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1.3-A Loss Estimation Model

44 CFR 201.4(c)(2): [The State plan must include a risk assessment] that provides the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments.

1. Identifying Hazards

44 CFR 201.4(c)(2)(i): [The State risk assessment shall include an] overview of the type…of all natural hazards that can affect the State… .

Iowa's foundation for hazard mitigation is based on a hazard analysis and risk assessment that is comprehensive and multi-hazard. This means that multiple hazards that can possibly occur anywhere in the state are considered and analyzed, and that the risk that each hazard poses is assessed in terms of a disaster or emergency that can be created from that hazard. The comprehensive planning approach depends upon a clear understanding of what hazards exist, what risks they pose, who and what can be impacted.

The purpose of the Hazard Analysis and Risk Assessment (HARA) is to identify and prioritize hazards, both natural and human caused, that pose risk to the State of Iowa, the health and safety of its citizens, property, and economy. The HARA document both describes the methodology the State of Iowa entered into in developing the Hazard Analysis and Risk Assessment and describes the hazards identified through the process along with their resulting priority rank. It is also the primary vehicle in documenting and distributing concise yet informative results of the process to emergency management professionals and stakeholders in Iowa. The hazard profile and risk assessment section provides the historical information to include the previous occurrences available for this update. This was the best data available.

State and Local Hazard Analysis and Risk Assessment

Hazard analysis and risk assessment (HARA) is a shared responsibility between the state and local communities. Both the state and local communities should assess their risks from hazards as part of their respective planning processes. While local governments focus on the hazards, vulnerabilities, and risks on a local or regional scale, the state should focus on the regional and statewide implications of hazards. The HARA process introduced in this guide encourages reciprocity of information and support between the state and local governments. The state of Iowa provides leadership and support to local communities and counties, and local communities provide the state with local-level risk analyses. Through this exchange of information, statewide risk assessments based on detailed, local-level analysis are produced. This is not only a good way of conducting business; it is required by federal regulations.

The Iowa Homeland Security & Emergency Management Division (HSEMD) can provide leadership early on by establishing guidance, setting expectations, and providing incentives for local HARA and mitigation planning activities. To support and facilitate the HARA process, HSEMD is able to provide communities with technical assistance, basic hazard data, and access to a range of state agency technical resources. Key decisions must be made by HSEMD to ensure a level of consistency in local risk data to facilitate a comparable statewide analysis.

As HSEMD and its partner state agencies gain a greater understanding of where the highest risks are across the state, they will be better prepared to decide where and how mitigation resources can be most effective. This information will become part of the Iowa Hazard Mitigation Plan, where mitigation priorities and criteria for those priorities are articulated.

Multi-Hazard Approach

Where appropriate, the document includes specific information to estimate losses for several hazards. Obviously, there are other hazards that can affect communities. While the guide does not provide specific direction for all hazards, the basic procedures explained could be adapted for any hazard with variations that respond to the peculiar nature of each hazard.

Getting Started

The HARA process helps answer the following questions:

What kinds of hazards can affect my jurisdiction?

What may have happened in the past that you should know about?

Quite naturally, many people are only aware of the most obvious risks, usually as a result of a disaster that affected their community or state in the recent past such as a tornado or flood. In many cases, however, there are hazards most people are not aware of because they haven't affected the community during the lifetimes of current residents.

Step 1 of this process – Identifying Hazards – helps explain how to determine which hazards can affect your community.

What will be affected by these hazards?

Are there buildings, roads, utilities, or other facilities in the community that will be damaged or destroyed by these hazards? Are there concentrations of certain populations in hazard areas that are especially vulnerable, such as elderly or non-English speaking people? Are there unique or symbolic characteristics about the community that will be impacted adversely by a hazard? How will the economy of the community or region be impacted by the occurrence of the hazard?

An inventory will help you identify the assets that can be damaged or affected by the hazard event. For detailed assessments, the inventory will also include information on special populations and building characteristics like size, replacement value, content value, and occupancy. In many cases, community assets may be vulnerable to more than one type of hazard, and you may need to look at different characteristics of the same asset to understand its vulnerability to each type of hazard. For example, if a building is subject to both floods and earthquakes, you will be interested in the location and elevation of the building so you can tell how much of its structure and contents will be damaged by flooding. You will also be interested in the construction of the building and its ability to resist physical damage caused by the anticipated ground movements during an earthquake.

Step 2 of this process – Community Profile – will help determine if and to what extent these hazards will affect the assets of your jurisdiction.

How bad can it get?

How "big" is each hazard's potential impact? Will it affect every area the same or will certain areas get hit harder than others? How often will each type of hazard impact your community?

It is important to know the location and amount of land area that may be affected by certain kinds of hazards. For example, there may be areas that can be affected repetitively by a hazard in one part of the community (such as floodplains adjacent to streams and rivers or areas around chemical facilities) or there may be potential community-wide impacts from events such as windstorms or winter storms. You should also note that a specific type of hazard can have varying effects on a community, depending on the severity of individual hazard events. For example, differences in the depth of floodwaters from discrete flood events will yield corresponding differences in the amount of damages.

Step 3 of this process – Profile Hazard Events – will help determine how bad a hazard can get.

What secondary impacts can the hazard create? What secondary hazards can be triggered by another hazard? Although the likely cascading effects of certain hazards is to be considered for emergency response planning, the SHMT determined that while we will consider cascading effects in the discussion and analysis of hazards, it will not affect the overall score used in the hazard analysis and risk assessment methodology.

Hazards create direct damages, indirect effects, and secondary hazards to the community. Direct damages are caused immediately by the event itself, such as a bridge washing out during a flood. Indirect effects usually involve interruptions in asset operations and community functions, also called functional use. For example, when a bridge is washed out due to a flood, traffic is delayed or rerouted, which then impacts individuals, businesses, and public services such as fire and police departments that depend on the bridge for transportation. Secondary hazards are caused by the initial hazard event, such as when an earthquake causes a tsunami, landslide, or dam break. While these are disasters in their own right, their consequent damages should be included in the damage calculations of the initial hazard event. Your loss estimations will include a determination of the extent of direct damages to property and indirect effects on functional use.

Which hazards are priorities for planning?

Which hazards are candidates for special attention for response planning? On which hazards should we focus our mitigation efforts? Which hazards require further planning for post-disaster recovery?

Through completion of steps 1-3, the hazards can be sorted by their composite score. The hazard with a higher score represents the hazard with a higher risk to the community. At first glance, the top third can be taken as the first priority group, the following third as the second priority group, and the remaining third as the third priority group. Adjustments can be made to this preliminary ranking by the planning team. The hazard analysis and risk assessment is a sound prioritization tool and can be used to set priorities, but the planning team should make the final determination of the priority group in which a hazard is placed.

Step 4 of this process – Prioritizing Hazards – will help determine which hazards need to be addressed through mitigation planning. The hazards or impacts that cannot be mitigated need to be addressed in the response plan and the recovery plan.

The hazard analysis and risk assessment is a process for determining the emergency management needs for the state. This is possible when the knowledge of the hazards is combined with the knowledge of the impact it would have on citizens and property in Iowa. The result is a measure of the state's vulnerability and the probability of an incident occurring. Adequate information about the hazards will enable the State of Iowa to know:

- How frequently damage from a particular event could occur,
- The extent of the damage, and
- Which portions of the State could be impacted?

When the data for each hazard is combined, state and local officials can determine its relative vulnerability to each hazard, the potential risk, and the direct impact on the citizens and public/private property. This will allow assignment of priorities for emergency management needs and mitigation efforts.

