2	2.75	Moderate
West Des Moines	4	1	3	2	2.75	Moderate

3.4.20 Winter Storm

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	2	3	3	3.15	High

Profile

Hazard Description

A major winter storm can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. The National Weather Service describes different types of winter storm events as follows:

- **Blizzard—**Winds of 35 mph or more with snow and blowing snow reducing visibility to less than ¼ mile for at least three hours.
- **Blowing Snow**—Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- **Snow Squalls**—Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
- **Snow Showers**—Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- **Freezing Rain—**Measurable rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces, such as trees, cars, and roads, forming a coating or glaze of ice. Most freezing-rain events are short lived and occur near sunrise between the months of December and March.
- **Sleet**—Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects.

Heavy accumulations of ice, often the result of freezing rain, can bring down trees, utility poles, and communications towers and disrupt communications and power for days (see **Figure 3.110**). Even small accumulations of ice can be extremely dangerous to motorists and pedestrians.

Figure 3.110. Ice on Stop Sign in Polk County, IA

Source: Polk County Emergency Management, 2013

Severe winter storms include extreme cold, heavy snowfall, ice, and strong winds which can push the wind chill well below zero degrees in the planning area. Heavy snow can bring a community to a standstill by inhibiting transportation (in whiteout conditions), weighing down utility lines, and by causing structural collapse in buildings not designed to withstand the weight of the snow. Repair and snow removal costs can be significant. Ice buildup can collapse utility lines and communication towers, as well as make transportation difficult and hazardous. Ice can also become a problem on roadways if the air temperature is high enough so that precipitation falls as freezing rain rather than snow.

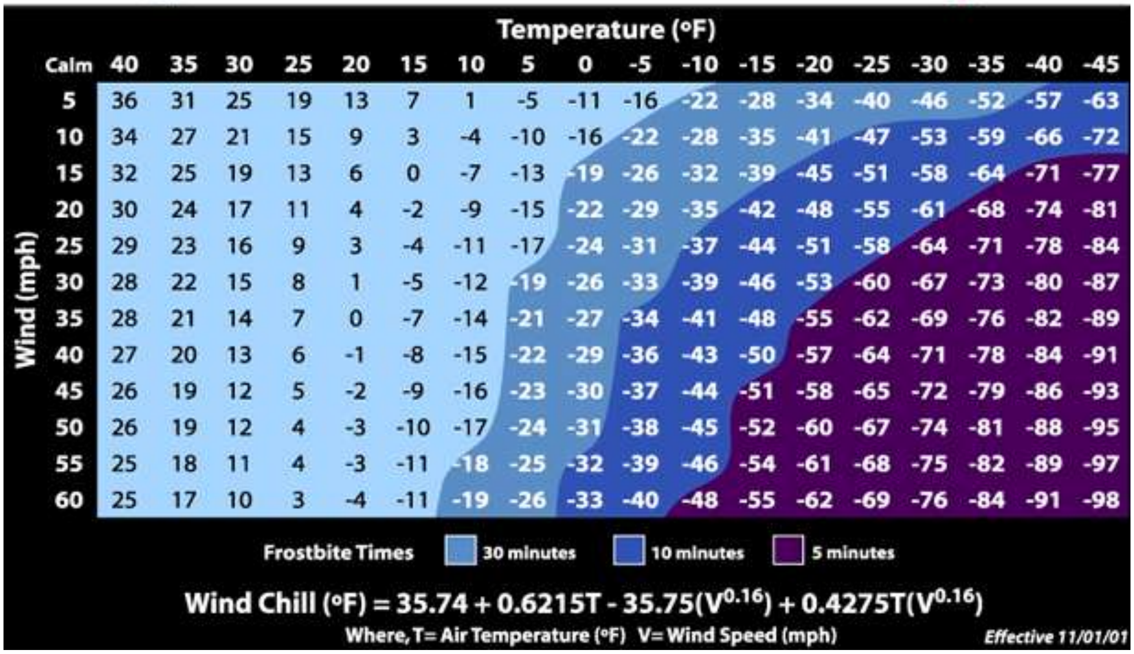
Extreme cold often accompanies severe winter storms and can lead to hypothermia and frostbite in people who are exposed to the weather without adequate clothing protection. Cold can cause fuel to congeal in storage tanks and supply lines, stopping electric generators. Cold temperatures can also overpower a building’s heating system and cause water and sewer pipes to freeze and rupture. Extreme cold also increases the likelihood for ice jams on flat rivers or streams. When combined with high winds from winter storms, extreme cold becomes extreme wind chill, which is extremely hazardous to health and safety.

The National Institute on Aging estimates that more than 2.5 million Americans are especially vulnerable to hypothermia, with the isolated elderly being most at risk. About 10 percent of people over the age of 65 have some kind of temperature-regulating defect, and 3-4 percent of all hospital patients over 65 are hypothermic.

Also at risk are those without shelter or who are stranded, or who live in a home that is poorly insulated or without heat. Other impacts of extreme cold include asphyxiation (unconsciousness or death from a lack of oxygen) from toxic fumes from emergency heaters; household fires, which can be caused by fireplaces and emergency heaters; and frozen/burst pipes.

Wind can greatly amplify the impact of cold ambient air temperatures. Provided by the National Weather Service**, Figure 3.111** below shows the relationship of wind speed to apparent temperature and typical time periods for the onset of frostbite.