Current hazard analysis and risk assessments received at HSEMD from local jurisdictions, were used to accumulate a list of all hazards that occur in the State. Along with gathering information from local plans other resources, including data from the NCDC website, were gathered for analysis. A well-written local hazard mitigation plan includes a list of high-risk hazards in that jurisdiction. The main text of the plan includes strategies to minimize the risk from those identified hazards. A composite of local hazard mitigation plans from across the State contributed to the state hazard analysis and risk assessment.

The hazard identification portion of the hazard analysis and risk assessment is an inventory of all the hazards that could potentially impact the State of Iowa. The planning team developed a list of all foreseeable, potentially significant hazards. The overall list was very inclusive. The team did not want to leave a hazard off the identification list because of its lack of historical occurrence in the state.

Hazards were cross-checked and validated against Iowa's approved DMA 2000 Local Hazard Mitigation Plans. After agency experts presented their evaluation of the additional hazards, the team considered and agreed upon the hazards to be included in the state list of identified hazards. Several hazards in the previous plan were consolidated into general categories for the purpose of the risk assessment. The hazards of human disease incident and pandemic human disease were combined into human disease. Fixed hazardous materials incident, pipeline transportation incident, and transportation hazardous materials incident were combined into hazardous materials. Communication failure, energy failure, structural failure, and structural fire were combined into infrastructure failure. Air transportation incident, highway transportation incident, railway transportation incident, and waterway incident were combined into transportation incident. Enemy attack, biological terrorism, agro-terrorism, chemical terrorism, conventional terrorism, cyber terrorism, radiological terrorism, and public disorder were combined into terrorism. Finally, fixed radiological incident and transportation radiological incident were combined into radiological. The following table lists the consolidated hazards with sub-categories for each modified hazards in this update:

Consolidated Hazard Chart	
2010 Hazard	**2007 Hazards**
Human Disease	Human Disease Incident; Pandemic Human Disease
Hazardous Materials	Fixed Hazardous Materials; Pipeline Transportation; Transportation Hazardous Materials
Infrastructure Failure	Communication Failure; Energy Failure; Structural Failure; Structural Fire
Transportation Incident	Air Transportation; Highway Transportation; Railway Transportation; Waterway Incident
Terrorism	Enemy Attack; Biological Terrorism; Agro-Terrorism; Chemical Terrorism; Conventional Terrorism; Cyber Terrorism; Radiological Terrorism; Public Disorder
Radiological	Fixed Radiological Incident; Transportation Radiological Incident

As a result of this process the SHMT identified 23 hazards in two categories, with a total of 16 natural hazards and 7 human caused/combination hazards. The full list of hazards is provided in the table below.

2010 Hazards List

Natural Hazards	Human Caused/Combination Hazards
Flash Flood	Human Disease
Tornadoes	Hazardous Materials
Windstorms	Transportation Incident
Extreme Heat	Infrastructure Failure
Hailstorms	Terrorism
Grass or Wild land Fire	Radiological
Sink Holes	Animal/Plant/Crop Disease
River Flooding	
Severe winter storms	
Drought	
Earthquakes	
Landslide	
Expansive Soils	
Thunderstorm & Lightning	
Dam Failure	
Levee Failure	

Hazard Scoring Methodology

The assessment of the risk to people and property in Iowa from a variety of hazards requires a tremendous amount of data from all levels of government and the private sector. To accomplish this task and to do it as objectively as possible, a number of factors were taken into account:

- Probability of occurrence in any given year;
- Magnitude and Severity of impact in terms of life, property, infrastructure, etc;
- Amount of warning time available before the hazard occurs;
- Duration of the hazard's impact on the state.

The economic impact of disasters is a relatively new area of record-keeping and is generally restricted to major disasters involving both state and federal funding. Smaller, less significant events often do not reflect the economic impact of the incident. For these smaller events, there is a greater reliance on local information and records of impacts.

Members of the State Hazard Mitigation Team were asked to discuss each of the hazards. They were also asked with respect to the agency's goals and mission for their expertise and input as to applicable hazards considered in the hazard mitigation plan using the updated methodology for scoring.

This hazard analysis seeks to strike a balance between evaluation criteria, for example, the evaluation of low probability-high impact events versus high probability-low impact events. Each category of a

particular hazard is rated on a scale of one (1) through four (4). Totaling and averaging categorical ratings will provide an overall rating for each hazard (for a total average in the range of 1 to 4). The hazard worksheet score was recorded in the worksheet score column of the composite scoring worksheets.

It was important for the assessment team to score each hazard as a single event. Only impacts from that particular hazard were to be considered in the analysis. The effects of applying an additional methodology to analyze the effects of cascading hazards were considered for application in the new methodology but it was determined that this added analysis yielded little to no effect on the overall scoring of hazards and analysis of vulnerability to individual hazards.

A scale of one (1) through four (4) was used in all of the scoring guide tables outlined on pages 8 and 9 of this section because of the large variation in historical occurrences and probabilities, percentages of vulnerabilities and spatial extent, the number of casualties, or the value of property damaged. Often this data was not available, or would have been impossible to extract from aggregate data. Using this scale provided the best option for comparison of vastly different types of hazards. The use of overlapping values between each of the categories was analyzed but decided against due to the nature of including a proper narrative with the scoring. Other hazard analyses across the country have used the "high, medium, and low" criteria to score the categories. Using a quantifiable system gives more detail and still allows for adjustments where necessary.

The idea of weighting certain categories relative to the other categories was discussed and considered. It was determined that Iowa would use a weighting criteria to allow for state priorities to be reflected in the final scoring of the hazards and to allow for a higher priority to be placed on hazards that have a higher occurrence in the state and have a high potential for adverse impact. Using the four elements described above the formula the SHMT determined to be the most effective for the Iowa risk analysis was determined with the justification that Iowa's priorities in criteria considers the probability and historical occurrence of a hazard is the highest priority for mitigation with the duration that the hazard affects Iowa being the lowest. The formula used for this risk assessment is as follows:

(Probability x .45) + (Magnitude/Severity x .30) + (Warning Time x .15) + (Duration x .10) = Final Hazard Assessment Score

Probability (incorporating data on historical occurrence)

This is a measure of how many times has this hazard occurred in the past. Each hazard may or may not have a comprehensive documented historical record. Local, state, and federal government agencies have increasingly improved record-keeping with respect to incidents, accidents, and disasters which affect people and property. The National Weather Service, a division of the National Oceanic and Atmospheric Administration (NOAA) maintains a thorough history of weather events, as does the State Climatologist's office. Agencies in recent years have initiated record-keeping efforts in the areas of hazardous materials incidents, transportation accidents, and fires.

The probability score 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. Many times the historical occurrence can be extrapolated into the future using best available data, but others, due to the nature of the hazard are more difficult to estimate the probability of future occurrence. If a hazard or its impacts have been mitigated against, the probability of future occurrence decreases. Conversely, hazards that have not occurred in the past may present themselves to the community in the future.

Probability

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		
Score	Description	
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 if 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

The magnitude of the impact of a hazard event (past and perceived) is related directly to the extent that hazards affect the State and is measured using technical measures specific to the hazard (ideally determined with standard scientific scales). This is also a function of when the event occurs (year-round, seasonal), the location affected (both geographically and non-geographically determined), the resilience of the community, and the effectiveness of the emergency response and disaster recovery efforts.

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 state		
Score	**Description**	
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 a 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

The speed of onset is the amount of warning time available before the hazard occurs. This should be taken as an average warning time. For many of the atmospheric natural hazards there is a considerable amount of warning time as opposed to the human caused accidental hazards that occur instantaneously or without any significant warning time.

Warning Time: Rating of the potential amount of warning time that is available before the hazard occurs	
Score	**Description**
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 (Up to 6 hours warning)

Duration

This consists of the typical amount of time that the jurisdiction is impacted by the hazard. As an example, a snowstorm will likely last several hours, whereas a lightning strike would last less than a second.

Duration: A measure of the duration of time that the hazard will affect the state	
Score	**Description**
1	Less than 6 hours
2	Less than 1 day
3	Less than 1 week
4	More than 1 week

2. Hazard Profile and Risk Assessment

44 CFR 201.4(c)(2)(i): [The State risk assessment shall include an overview of the] location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future events, using maps where appropriate... .

The Iowa hazards assessment requires a tremendous amount of data from all levels of government and the private sector. To determine what hazards affect the State of Iowa, information was gathered from several sources. Local plans from hundreds of Iowa communities and jurisdictions provided a great amount of information on hazards that affect local jurisdictions. In addition, the State Hazard Mitigation Team (SHMT) members, representing virtually all departments of the State of Iowa as well as some federal agencies, county emergency management commissions, and private and non-profit agencies that have either a direct or indirect stake in hazard mitigation, contributed data and information. Since SHMT representatives are virtually subject matter experts in each of their departments, they gave valuable information throughout the hazard identification and profiling process for the process of identifying and profiling hazards.

Currently, data limitations exist for the location and profile of animal/plant/crop disease, grass/wildland fire, infrastructure failure, terrorism, and windstorms. However, these limitations will be addressed in the planning process as data becomes available for use by the State Hazard Mitigation team, in partnership with various state agencies, data will be analyzed for inclusion in future updates. Along with incorporating any new studies and technical information for all natural hazards, including HAZUS studies, or reports from other Federal or State agencies that relate to the location of natural hazards, past hazard events, and the probability of future hazards.

In addition, information from local risk assessments will be incorporated into the planning process as new data becomes available. During this plan update limited information was available for analyzing local risk assessments using the newly implemented system in Iowa for collecting this information, The Local Mitigation Plan Data Collection Worksheet. This limitation was in part due to the number and intensity of disasters that Iowa was responding to and also due to the timeline of planning grants and the required submission dates for the Data Collection Worksheets. In the future, additional information, as collected in the worksheets will provide further analysis with respect to the local risk assessments and vulnerability data.

For this update, the information gathered from local plans and the involvement of the SHMT in the overall planning process resulted in the identification of 23 hazards as listed in the previous section.

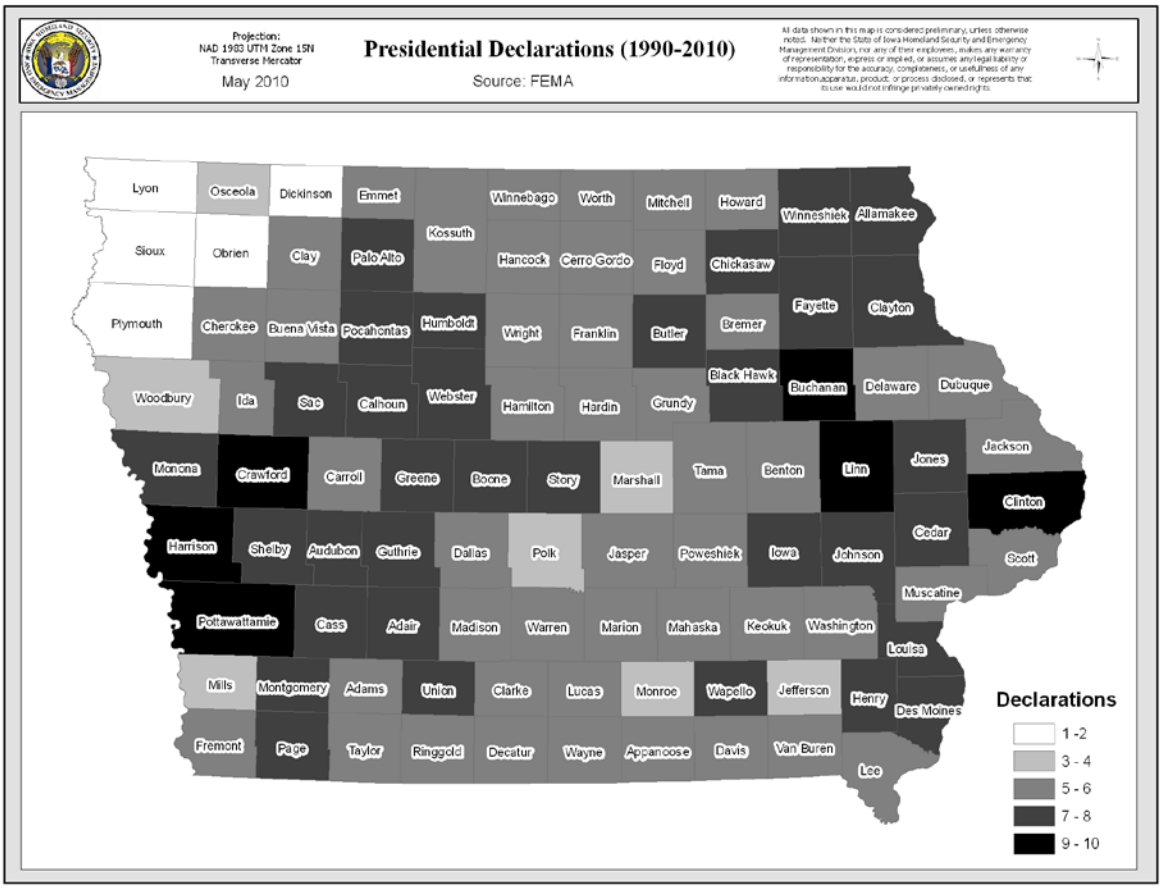
The SHMT was asked to review the existing identified hazards and to consider other hazards that should be profiled.

In the overall hazard analysis and risk assessment process of the 322 Plan, the SHMT used a profile of each hazard developed by the planning team. This required the research of climate and weather, geography, land use, and other conditions that impact or can be influenced by hazards in the state. In order to thoroughly assess each of the 23 identified hazards, a methodology was established to account for how each hazard has either impacted or could potentially impact the state.

A hazard profile was created at the statewide level by providing an overview of the hazards in terms of the location of the hazards that can affect the state, historical occurrences of hazard events, and the probability of future hazard events. When possible, maps are used to identify geographic location of hazards, historical occurrences, or provide other information that helps profile a hazard.

Historical occurrence represents how many times a hazard occurred in the past. Each hazard may or may not have a complete documented historical record. Because each hazard has a different period for which historical occurrences have been collected, each hazard was analyzed in context of their respective years of occurrence data. Local, state, and federal government agencies have improved record keeping on incidents, accidents, and disasters that affect people and property (e.g. areas of hazardous materials incidents, transportation accidents, fires, etc.) The National Weather Service, a division of the National Oceanic and Atmospheric Administration (NOAA), and the State Climatologist's Office maintain a history of weather events in Iowa.

The following map shows the number of Presidential Disaster Declarations by county in Iowa between 1990 and May of 2010.



Probability reflects the estimated frequency of the hazard occurring in any given year. The historical occurrence can be extrapolated into the future, but this methodology may result in inaccuracies. Mitigating impacts of a hazard will likely result in a decrease in future occurrences as opposed to the historical numbers. However, there may be new hazards that present themselves to the community. For example, a new industry producing or housing hazardous material creates a new localized hazard in the jurisdiction.

2.1 Animal/Crop/Plant Disease

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
1	**4**	**4**	**4**	**2.65**

An outbreak of disease that can be transmitted from animal to animal or plant to plant represents an animal/crop/plant disease. The disease outbreak will likely have a significant economic implication or public health impact. The crop/plant pest infestation will likely have severe economic implications, cause significant crop production losses, or significant environmental damage. According to the USDA Risk Management Agency the table below lists the top crop losses by hazard.