Figure 3.111. Wind Chill Chart



Temperature (°F)

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

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: National Weather Service

Warning Time Score: 3—6-12 hours

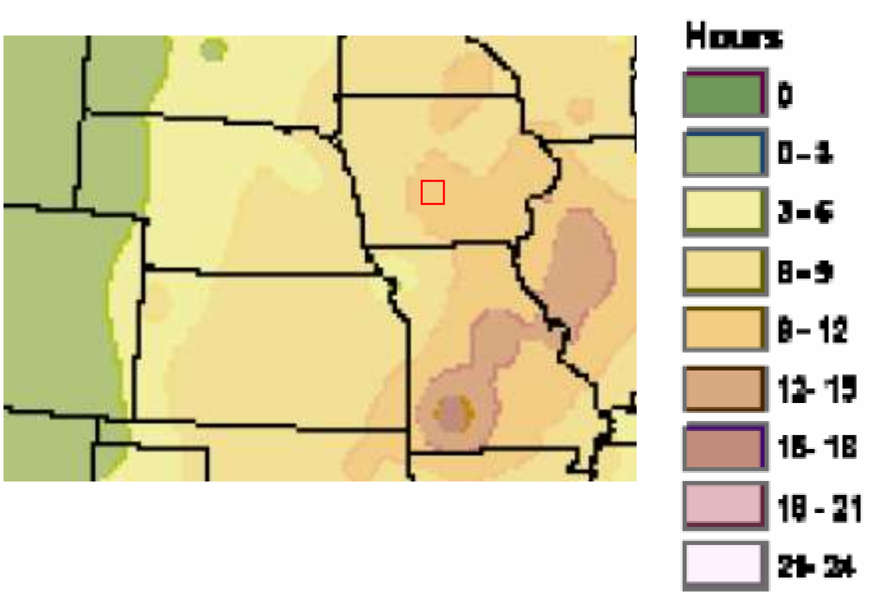
Duration Score: 3—less than 1 week

Geographic Location/Extent

The entire state of Iowa is vulnerable to heavy snow, extreme cold temperatures and freezing rain. The snow season normally extends from late October through mid-April but significant snows have fallen as early as September 16 (1881) to as late as May 28 (1947).

Figure 3.112 shows that the entire planning area (approximated within the red square) is in the orange-shaded area that receives 9-12 hours of freezing rain per year.

Figure 3.112. Average Number of Hours per Year with Freezing Rain

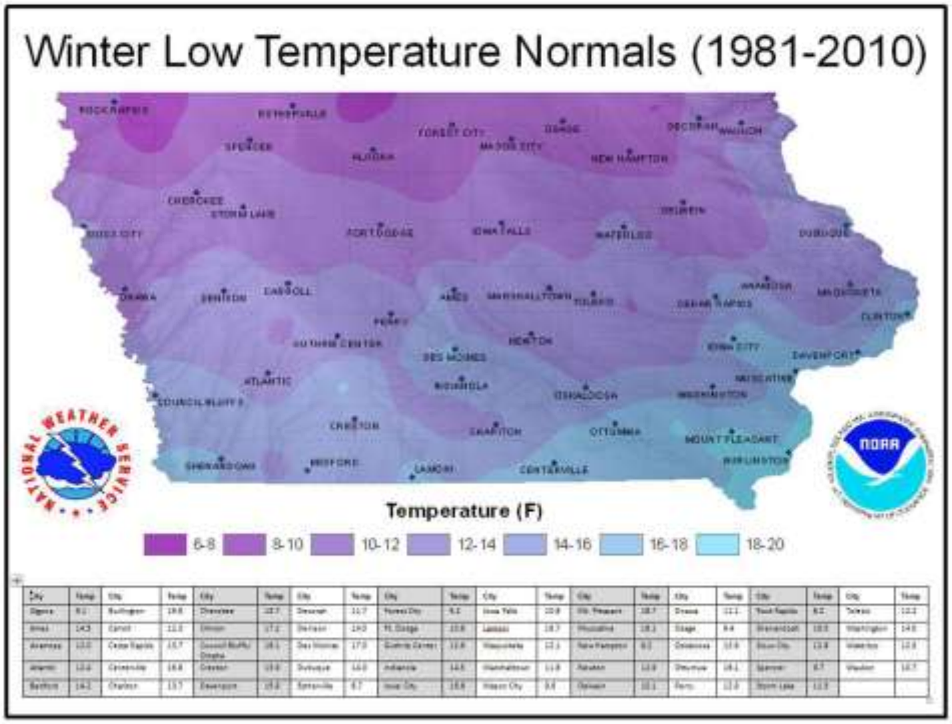


Source: American Meteorological Society. “Freezing Rain Events in the United States.” http://ams.confex.com/ams/pdfpapers/71872.pdf.; Note: red square provides approximate location of planning area.

Previous Occurrences

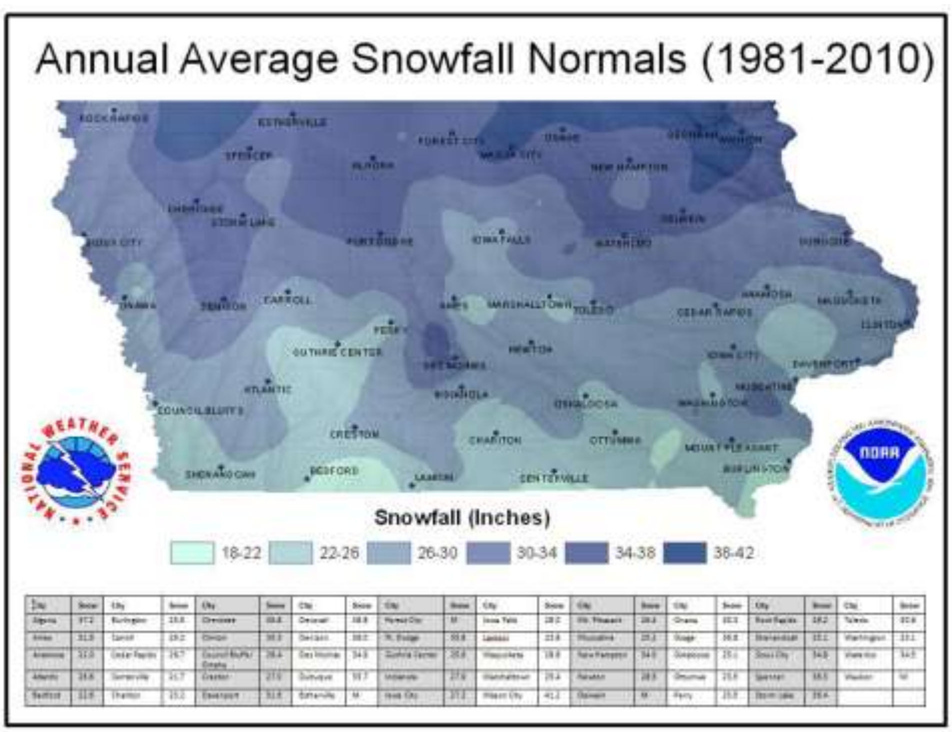
According to the NWS from 1981-2010 for Des Moines, the winter high temperature normal is 33.6 degrees (F), the winter low temperature normal is 17 degrees (F) (see **Figure 3.113**) and the annual average snowfall is 34.9 inches (see **Figure 3.114**).