Rank	Hazard	Loss	Annualized Loss
1	Drought	$ 1,594,710,205.17	$ 26,142,790.25
2	Excess Moisture/Precip/Rain	$ 1,457,349,641.49	$ 23,890,977.73
3	Decline in Price	$ 550,432,870.43	$ 9,023,489.68
4	Hail	$ 383,204,851.78	$ 6,282,046.75
5	Flood	$ 162,159,127.39	$ 2,658,346.35
6	Windstorm	$ 121,977,611.04	$ 1,999,632.97
7	Fruit Set Failure	$ 120,629,771.89	$ 1,977,537.24
8	Severe Winter Storm	$ 94,939,391.71	$ 1,556,383.47
9	Heat	$ 62,241,713.24	$ 1,020,355.95
10	Plant Disease	$ 23,326,119.00	$ 382,395.39
11	Insects	$ 17,297,844.59	$ 283,571.22
12	Mycotoxin (Aflatoxin)	$ 10,882,679.27	$ 178,404.58
13	Other (Snow-Lightning-Etc.)	$ 9,725,078.21	$ 159,427.51
14	Wildlife	$ 3,030,384.99	$ 49,678.44
15	Fire	$ 1,626,564.86	$ 26,665.00
16	Hot Wind	$ 724,235.24	$ 11,872.71
17	No Listed Cause	$ 499,018.73	$ 8,180.63
18	Tornado	$ 372,777.26	$ 6,111.10
19	Poor Drainage	$ 244,624.60	$ 4,010.24
20	Failure Irrig Supply	$ 198,590.10	$ 3,255.58

The introduction of some high consequence diseases may severely limit or eliminate our ability to move, slaughter, and export animals and animal products. The outbreak will have wide spread economic and societal implications for our state. Response and recovery to infectious animal disease outbreaks will be lengthy, and many producers may never be able to return to business. There will be many indirect effects on our economy. Rumors of an infectious animal disease outbreak could cause significant damage to the markets; as was evidenced in an incident in Kansas in 2003 where the mere rumor of a Foot and Mouth Disease outbreak caused the market to plummet. Further evidence of this occurred in the 2009 H1N1 (Swine Flu) influenza outbreak where lack of understanding about the transmission of the virus caused market loss in Iowa's pork markets.

Crop/plant pest infestations can cause widespread crop/plant loss and severe economic hardship on farmers and landowners and related businesses. Once infestation occurs, the pest may become endemic, causing repeated losses in subsequent growing years. Loss of production will affect all related industries, such as fuel, food, synthetics, processors, etc. Every year the Iowa Department of Agriculture and Land Stewardship (IDALS) conduct numerous animal disease investigations.

The SHMT analysis evaluated the probability that a high impact occurrence of animal/crop/plant disease has a low probability to occur in any given year. However, Iowa is a productive agricultural state producing both crop and livestock. Due to the severity of potential agricultural losses this hazard is severe if an event of this nature were to occur.

Evaluation Criteria	Description	Score
Probability	Every year the Iowa Department of Agriculture and Land Stewardship (IDALS) conduct numerous animal disease investigations. IDALS, under the direction of the state plant regulatory official works with Iowa's universities and industries to conduct regular crop / plant pest surveillance. In the evaluation of the probability of a serious animal / plant / crop disease incident was that an event has a low probability of occurrence in any given year.	**1**
Magnitude/Severity	The movement of people, animals, animal products, wildlife, plants, crops and potential disease/pest vectors could all cause the introduction of diseases/pests. Diseases/pests could also be introduced naturally, for example by hurricanes or jet streams. Emerging disease is also a threat such as West Nile Virus, new more virulent influenza strains, etc. Because many diseases/pests are not present in Iowa, our populations of animals, crops, and plants have no immunity and are highly susceptible. The impact will vary by disease/pest and the type of animal/crop/plant infected/infested. When the United Kingdom faced an outbreak of Foot and Mouth Disease in 2001, the total economic loss to that country exceeded $7 billion. This incident was one of the most economically significant historically, second only to World War II. The state of Michigan is currently dealing with an Emerald Ash Borer infestation. To date the state and federal governments have spent in excess of $550 million to detect, delimit, control and eradicate the pest. Should the disease/pest have public health implications, the economic and social impact would be even greater. The severity will vary by disease/pest. The types of animals, crops, or plants affected will also significantly influence the severity.	**4**
Warning Time	If the diseases / pests are highly infectious (many animals that are infected with disease can be transmitting disease before they show clinical signs), by the time they are discovered, they will likely have spread across the state or nation. This will put us at a severe disadvantage during response and recovery.	**4**
Duration	Response and recovery from serious infestation or disease are lengthy, with many producers likely to never be able to return to business, in addition, crop infestations/animal diseases can reoccur, causing repeated losses in subsequent years.	**4**
	Worksheet Total	**2.65**

Sources for Animal / Crop / Plant Disease	
U.S. Department of Agriculture -USDA	http://www.aphis.usda.gov/
Department of Agriculture and Land Stewardship	http://www.iowaagriculture.gov/default.asp
USDA Crop and Plants Statistics	http://www.nass.usda.gov/QuickStats/indexbysubject.jsp?Pass_group=Crops+%26+Plants
USDA Livestock Statistics	http://www.nass.usda.gov/QuickStats/indexbysubject.jsp?Pass_group=Livestock+%26+Animals
Iowa State University	http://vetmed.iastate.edu/vmc
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Local Sources	Varies

2.2 Dam Failure

Hazard Score Calculation				
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score
1	4	4	4	2.65

Dam failure is the uncontrolled release of impounded water resulting in downstream flooding, which can affect life and property. Flooding, earthquakes, blockages, landslides, lack of maintenance, improper operation, and poor construction, vandalism, or terrorism cause dam failures. Dams are constructed for a variety of uses, including flood control, erosion control, water supply impoundment, hydroelectric power generation, and recreation.

Dams are classified into three (3) categories based on the potential risk to people and property should a failure occur. The classification may change over time because of development downstream from the dam since its construction. Older dams may not have been built to the standards of its new classification. Below are the hazard classifications defined by Iowa Department of Natural Resources (DNR):

- High Hazard – 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) Hazard – 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 Hazard – 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 life is considered unlikely;

Dam hazard potential classifications have nothing to do with the material condition of a dam, only the potential for death and/or destruction due to the size of the dam, the size of the impoundment, and the characteristics of the area downstream of the dam. The Iowa Department of Natural Resources (DNR) tracks all dams in Iowa with a height of at least 25 feet or a total storage of at least 50 acre feet of water. The inventory excludes all dams less than six (6) feet high regardless of storage capacity and dams less than fifteen (15) acre feet of storage regardless of height.

There are 3787 dams on the State of Iowa Dam Inventory. 270 are classified as “major dams” subject to periodic inspections. Major dams are all high hazard dams, plus significant hazard dams that have a permanent storage volume exceeding 100 acre-feet or a total water storage

volume to the top of the dam exceeding 250 acre-feet, and low hazard dams with a product of storage (acre-feet) times height (feet) which exceeds 30,000 acre ft. The height and storage volumes are measured at the emergency spillway crest unless there is not an emergency spillway then they are measured at the top of the dam. In addition, the DNR identified 17 federally owned dams as falling within the "major dam" classification. Federally owned dams are not subject to state inspection. These 270 dams are not all inclusive of the number of high and significant hazard dams, of which, 328 are identified within the State of Iowa as described below.

Planning District 1 has the highest number of high hazard dams (28). Planning District 2 has the lowest number of high hazard dams (1). The table below shows the Planning District, Number of High Hazard Dams in the Planning District, the Counties where dams are located, and the number of dams in each county.

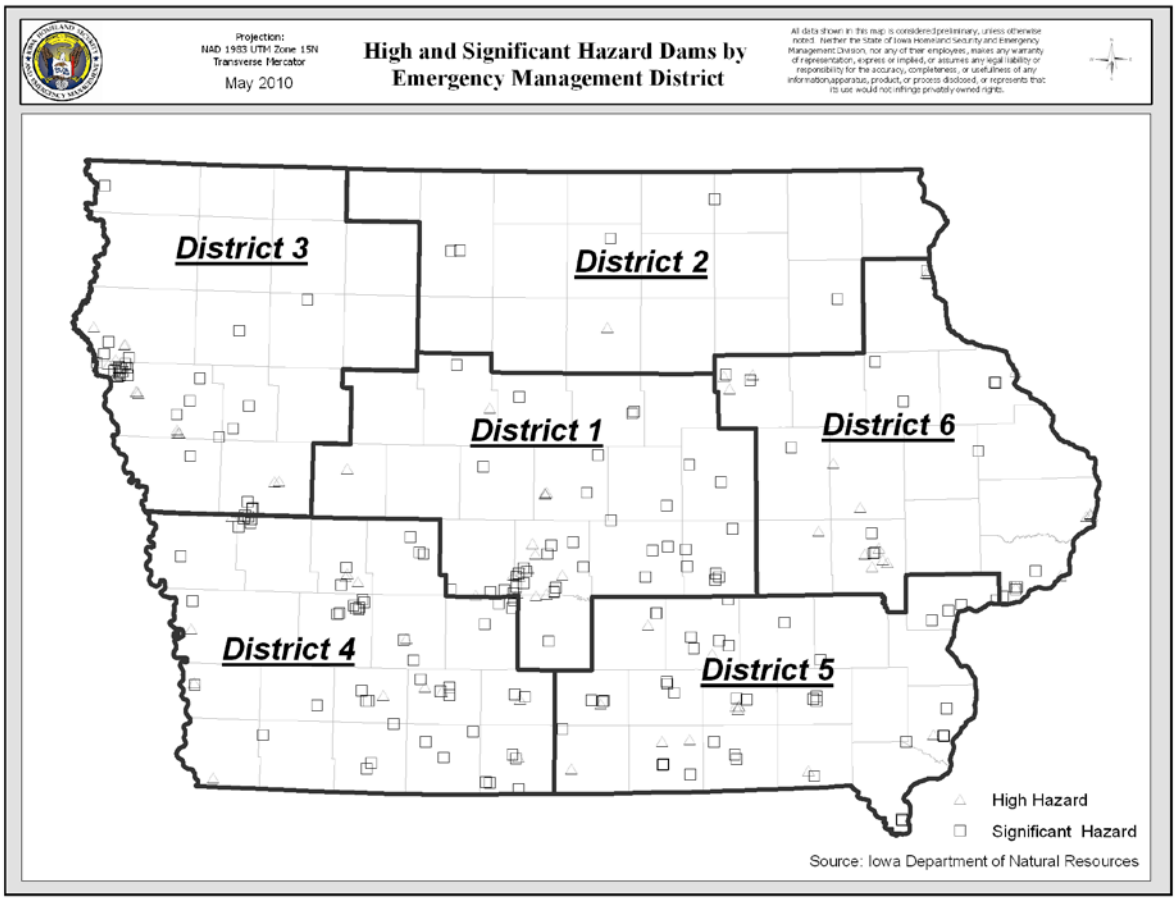
Planning District	Number of High Hazard Dams	Counties (# of Dams)
1	28	Carroll (1), Dallas (6), Polk (13), Poweshiek (1), Story (4), Warren (2), Webster (1)
2	1	Franklin
3	20	Buena Vista (1), Crawford (2), Plymouth (4), Sioux (1), Woodbury (12)
4	15	Adair (1), Adams (1), Audubon (3), Clarke (2), Decatur (1), Fremont (1), Harrison (1), Madison (1), Mills (1), Pottawattamie (1), Union (2)
5	12	Appanoose (1), Des Moines (2), Lucas (1), Marion (2) Van Buren (1), Wapello (5)
6	24	Black Hawk (4), Clayton (3), Clinton (4), Dubuque (2), Iowa (1), Johnson (5), Linn (2), Scott (3)

Planning District 4 has the highest number of significant hazard dams and Planning District 2 has the lowest. The table below shows the Planning District, the Number of High Hazard Dams in the Planning District, and the Counties where dams are located, and the number of dams in each county.

Planning District	# Significant Hazard Dams	Counties
1	49	Boone (1), Dallas (10), Greene (1), Hamilton (1), Hardin (2), Jasper (4), Marshall (2), Polk (15), Poweshiek (6), Story (3) Tama (2), Warren (1), Webster (1)
2	5	Cerro Gordo (1), Fayette (1), Howard (1), Kossuth (2)
3	38	Buena Vista (2), Cherokee (1), Crawford (4), Ida (2), Lyon (1), Monona (1), Plymouth (3), Sac (1), Sioux (2), Woodbury (21),
4	59	Adair (3), Adams (4), Audubon (2), Cass (7), Clarke (2), Decatur (7), Guthrie (6), Harrison (1), Madison (4), Mills (2), Montgomery (1), Page (1), Pottawattamie (1), Ringgold (4), Shelby (6), Taylor (3), Union (5)
5	46	Appanoose (3), Davis (3), Des Moines (6), Henry (1), Jefferson (3), Keokuk (1), Lee (2), Lucas (3), Mahaska (6), Marion (3), Monroe (1), Muscatine (6), Van Buren (1), Wapello (2), Washington (1), Wayne (4)
6	23	Benton (1), Black Hawk (2), Clayton (1), Delaware (2), Dubuque (4), Jackson (1), Johnson (5), Linn (2), Scott (5)

There are 7 high hazard and 1 significant hazard Federal dams identified on the State Major Dam Inventory. The Planning District, Potential Hazard, Number of Potential Hazard, County, and Number of Dams in the County are shown below:

Planning District	Hazard Potential (#)	Counties (#)
1	High (2)	Polk (2),
5	High (2)	Appanoose (1), Marion (1)
5	Significant (1)	Des Moines (1)
6	High (3)	Dubuque (1), Johnson (1), Scott (1)



There have been two historical occurrences of dam failure in the State of Iowa; one occurred in 1968 in Waterloo when the Virden Creek Dam failed. The incidence claimed one life, and the dam is no longer in existence. There was concern during the very wet period of 1993 that water would overtop Saylorville Reservoir in Polk County. With the outfall flowing at full capacity and water flowing out the spillway, the reservoir did not overtop the dam.

The second occurrence happened at the Lake Delhi in July of 2010 when a 92 year old dam was breached at a nine mile long lake that was owned by a local homeowner's recreation association. The breach occurred at a 300 foot section of the earthen portion of the dam near the main concrete structure. The breach caused significant property loss, an evacuation of as

many as 700 near the dam, as well as severe economic impacts to the tourism industry in the area.

With increased attention to sound design, quality construction, and continued maintenance and inspection, dam failure probability can be reduced. It is important to consider that by 2020, 85% of the dams in the United States will be more than 50 years old (the design life of a dam). In Iowa, 41% of dams by 2020 will be more than 50 years old. This reflects the need to consider and encourage dam failure emergency action plans for high and significant hazard dams in the State.

The SHMT analysis evaluated the probability that a dam failure in Iowa has a low chance of occurrence in any given year.