Figure 3.113. NWS Statewide Winter Low Temperature Normals (1981-2010)



Source: National Weather Service Weather Forecast Office, Des Moines, IA

Figure 3.114. NWS Statewide Annual Average Snowfall Normals (1981-2010)



Source: National Weather Service Weather Forecast Office, Des Moines, IA

Historically, there have been two Presidential Disaster Declarations for Severe Winter Storm that included Polk County (**Table 3.113)**.

Table 3.113. Winter Storm Presidential Disaster Declarations (1965-April 2013)

Disaster Number	Description	Declaration Date (Incident Period)
DR-1688	Severe Winter Storms	03/14/2007 (2/23 to 3/2/2007)
DR-1191	Severe Snow Storm	11/20/1997 (10/26 to 10/28/1997)

Source: Federal Emergency Management Agency, www.fema.gov/; Note: Incident dates are in parentheses

From 1996 to April 2013, the National Climatic Data Center and NWS reports 11 blizzard events, 19 heavy snow events, 15 winter storm events, 10 ice storm events, and three wind chill events for a total of 58 winter events that impacted the planning area during this 17.3 year time-period. This translates to an average of three winter storm events each year. The total property damage for these 58 events was over $7 million.

NOAA's National Weather Service Des Moines Weather Forecast Office has issued 178 Advisory, Watch, and/or Warnings concerning winter weather phenomena between 2005 and May 2013 (see **Table 3.114**).

Table 3.114. National Weather Service Des Moines Weather Forecast Office Issuances for Winter Weather

Phenomena	Significance	Number Issued between 2005 and May 2013
Blizzard	Warning	8
Blizzard	Watch	3
Blowing Snow	Advisory	5
Freeze	Warning	9
Freeze	Watch	4
Freezing Fog	Advisory	1
Freezing Rain	Advisory	5
Frost	Advisory	10
Heavy Snow	Warning	1
Ice Storm	Warning	3
Snow	Advisory	12
Snow & Blowing Snow	Advisory	7
Wind Chill	Warning	3
Winter Storm	Warning	19
Winter Storm	Watch	33
Winter Weather	Advisory	58
Total		**178**

The following section provides additional information for some of the winter storm and ice storm events that have impacted Polk County:

- **Year of 2012**—There were 279 days without measurable snowfall starting on March 5th and extending through December 8th**.** This is the longest streak on record without measurable snowfall. The old record was set in 1889.

January 25-26, 2010—Nearly 5 inches of snow fell during this blizzard event causing treacherous road conditions as well as costs for snow removal causing an estimated $75,000 in property damages.

- **January 20, 2010**—A large area of freezing rain developed with embedded thunderstorms across southern Iowa during the early morning hours of the 20th. Thunderstorms produced moderate to heavy freezing rain and some small hail as they overspread the southern third of the State causing an estimated $300,000 in property damages.
- **January 8, 2010**—The NWS in Des Moines issued a wind chill warning for that evening.
- **December 8-9, 2009**—12-14 inch snowfall was received followed by wind gusts up to 50 miles per hour causing whiteout conditions and blocked roadways. With this near-record snowfall and persistent cold weather combined to all the statewide average snow cover to exceed five inches for 89 consecutive days.
- **January 14, 2009**— The NWS in Des Moines issued a wind chill warning for that evening.
- **December 21, 2008**—The NWS in Des Moines issued a wind chill warning for that evening.
- **FEMA-1688-DR-IA, February 2007—**A major winter storm affected Iowa through the 24th and 25th of February. Widespread tree and power line damage was reported. At the height of the storm, at least 265,000 customers were without power in a multi-county area. Alliant Energy/Interstate Power and Light Company reported that 1,000 miles of transmission line was down at one point and 2,000 utility poles were snapped in their area. MidAmerican Energy reported 360 miles of transmission line down and 1,600 utility poles snapped in their area. Final damage figures for the three utility entities involved in the ice storm were $70,000,000 damage to Alliant Energy equipment, $36,000,000 damage to MidAmerican Energy equipment, and $32,000,000 damage to Rural Electric Cooperative equipment. These figures are statewide figures. Travel became very hazardous with many roads closed due to the combination of snow, blowing snow, fallen wires, and fallen trees. Numerous activities were canceled on the 25th as well. By the afternoon of the 25th, Iowa Governor Chet Culver declared 60 counties as State Disaster Areas. Subsequently, 46 of the counties were declared Presidential Disaster Areas.

  In Polk County, homes suffered roof damage and downed trees and limbs were costly to clean up. Roads and schools were also closed as a result of this event.

- **December 11, 2007**—A large area of freezing rain developed by the late evening hours over southern Iowa. The heaviest ice accumulations took place over south central Iowa from just south of Des Moines, southwest to Taylor County and east toward into Wapello and Davis Counties. The Des Moines International Airport was closed for a 6 hour period as a plane slid off the tarmac in the icy conditions. No injuries were reported at the airport. The ice caused $200,000 damage to the Southern Iowa Electrical Cooperative. Due to the severity of the storm, Governor Chet Culver declared 23 southeast Iowa counties disaster areas.

Figure 3.115. Fog and Snow in Des Moines, IA, 2010

Source: Polk County Emergency Management, 2013

Agricultural Impacts

Winter storms, cold, frost and freeze take a toll on crop production in the planning area. According to the USDA's Risk Management Agency, payments for insured crop losses in the planning area as a result of cold conditions and snow from 2003-2012 totaled $395,163.