Evaluation Criteria	Description	Score
Probability	There have been two historical occurrences in the State of Iowa; one event occurred in 1968 in Waterloo when the Virden Creek Dam failed. The incidence claimed one life, and the dam is no longer in existence. There was concern during the very wet period of 1993 that water would overtop Saylorville Reservoir. With the outfall flowing at full capacity and water flowing out the spillway, the reservoir did not overtop the dam. The second occurrence happened when the Lake Delhi dam failed in July of 2010.	**1**
Magnitude/Severity	People and property along streams are most vulnerable. Facilities and lives considerable distances from the actual impoundment are not immune from the hazard. Depending on the size and volume of the impoundment as well as the channel characteristics, a flash flood can travel a significant distance. The area impacted following a dam failure would be limited to those areas in and near the floodplain. People and property outside the floodplain could also be impacted depending on the proximity to the dam and the height above the normal stream level. The severity of damage could range from property damage, if a small subdivision impoundment failed, all the way to multiple deaths, injuries, and extensive property damage if a large high hazard dam, such as the Saylorville Reservoir, failed upstream from Des Moines. Operations could be affected by communication loss, critical facility damage/destruction, etc. Worst case scenario could involve whole subdivisions being swept away by the fast flowing water.	**4**
Warning Time	A dam failure can be immediate and catastrophic leaving little or no time to warn those downstream of the imminent hazard. With maintenance and monitoring, weak areas and possible failure points can be identified allowing time for evacuation and securing of the dam. Most dams are only inspected periodically thus allowing problems to go undetected until a failure occurs.	**4**
Duration	Response to the effects of a dam failure are extensive and require wide-ranging recovery efforts for reconstruction of the original flood control structures.	**4**
	Worksheet Total	**2.65**

Sources for Dam Failure	
National Dam Safety Program	http://www.fema.gov/plan/prevent/damfailure/ndsp.shtm
Association of State Dam Safety Officials	http://www.damsafety.org/
Iowa Department of Natural Resources	http://www.state.ia.us/epd/wtresrce/wtrres.htm
Natural Resources Conservation Service	http://www.ftw.nrcs.usda.gov/pl566/agingwater/Iowa.pdf

Iowa Data (National Inventory of Dams)	http://geo.usace.army.mil/pgis/f?p=397:3:774105419566237::NO::P3_STATES:IA
Iowa Watershed Protection & Flood	http://www.ia.nrcs.usda.gov/programs/PL566.html
National Resource Conservation Service	http://www.nrcs.usda.gov/programs/watershed/
Iowa Department of Natural Resources	http://www.iowadnr.gov/water/floodplain/damsafety.html
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com

2.3 Drought

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
2	**3**	**1**	**4**	**2.35**

Drought is defined as a period of prolonged lack of precipitation for weeks at a time producing severe dry conditions. There are four (4) types of drought conditions relevant to Iowa:

- Meteorological drought, which refers to precipitation deficiency;
- Hydrological drought, which refers to declining surface and groundwater supplies;
- Agricultural drought, which refers to soil moisture deficiencies; and
- Socioeconomic drought, which refers to when physical water shortages begin to affect people.

The highest occurrence of drought conditions with recorded events in Iowa are associated with agricultural and meteorological drought as a result of either low soil moisture or a decline in recorded precipitation.

Droughts can be spotty or widespread and last from a few weeks to a period of years. A prolonged drought can have a serious impact on a community's water supply and economy. Increased demand for water and electricity may result in shortages of resources. Moreover, food shortages may occur if agricultural production is damaged or destroyed by a loss of crops or livestock. While droughts are generally associated with extreme heat, droughts can and do occur during cooler months.

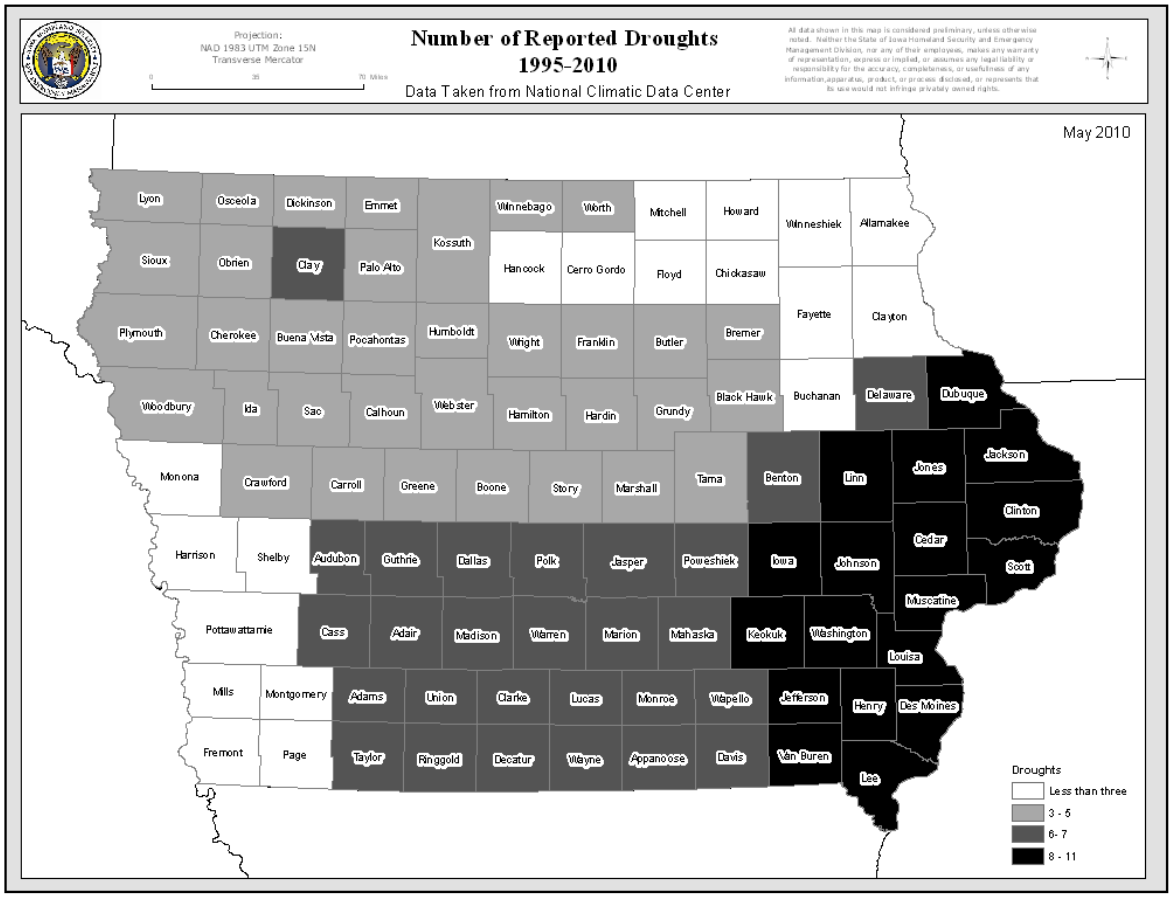
According to the National Climactic Data Center, Iowa has had twenty (20) periods of drought from 1980-2009. Regionally The periods were:

Drought Period	Geographic Impact
8/1/95 – 8/31/95	Statewide
7/20/99 – 7/30/99	24 percent of the state
11/1/99 – 11/30/99	11 percent of the state
12/1/99 – 12/31/99	11 percent of the state
2/1/00 – 2/29/00	11 percent of the state
3/1/00 – 3/31/00	11 percent of the state
4/1/00 – 4/30/00	11 percent of the state
8/14/00 – 8/31/00	32 percent of the state
9/1/00 – 9/6/00	32 percent of the state

9/1/01 – 9/23/01	51 percent of the state
9/1/03 – 9/31/03	51 percent of the state
7/1/05 – 7/31/05	20 percent of the state
8/1/05 – 8/31/05	20 percent of the state
9/1/05 – 9/30/05	20 percent of the state
10/1/05 – 10/31/05	20 percent of the state
11/1/05 – 11/30/05	18 percent of the state
12/1/05 – 12/31/05	18 percent of the state
1/1/06 – 1/31/06	18 percent of the state
2/1/06 – 2/28/06	17 percent of the state
3/1/06 – 3/31/06	16 percent of the state

During the period from 1980 to 2009, there was $2.010 billion in crop damages resulting from drought periods. The most common trend was the consistency of drought periods during the months of July through August; out of the twenty (20) periods, nine (9) of them were between July through August. While some may have been more severe than others, agricultural areas were impacted much more than the metropolitan areas where impacts were indirect.

Regionally, the East Central to Southeast portion of Iowa has experienced at least eight droughts in the last ten years. Mid- to South Central Iowa has experienced five to seven droughts since 1995, followed by the Northwest to North Central areas of Iowa experiencing three or four recorded events. The Southwest and Northeast portions of the State have not been as significantly impacted as other areas. The following map depicts a county level record of drought occurrences since 1995.



Drought is a normal part of climate fluctuations. Climatic variability can bring dry conditions to the region up to years at a time. Research and observations of the El Nino/La Nina climatic events are resulting in more predictable climatic forecasts. A drought would likely affect most of Iowa if not the Midwest as a whole. Because of their dependence on precipitation and water, the agricultural community would be the most adversely effected, but the entire state would likely feel some impact.

The SHMT analysis evaluated the statewide probability of future droughts in Iowa in the order of magnitude of between -3.0 to -3.9 Palmer drought severity index (severe drought event) at between 10% and 20% probability in any given year.

Evaluation Criteria	Description	Score
Probability	According to the National Climactic Data Center, Iowa has had 20 periods of drought from 1980-2009. The most common trend was the consistency of drought periods during the month of August. While some may have been more severe than others, agricultural areas were impacted much more than the metropolitan areas where impacts were indirect. Drought is part of normal climate fluctuations. Climatic variability can bring dry conditions to the region for up to years at a time. Research and observations of the El Nino/La Nina climatic events are resulting in more predictable climatic forecasts.	**2**
Magnitude/Severity	Those dependent on rain would be the most vulnerable to a drought. This means that agriculture, agribusiness, and consumers (if the drought lasted	**3**

Evaluation Criteria	Description	Score
	long enough or impacted a large area) would be impacted. A drought limits the ability to produce goods and provide services. Because citizens draw their drinking water from surface water and groundwater sources, a prolonged severe drought may impact all citizens if there were to be a dramatic drop in the stream flow coupled with the drop in the water table. Fire suppression can also become a problem due to the dryness of the vegetation and possible lack of water. A drought would likely affect most of Iowa if not the Midwest as a whole. Because of the dependence on precipitation and water, the agricultural community would be impacted the most. The agricultural areas would be most adversely impacted, but the entire state would likely feel at least some impact. Few if any health impacts to people in the affected area because of secondary sources of water. Drought in the U.S. seldom results directly in the loss of life. Health impacts would be more significant on livestock without auxiliary water supplies. Property losses would be limited to livestock and crops to the agricultural community. Facilities would not be impacted. Infrastructure could be affected in areas of expansive soils due to drying soils, lower water levels around dams, etc. Delivery of services would be limited to source water delivery and those services that consume large amounts of water. Drought can lead to large and damaging impacts to the agricultural economy. Because of Iowa's reliance on the agricultural economy, the economic and financial impacts would certainly ripple out into other sectors. Rural areas can be especially affected by long-term drought. If restrictions are put on manufacturers that use large amounts of water, the local economy can be impacted that way as well.	
Warning Time	Drought warning is based on a complex interaction of many different variables, water uses, and consumer needs. Drought warning is directly related to the ability to predict the occurrence of atmospheric conditions that produce the physical aspects of drought, primarily precipitation and temperature. There are so many variables that can affect the outcome of climatic interactions, and it is difficult to predict a drought in advance. In fact, an area may already be in a drought before it is even recognized. While the warning of the drought may not come until the drought is already occurring, the secondary effects of a drought may be predicted and warned against weeks in advance.	**1**
Duration	According to Iowa's drought history, most droughts that affect Iowa occur for at least a month at a time.	**4**
	Worksheet Total	**2.35**

Sources for Drought	
Iowa Climatology Bureau	http://www.agriculture.state.ia.us/climatology.asp
Iowa Department of Natural Resources	http://www.iowadnr.gov/water/index.html
National Oceanic Atmospheric Administration	http://www.drought.noaa.gov/
NOAA Economics	http://www.economics.noaa.gov/?goal=climate&file=events/drought/
National Drought Mitigation Center	http://www.drought.unl.edu/index.htm
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climate/severeweather/extremes.html
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=852fa5f0f013b110VgnVCM10000089f0870aRCRD&vgnextfmt=default
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/

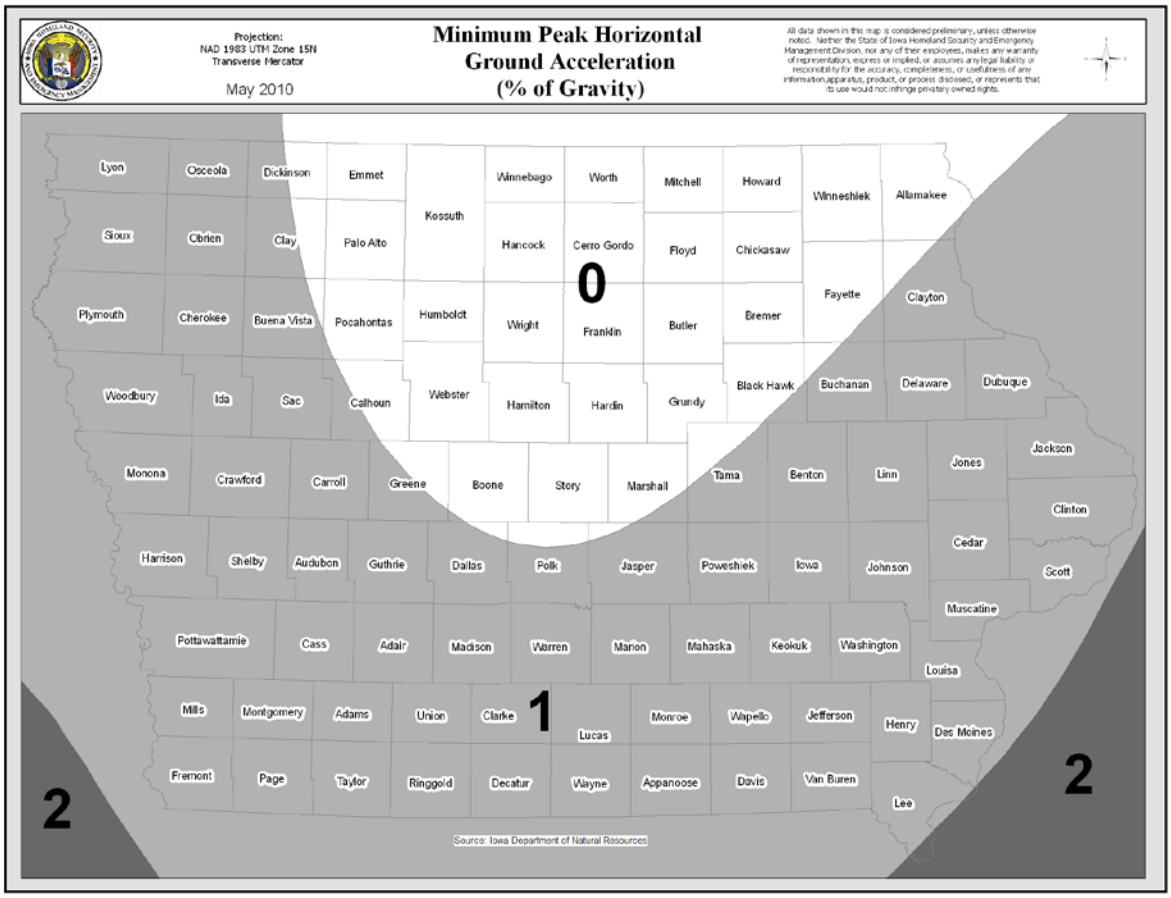
Sources for Drought	
Disaster Center.com	http://www.disastercenter.com
Local Media and Newspapers	Varies

2.4 Earthquake

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

An earthquake is any shaking or vibration of the earth caused by the sudden release of energy that may impose a direct threat on life and property. It is a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. This shaking can cause buildings and bridges to collapse; disrupt gas, electric, and phone service; it sometimes triggers landslides, flash floods, and fires. The three (3) general classes of earthquakes are, tectonic, volcanic, and artificially produced.