Table 3.115. Crop Insurance Claims Paid in Polk County as a Result of Cold Conditions and Snow (2003-2012)

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2003	Corn	Cold Wet Weather	$711
2005	Corn	Cold Wet Weather	$15,170
2005	Soybeans	Cold Wet Weather	$2,751
2005	Fresh Market Sweet Corn	Freeze	$4,393
2007	Corn	Snow	$1,285
2008	Corn	Cold Wet Weather	$4,298
2008	Soybeans	Frost	$6,036
2008	Corn	Snow	$5,801
2009	Corn	Cold Wet Weather	$160
2009	Soybeans	Frost	$1,860
2010	Corn	Cold Wet Weather	$8,592
2010	Hybrid Corn Seed	Frost	$331,344
2011	Corn	Cold Wet Weather	$4,349
2011	Soybeans	Cold Wet Weather	$5,596
2012	CORN	Cold Wet Weather	$2,817
Total			**$395,163**

Source: USDA Risk Management Agency, 2013

Probability of Future Occurrence
According to NCDC, during the 17.3 year period from 1996 to April 2013, the planning area experienced 58 total blizzards, winter storms, ice storms and extreme cold events. This translates to an annual probability of approximately three blizzard, winter or ice storm events per year.

Probability Score: 1—Highly Likely

Vulnerability

Vulnerability Overview
The entire planning area is vulnerable to the effects of winter storm. Hazardous driving conditions due to snow and ice on highways and bridges lead to many traffic accidents and can impact the response of emergency vehicles. The leading cause of death during winter storms is transportation accidents. About 70 percent of winter-related deaths occur in automobiles due to traffic accidents and about 25 percent are from people caught outside in a storm. Emergency services such as police, fire, and ambulance are unable to respond due to road conditions. Emergency needs of remote or isolated residents for food or fuel, as well as for feed, water and shelter for livestock are unable to be met. The probability of utility and infrastructure failure increases during winter storms due to freezing rain accumulation on utility poles and power lines. People, pets, and livestock are also susceptible to frostbite and hypothermia during winter storms. Those at risk are primarily either engaged in outdoor activity (shoveling snow, digging out vehicles, or assisting stranded motorists), or are the elderly. Schools often close during extreme cold or heavy snow conditions to protect the safety of children and bus drivers. Citizens' use of kerosene heaters and other alternative forms of heating may create other hazards such as structural fires and carbon monoxide poisoning.

According to the 2013 Iowa Hazard Mitigation Plan, of the 8 hazards for which date was available to estimate annualized losses, severe winter storm ranked 6th with $2.2 million in annualized losses based on data spanning a 13-year period.

Magnitude Score: 2—Limited

Potential Losses to Existing Development
Vulnerable Buildings, Infrastructure, and Critical Facilities

Buildings with overhanging tree limbs are more vulnerable to damage during winter storms. Businesses experience loss of income as a result of closure during power outages. In general heavy winter storms increase wear and tear on roadways though the cost of such damages is difficult to determine. Businesses can experience loss of income as a result of closure during winter storms.

Loss of Use
Overhead power lines and infrastructure are also vulnerable to damages from winter storms, in particular ice accumulation during winter storm events can cause damages to power lines due to the ice weight on the lines and equipment as well as damage caused to lines and equipment from falling trees and tree limbs weighted down by ice. Potential losses would include cost of repair or replacement of damaged facilities, and lost economic opportunities for businesses.

Secondary effects from loss of power could include burst water pipes in homes without electricity during winter storms. Public safety hazards include risk of electrocution from downed power lines. Specific amounts of estimated losses are not available due to the complexity and multiple variables associated with this hazard. According to FEMA standard values for loss of service for utilities reported in the 2009 BCA Reference Guide, the economic impact as a result of loss of power is $126 per person per day of lost service. The loss of use estimates in the **Windstorm Section 3.4.19** in **Table 3.111** are provided to estimate costs associated with the loss of power in relation to the populations in each jurisdiction.

Property Losses
The total property losses reported by the National Climatic Data Center for a total of 58 winter events that impacted the planning area during the 17.3 year time-period from 1996 to April 2013 were over $7 million. However, damages for winter and ice storms are reported for all weather zones impacted. So, it is not possible to determine the damages from these events to just Polk County.

USDA crop insurance claims for cold conditions and snow for the ten-year period of 2003-2012 totaled $395,163. The 2012 Iowa Crop Insurance Profile from USDA, RMA shows that 88 percent of crops are insured in Iowa and the adjusted losses calculate to $449,049 for the period (see **Table 3.116**).

Considering the value of crops from the 2007 Census of Agriculture as baseline crop exposure, the estimated annual losses from cold conditions and snow was determined minimal compared to the value of the insurable crops.

Table 3.116. Estimated Insurable Annual Crops Lost Resulting From Cold Conditions and Snow

10-Year Winter Weather Insurance Paid	Adjusted 10-Year Winter Weather Losses (considering 88% insured)	Estimated Annualized Losses*	2007 Value of Crops
$395,163	$449,049	$44,905	$105,403,000

Source: Crop value is from USDA 2007 Census of Agriculture; Crop Insurance Paid is from the USDA's Risk Management Agency for 2003-2012.: *Note: This includes insurable crops that are insured

Increased Risk Populations
Elderly populations are considered to be at increased risk to Winter Storms and associated extreme cold events. **Table 3.38** in the Extreme Heat hazard profile section provides the number of population over 65 in each jurisdiction in the planning area.

Future Development
Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks.

Winter Storm Hazard Summary by Jurisdiction
Although crop loss as a result of winter storm occurs more in the unincorporated portions of the planning area, the crops losses are not high since corn and soybeans are not in the ground during winter months and only get affected from unusually weather events. The density of

vulnerable populations is higher in the urban areas of the planning areas. Transportation incidents related to winter storm could also impact all jurisdictions. So, the magnitude of this hazard is relatively equal. The factors of probability, warning time, and duration are also equal across the planning area. This hazard does not substantially vary by jurisdiction.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Polk County	4	2	3	3	3.15	High
Cities						
City of Alleman	4	2	3	3	3.15	High
City of Altoona	4	2	3	3	3.15	High
City of Ankeny	4	2	3	3	3.15	High
City of Bondurant	4	2	3	3	3.15	High
City of Clive	4	2	3	3	3.15	High
City of Des Moines	4	2	3	3	3.15	High
City of Elkhart	4	2	3	3	3.15	High
City of Grimes	4	2	3	3	3.15	High
City of Johnston	4	2	3	3	3.15	High
City of Mitchellville	4	2	3	3	3.15	High
City of Pleasant Hill	4	2	3	3	3.15	High
City of Polk City	4	2	3	3	3.15	High
City of Runnells	4	2	3	3	3.15	High
City of Urbandale	4	2	3	3	3.15	High
City of West Des Moines	4	2	3	3	3.15	High
City of Windsor Heights	4	2	3	3	3.15	High
Des Moines Water Works	4	2	3	3	3.15	High
School Districts						
Ankeny, 261	4	2	3	3	3.15	High
Bondurant-Farrar, 720	4	2	3	3	3.15	High
Dallas Center-Grimes, 1576	4	2	3	3	3.15	High
Des Moines Independent, 1737	4	2	3	3	3.15	High
Johnston, 3231	4	2	3	3	3.15	High
North Polk, 4779	4	2	3	3	3.15	High
Saydel, 5805	4	2	3	3	3.15	High
Southeast Polk, 6101	4	2	3	3	3.15	High
Urbandale, 6579	4	2	3	3	3.15	High
West Des Moines	4	2	3	3	3.15	High

3.5 Hazard Analysis Summary

This section provides a tabular summary of the hazard ranking for each jurisdiction in the planning area as well as a consequence analysis summary for each hazard based on Emergency Management Accreditation Program (EMAP) risk assessment standards.

3.5.1 Hazard Ranking Summary by Jurisdiction

Jurisdiction	Animal/Plant/ Crop Disease	Dam Failure	Drought	Earthquake	Expansive Soils	Extreme Heat	Flash Flooding	Grass/Wildland Fire	HAZMAT incident	Human Disease	Infrastructure Failure	Levee Failure	River Flooding	Sinkholes/Landslide	Structural Fire	Thunderstorm/Lightning/Hail	Tornado	Transportation Incident	Windstorm	Winter Storm
Polk County	1.60	2.35	2.20	1.45	1.45	1.95	3.10	2.65	3.10	2.50	2.50	N/A	3.25	1.45	3.10	2.65	2.95	3.10	2.75	3.15
City of Alleman	1.60	N/A	2.20	1.45	1.45	1.95	3.10	1.00	2.20	2.50	2.50	N/A	3.25	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Altoona	1.60	2.05	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	N/A	2.65	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Ankeny	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.90	3.10	2.50	2.50	N/A	2.95	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Bondurant	1.60	N/A	2.20	1.45	1.45	1.95	1.60	1.00	2.20	2.50	2.50	N/A	3.25	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Clive	1.60	2.35	2.20	1.45	1.45	1.95	1.60	1.00	3.10	2.50	2.50	N/A	3.25	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Des Moines	1.60	2.35	2.20	1.45	1.45	1.95	3.10	2.35	3.10	2.50	2.50	2.80	2.95	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Elkhart	1.60	N/A	2.20	1.45	1.45	1.95	3.10	1.00	2.20	2.50	2.50	N/A	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Grimes	1.60	N/A	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	N/A	3.25	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Johnston	1.60	2.35	2.20	1.45	1.45	1.95	1.60	1.45	3.10	2.50	2.50	N/A	3.25	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Mitchellville	1.60	N/A	2.20	1.45	1.45	1.95	3.10	1.00	2.20	2.50	2.50	N/A	2.65	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Pleasant Hill	1.60	2.35	2.20	1.45	1.45	1.95	3.10	2.35	3.10	2.50	2.50	N/A	2.95	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Polk City	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.45	2.20	2.50	2.50	N/A	2.95	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Runnels	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.00	2.20	2.50	2.50	N/A	2.65	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Urbandale	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	N/A	3.25	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of West Des Moines	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.90	3.10	2.50	2.50	2.80	2.95	1.45	3.10	2.95	2.95	3.10	2.75	3.15
City of Windsor Heights	1.60	N/A	2.20	1.45	1.45	1.95	3.10	1.00	2.20	2.50	2.50	N/A	3.25	1.45	3.10	2.95	2.95	3.10	2.75	3.15
Des Moines Water Works	N/A	2.35	2.20	1.45	1.45	1.95	1.60	1.00	3.10	2.50	2.50	2.80	3.25	1.45	3.10	2.95	2.95	3.10	2.75	3.15
Ankeny, 261	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	N/A	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15
Bondurant-Farrar, 720	1.60	N/A	2.20	1.45	1.45	1.95	1.60	1.00	2.20	2.50	2.50	N/A	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15
Dallas Center-Grimes, 1576	1.60	N/A	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	N/A	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15
Des Moines Independent, 1737	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	2.80	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15
Johnston, 3231	1.60	2.35	2.20	1.45	1.45	1.95	1.60	1.00	3.10	2.50	2.50	N/A	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15
North Polk, 4779	1.60	N/A	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	N/A	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15
Saydel, 5805	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	N/A	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15
Southeast Polk, 6101	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	N/A	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15
Urbandale, 6579	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	N/A	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15
West Des Moines Schools	1.60	2.35	2.20	1.45	1.45	1.95	3.10	1.00	3.10	2.50	2.50	2.80	N/A	1.45	3.10	2.95	2.95	3.10	2.75	3.15

3.5.2 Consequence Analysis Summary

The Emergency Management Accreditation Program (EMAP) standards for a risk assessment require inclusion of a consequence analysis for the hazards that have potential impact on the planning area. **0** is the consequence analysis summary for the hazards in this plan update.

Table 3.117. EMAP Consequence Analysis

Hazard	Subject	Impacts
Animal/Plant/ Crop Disease	General Public	Impact of this hazard on the Health and Safety of the General Public would be minimal as long as it is recognized and contained. If the infestation is unrecognized, then there is the potential for the food supply to be contaminated or plants to be destroyed.
	First Responders	Impact to responders would be minimal with protective clothing, gloves, etc. Most of the plant/crop diseases cause no risk to humans. Animal diseases are more likely to impact responders. As a result, the type of disease should dictate the type of personal protective equipment necessary.
	Continuity of Government and Services	Minimal expectation of execution of the COOP.
	Property, Facilities and Infrastructure	Localized impact to facilities and infrastructure in the incident area is minimal to non-existent.
	Environment	Impact could be severe to the incident area, specifically, plants, trees, bushes, and crops.
	Economic Conditions	Impacts to the economy will depend on the severity of the infestation. The potential for economic loss to the community could be severe if the infestation is hard to contain, eliminate, or reduce. Impact could be minimized due to crop insurance.
	Public Confidence in Jurisdiction's Governance	Confidence could be in question depending on timeliness and steps taken to warn the producers and public, and treat/eradicate the infestation.
Dam Failure	General Public	Localized impact expected to be severe for the inundation area and moderate to minimal for other affected areas.
	First Responders	Impact to responders is expected to be minimal with proper training. Impact could be severe if there is lack of training.
	Continuity of Government and Services	Temporary relocation may be necessary if inundation affects government facilities.
	Property, Facilities and Infrastructure	Localized impact could be severe in the inundation area of the incident to facilities and infrastructure. The further away from the incident area the damage lessens to minimal to moderate.
	Environment	Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area.
	Economic Conditions	Impacts to the economy will greatly depend on the scope of the inundation and the amount of time it takes for the water to recede.
	Public Confidence in Jurisdiction's Governance	Depending on the perception of whether the failure could have been prevented, warning time, and the time it takes for response and recovery will greatly impact the public's confidence.

Hazard	Subject	Impacts
Drought	General Public	Drought impact tends to be agricultural, however, because of the lack of precipitation that precipitates drought, water supply disruptions can occur which can affect people. Mental health issues such as stress, anxiety, depression, and addition recurrence may arise with loss of income in agricultural areas. Impact is expected to be minimal.
	First Responders	With proper preparedness and protection, impact to the responders is expected to be minimal.
	Continuity of Government and Services	Minimal expectation for utilization of the COOP.
	Property, Facilities and Infrastructure	Impact to property, facilities, and infrastructure are mainly minimal. Structural integrity of buildings and buckling of roads could occur. Damaged landscaping from municipal water restrictions may occur. Increased secondary risk of grass / wildfires may threaten property.
	Environment	The impact to the environment could be severe. Drought can severely affect farming, ranching, wildlife and plants due to the lack of precipitation. Land quality can be negatively impacted by overgrazing during drought. Water quality can become degraded and can cause a large nitrate concentration in the rivers. Low stream flow will be negative impacts on riparian habitats and aquatic species.
	Economic Conditions	Impacts to the economy will be dependent on how extreme the drought is and how long it lasts. Communities whose economy depends on water recreation/tourism and agriculture could be stressed (Minimal to Moderate)
	Public Confidence in Jurisdiction's Governance	Confidence could be at issue during periods of extreme drought if planning is not in place to address intake needs and loss of agricultural income.
Earthquake	General Public	Impact in the incident area expected to be minimal in the State of Iowa.
	First Responders	With proper preparedness and protection, impact to the responders is expected to be non-existent to minimal.
	Continuity of Government and Services	COOP is not expected to be activated (minimal).
	Property, Facilities and Infrastructure	Impact to property, facilities, and infrastructure could be minimal. Facilities, Infrastructure, and personnel could be minimally affected.
	Environment	No expectation of environmental impact (minimal).
	Economic Conditions	No expectation of economic conditions being impacted (minimal).
	Public Confidence in Jurisdiction's Governance	No change in confidence in jurisdictions governance (minimal).
Expansive Soils	General Public	Minimal impact.
	First Responders	Minimal impact.
	Continuity of Government and Services	Minimal expectation for utilization of the COOP unless facility structures have extensive damage.
	Property, Facilities and Infrastructure	Localized impact could be moderate as it relates to property, facilities, and infrastructure. Expansive soils could cause structural integrity to be lost, and roadways, railways, etc., to buckle.
	Environment	Expansive soils could cause moderate damage to the environment, particularly dams and levees.
	Economic Conditions	The impact to the economy is with the rebuilding of the property, facility, and infrastructure issues that expansive soils cause. During years of drought and extreme rain events the damage could be moderate.
	Public Confidence in Jurisdiction's Governance	No change in confidence in jurisdictions governance (minimal).

Hazard	Subject	Impacts
Extreme Heat	General Public	The impact in with people's ability to get cooler off with air conditioning or visiting local cooling center provided throughout the Des Moines metropolitan area. Impact will be minimal to moderate for persons.
	First Responders	Impact could be severe if proper precautions are not taken, i.e. hydration in heat. With proper preparedness and protection the impact would be minimal.
	Continuity of Government and Services	Minimal expectation for utilization of the COOP.
	Property, Facilities and Infrastructure	Impact to infrastructure could be minimal.
	Environment	The impact to the environment could be severe. Extreme heat has the potential to seriously damage wildlife and plants, trees, crops, etc. Wildland/grass fires are also more likely.
	Economic Conditions	Impacts to the economy will be dependent on how extreme the temperatures get, but only in the sense of whether people will venture out to spend money. Utility bills could shoot up causing more financial hardship and could put a strain on infrastructure and crops (minimal to severe).
	Public Confidence in Jurisdiction's Governance	Confidence will be dependent on how well electrical utilities are able to continue to provide service during heat event. Planning and response could be challenged (minimal to severe).
Flash Flood	General Public	Impact of the immediate area could be severe depending on the level of flood waters. Individuals further away from the incident area are at a lower risk of being affected. Casualties are dependent on warning time.
	First Responders	Impact to responders is expected to be minimal to moderate if required to get in the flood waters.
	Continuity of Government and Services	Temporary relocation may be necessary if inundation affects government facilities (minimal to severe).
	Property, Facilities and Infrastructure	Localized impact could be severe in the inundation area of the incident to facilities and infrastructure. The further away from the incident area the damage lessens to minimal to moderate.
	Environment	Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area.
	Economic Conditions	Impacts to the economy will greatly depend on the area flooded, depth of water, and the amount of time it takes for the water to recede (minimal to severe).
	Public Confidence in Jurisdiction's Governance	Depending on the perception of whether the flood could have been prevented, warning time, and the time it takes for response and recovery will greatly impact the public's confidence (minimal to severe).
Grass/Wildland Fire	General Public	Impact of the immediate area could be severe for affected areas and moderate to light for other less affected areas.
	First Responders	Impact to responders is could be severe depending on the size and scope of the fire, especially for fire fighters. Impact will be low to moderate for support responders with the main threat being smoke inhalation.
	Continuity of Government and Services	Temporary relocation may be necessary if government facilities experience damage (minimal to severe).
	Property, Facilities and Infrastructure	Localized impact could be severe to facilities and infrastructure in the incident area. Property, Facilities, and infrastructure are all vulnerable to destruction by wildfire.
	Environment	Impact will be severe for the immediate impacted area with regards to trees, bushes, animals, crops, etc. Impact will lessen as distance increases from the immediate incident area.
	Economic Conditions	Impacts to the economy could be moderate in the immediate area.
	Public Confidence in Jurisdiction's Governance	Response and recovery will be in question if not timely and effective. Evacuation orders, shelters availability could be called in to question (minimal to severe).

Hazard	Subject	Impacts
HAZMAT Incident	General Public	Localized impact will be severe within the plume/spill area, depending on the type of chemical/material released. As distance is increased from the plume area, the impact will become minimal to moderate.
	First Responders	Impact to responders could be severe if not trained and properly equipped. Responders that are properly trained and equipped will have a minimal to moderate impact.
	Continuity of Government and Services	Temporary relocation could be necessary if government facilities are in close proximity to the incident area. This temporary relocation could become significant depending on clean-up (minimal to severe).
	Property, Facilities and Infrastructure	Impact is expected to be minimal for actual structural properties, facilities, and infrastructure. Unless it is accompanied by an igniting device in which case it could be severe.
	Environment	Localized impact within the plume/spill area could be severe to native plants, wildlife and natural habitats. Clean up and remediation will be required.
	Economic Conditions	Economic conditions could be adversely affected depending on whether agriculture is affected, what type of material is released, is the company a major employer, etc.
	Public Confidence in Jurisdiction's Governance	Impact will be dependent on whether or not the release could have been avoided by government or non-government entities, clean-up and investigation times, and outcomes.
Human Disease	General Public	Impact over a widespread area could be severe depending on type of outbreak and whether it is a communicable disease. Casualties are dependent on warning systems, warning times and the availability of vaccines, antidotes, & medical svc.
	First Responders	Impact to responders could be severe, depending on the type of exposure during response. With proper precautions and safety nets in place the impact is lessened.
	Continuity of Government and Services	Continuity of Operations will be greatly dependent on availability of healthy individuals. COOP is not expected to be exercised (minimal).
	Property, Facilities and Infrastructure	Access to facilities and infrastructure could be affected until decontamination is completed
	Environment	Impact could be severe for the immediate impacted area depending on the source of the outbreak. Impact could have far-reaching implications if disease is transferable between humans and animals or to wildlife.
	Economic Conditions	Impacts to the economy could be severe if the disease is communicable. Loss of tourism, revenue, and business as usual will greatly affect the local economy and the state as a whole.
	Public Confidence in Jurisdiction's Governance	Response and recovery will be in question if not timely and effective. Availability of medical supplies, vaccines, and treatments will come into question (minimal to severe).
Infrastructure Failure	General Public	Localized impact will be moderate to severe for persons with functional and access needs, and the elderly, depending on length of failure and time of year.
	First Responders	Impact to responders will be minimal if properly trained and equipped.
	Continuity of Government and Services	Due to the nature of the hazard, the COOP plan is not expected to be activated, however, if the recovery time is excessive than temporary relocation may become necessary (minimal).
	Property, Facilities and Infrastructure	Impact is dependent on the nature of the incident, e.g., electric, water, sewage, gas, communication disruptions). (Minimal)
	Environment	Impact, depending on the nature of the incident, should be minimal.
	Economic Conditions	Economic conditions could be adversely affected depending on damages suffered, extent of damages, etc. (minimal)
	Public Confidence in Jurisdiction's Governance	Impact will be dependent on whether or not the government or non-government entities response, recovery, and planning were not timely and effective (minimal).

Hazard	Subject	Impacts
Levee Failure	General Public	Localized impact expected to be severe for the inundation area and moderate to minimal for other affected areas.
	First Responders	Impact to responders is expected to be minimal with proper training. Impact could be severe if there is lack of training.
	Continuity of Government and Services	Temporary relocation may be necessary if inundation affects government facilities.
	Property, Facilities and Infrastructure	Localized impact could be severe in the inundation area of the incident to facilities and infrastructure. The further away from the incident area the damage lessens to minimal to moderate.
	Environment	Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area.
	Economic Conditions	Impacts to the economy will greatly depend on the scope of the inundation and the amount of time it takes for the water to recede.
	Public Confidence in Jurisdiction’s Governance	Depending on the perception of whether the failure could have been prevented, warning time, and the time it takes for response and recovery will greatly impact the public’s confidence.
River Flooding	General Public	Impact of the immediate area could be severe depending on the level of river flood waters. Individuals further away from the incident area are at a lower risk of being affected. Casualties are dependent on warning time.
	First Responders	Impact to responders is expected to be minimal to moderate if required to get in the flood waters.
	Continuity of Government and Services	Temporary relocation may be necessary if inundation affects government facilities (minimal to severe).
	Property, Facilities and Infrastructure	Localized impact could be severe in the inundation area of the incident to facilities and infrastructure. The further away from the incident area the damage lessens to minimal to moderate.
	Environment	Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area.
	Economic Conditions	Impacts to the economy will greatly depend on the area flooded, depth of water, and the amount of time it takes for the water to recede (minimal to severe).
	Public Confidence in Jurisdiction’s Governance	Depending on the perception of whether the flood could have been prevented, warning time, and the time it takes for response and recovery will greatly impact the public’s confidence (minimal to severe).
Sinkholes/Landslide	General Public	Local impact expected to be moderate for the incident area.
	First Responders	Impact to responders would be minimal.
	Continuity of Government and Services	Minimal expectation of execution of the COOP, unless a facility is impacted.
	Property, Facilities and Infrastructure	Localized impact to facilities and infrastructure in the incident area has the potential to do severe damage.
	Environment	Impact to the area would be minimal.
	Economic Conditions	Impacts to the economy will depend on the severity of the damage.
	Public Confidence in Jurisdiction’s Governance	Local development policies will be questioned (minimal to severe)
Structural Fire	General Public	Deaths and injury have occurred in past events.
	First Responders	Exposure exists to response personnel performing routine duties when event occurs; fire event-related duties may cause damage to response personnel including evacuation, suppression, lay enforcement, and damage assessment.

Hazard	Subject	Impacts
	Continuity of Government and Services	Potential loss of facilities or infrastructure function or accessibility or ability to provide services. Power interruption is likely if not adequately equipped with backup generation.
	Property, Facilities and Infrastructure	Buildings, vehicles, signage, and /or any unsecured property may be affected during an event. Property may be destroyed, have significant structural damage, or be affected by smoke.
	Environment	Depending on the area affected by a structural fire, it may cause loss of ground vegetation and damaged to trees near structure.
	Economic Conditions	Potential loss of facilities or infrastructure function or accessibility and uninsured damages (minimal to moderate).
	Public Confidence in Jurisdiction's Governance	Response and recovery will be in question if not timely and effective. Evacuation orders, shelters availability could be called in to question (minimal to severe).
Thunderstorm/ Lightning/Hail	General Public	Impact to the health and safety of persons could be minimal to moderate if within the incident area.
	First Responders	Impact to responders is expected to be minimal to moderate if needed to respond during the thunderstorm event.
	Continuity of Government and Services	Temporary relocation may be necessary if government facilities experience damage (Minimal).
	Property, Facilities and Infrastructure	Impact could be severe if property, facilities or infrastructure take a direct hit which could result in fire or destruction.
	Environment	Impact will be isolated, yet severe to any trees, animals, etc., that takes a direct hit from hail, or is in the path of any fire that may be generated due to the lighting strike.
	Economic Conditions	Local economy impact should be fairly minimal, unless the lightning causes fires which damage businesses and stops revenue. Hail can have significant impact on agriculture if it occurs during vulnerable crop growth periods (minimal to severe).
	Public Confidence in Jurisdiction's Governance	Response and recovery will be in question if not timely and effective, specifically if electricity and other utilities are affected (minimal).
Tornado	General Public	Impact of the immediate area could be severe depending on whether individuals were able to seek shelter and get out of the trajectory of the tornado. Casualties are dependent on warning systems and warning times.
	First Responders	Impact to responders is expected to be moderate to severe in assisting the tornado victims.
	Continuity of Government and Services	Temporary/Permanent relocation may be necessary if government facilities experience damage (minimal to severe).
	Property, Facilities and Infrastructure	Localized impact could be severe in the trajectory path. Roads, buildings, and communications could be adversely affected. Damage could be severe.
	Environment	Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area.
	Economic Conditions	Impacts to the economy will greatly depend on the trajectory of the tornado. If a jurisdiction takes a direct hit then the economic conditions will be severe. With an indirect hit the impact could still be anywhere from low to severe.
	Public Confidence in Jurisdiction's Governance	Response and recovery will be in question if not timely and effective. Warning systems and warning time will also be questioned (minimal to severe)
Transportation Incident	General Public	All motorists and passengers on airplanes, boats, and rail, are at risk to transportation incidents (minimal to severe).
	First Responders	Some hazmat risk and unstable situation risk occurs to personnel performing routine duties when responding to incident.

Hazard	Subject	Impacts
	Continuity of Government and Services	None or limited loss of facilities or infrastructure function or accessibility or ability to provide services.
	Property, Facilities and Infrastructure	Depending on the type of transportation incident the risk can be minimal to severe.
	Environment	Impact to the immediate area if hazardous materials are spilled.
	Economic Conditions	Impact to the movement of goods if it causes a rail line to be down or an interstate to be closed. (Minimal to severe).
	Public Confidence in Jurisdiction's Governance	Response, clean-up and recovery will be in question if not timely and effective.
Windstorm	General Public	Motorist, air travelers, outdoor workers, and outdoor recreationists are most at risk. Impact of the immediate area could be minimal to moderate for affected areas.
	First Responders	Some exposure exists to personnel performing routine duties when event occurs; otherwise storm-related duties are typically post-event.
	Continuity of Government and Services	None or limited loss of facilities or infrastructure function or accessibility or ability to provide services.
	Property, Facilities and Infrastructure	Localized impact could be minimal to moderate to facilities and infrastructure in the incident area. Utility lines most affected and could be severe.
	Environment	Impact may be limited short-term impacts for the immediate impacted area with regards to trees, bushes, crops, etc.
	Economic Conditions	Impacts to the economy will greatly depend on the magnitude of the windstorm. Revenue could be impacted if tourism, businesses are halted due to structural damages and infrastructure damage (minimal to severe).
	Public Confidence in Jurisdiction's Governance	Response and recovery will be in question if not timely and effective. Warning systems in place and the timeliness of those warnings could be questioned (minimal).
Winter Storm	General Public	Motorist, air travelers, outdoor workers, outdoor recreationist, homeless persons, persons with energy dependant medical needs, person with pre-existing medical conditions are more at risk.
	First Responders	Exposure exists to personnel performing routine duties when event occurs; storm-related duties may be during event. Snow and blowing snow, ice, and extreme cold will provide adverse working conditions.
	Continuity of Government and Services	Public holds high expectations of government capabilities for reducing impact of snow and ice events related to transportation (road, bridges, airports, rail). High expectations for rapid power restoration.
	Property, Facilities and Infrastructure	Buildings, vehicles, and equipment are exposed to winter weather. Heavy snow and ice, complicated by strong winds, may result in structural damage, collapse, or instability. Utility lines most affected. (Minimal to severe).
	Environment	Greatest impact will be to trees, bushes, foliage, crops, and wildlife, which could be moderate to severe.
	Economic Conditions	Impacts to the economy will greatly depend on the severity of the winter storm, longevity of the storm, and any damages sustained such as utilities and roads. Impact to transportation sector and movement of goods. Lost revenues to decreased business patronage or inability or workers to reach employment locations. (Minimal to severe).
	Public Confidence in Jurisdiction's Governance	Response and recovery will be in question if not timely and effective. Utility failure could be called in to question if outages are persistent. (Minimal to severe).