Iowa is located in low risk zones Seismic Zone 0 and 1. This does not mean that the state or certain counties are not vulnerable to earthquake effects. Most structures in Iowa are not built to earthquake standards, but because of the relatively low magnitude of a possible quake, property damage would likely be minor foundational damage. The most vulnerable structures are those built on poorly consolidated substrate, especially floodplain materials. The following map depicts vulnerability related to Seismic Zones and Minimum Peak Horizontal Ground Acceleration.



Iowa as a whole has experienced the effects of only a few earthquakes in the past 175 years. The epicenters of thirteen (13) earthquakes have been located in the state with the majority along the Mississippi River. The first know occurrence was in 1867 near Sidney in southwest Iowa; the most recent occurrence was in 2004 near Shenandoah in southwest Iowa. The largest Iowa earthquake (Mercalli magnitude VI) occurred near Davenport in southeast Iowa in 1934. Only the most recent of these events was instrumentally recorded. Outside Iowa the most recent quakes were in the 1960s occurring in Illinois and Missouri. While more than twenty (20) earthquakes have occurred in or around Iowa, over the past 175 years they have not seriously impacted the state.

The strongest earthquake in Iowa occurred in Davenport in 1934 and resulted in only slight damage. Estimated effects of a Richter scale 6.5 magnitude earthquake along the New Madrid Fault Zone suggest that Iowans in four (4) southeast counties could experience trembling buildings, some broken dishes and cracked windows. About 29 other counties, from Page (southwest) to Polk (central) to Muscatine (southeast), could experience vibrations similar to the passing of a heavy truck; rattling of dishes, creaking of walls, and swinging of suspended objects. Specific parts of central Iowa could sustain different levels of damage due to the soundness of the structures. A published FEMA report using the HAZUS-MH software determined that the loss associated with such an event would result in approximately $1,068,000 in damages to the State of Iowa. These losses are mainly attributed to the extreme southeastern portion of the State.

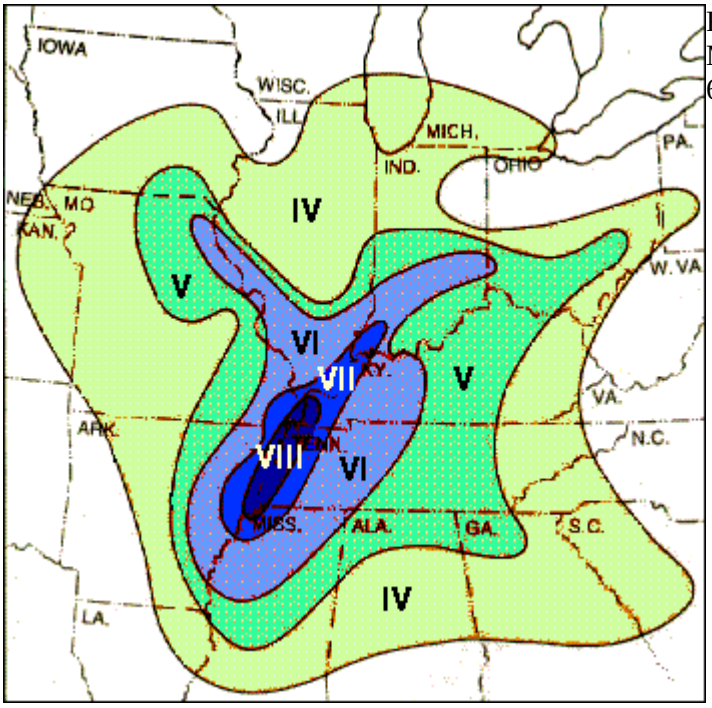
IOWA EARTHQUAKES

HISTORIC EARTHQUAKES WITH EPICENTERS IN IOWA

Number	Date	Nearest Town	Mercalli Intensity
1.	Apr. 28, 1867	Sidney (IA) / Nebraska City (NE)	IV
2.	Dec. 09, 1875	Sidney (IA) / Nebraska City (NE)	III
3.	April 13, 1905 **	Wayland (MO) / Keokuk (IA)	IV-V
4.	Jan. 26, 1925	Waterloo (IA)	II
5.	**Nov. 12, 1934**	**Davenport (IA) / Rock Island (IL)**	**VI**
6.	Jan. 05, 1935 **	Rock Island (IL) / Davenport (IA)	IV
7.	Jan. 05, 1935 **	Rock Island (IL) / Davenport (IA)	III
8.	Feb. 26, 1935	Burlington (IA)	III
9.	Oct. 11, 1938	Inwood (IA)	V
10.	Nov. 08, 1938	Dubuque (IA) *	~II
11.	Nov. 24, 1939	Davenport (IA) / Rock Island (IL)	II-III
12.	Apr. 20, 1948	Oxford (IA)	IV
13.	July 16, 2004	Shenandoah (IA)	III

Red identifies Iowa's largest earthquake
* Dubuque experienced three shocks
** Epicenter probably just outside Iowa

Seismologists attempt to forecast earthquake size and frequency based on data from previous events in the New Madrid Fault Zone, is difficult because there are few historic moderate to large earthquakes, and the active faults are too deeply buried to effectively monitor. Based on the recurrence intervals for small earthquakes, scientists estimate a 90% chance of a Richter scale 6.0 magnitude earthquake in the New Madrid Fault Zone by the year 2040. A magnitude 6.5 in New Madrid would create a magnitude four (4) effect in Iowa; resulting in little or no damage and/or fear.



Roman numerals indicate estimated Modified Mercalli intensities for a 6.5 magnitude earthquake.

The SHMT analysis evaluated the probability of future earthquakes in Iowa at less than 10% in any given year.

Evaluation Criteria	Description	Score
Probability	Only 13 earthquakes with epicenters in Iowa are known in historic times. The first known occurrence was in 1867 near Sidney in southwest Iowa; the most recent occurrence was in 2004 near Shenandoah in SW Iowa. The largest Iowa earthquake (Mercalli magnitude VI) occurred near Davenport in southeast Iowa in 1934. Only the most recent of these events was instrumentally recorded. Seismologists attempt to forecast earthquake size and frequency based on data from previous events. In the New Madrid Fault Zone, this analysis is difficult because there are few historic, moderate to large earthquakes, and the active faults are too deeply buried to monitor effectively. Based on recurrence intervals for small earthquakes, scientists estimate a 90% chance of a Richter magnitude 6.0 earthquake in the New Madrid Fault Zone by 2040. A magnitude 6.5 in New Madrid would create magnitude 4 effects in Iowa resulting in little or no damage or fear.	**1**
Magnitude/Severity	Most of Iowa is located in Seismic Zone 0, the lowest risk zone in the United States. Most structures in Iowa are not built to earthquake standards, but because of the relatively low magnitude of the possible quake, property damage would likely be minor foundational damage. The most vulnerable structures are those built on poorly consolidated substrate, especially floodplain materials. The strongest earthquake in Iowa occurred in Davenport in 1934 and resulted in only slight damage. Estimated effects of a 6.5 Richter magnitude earthquake along the New Madrid Fault Zone suggest Iowans in four southeast counties could experience trembling buildings, some broken dishes and cracked windows. About 29 other counties, from Page to Polk to Muscatine, could experience vibrations similar to the passing of a heavy truck, rattling of dishes, creaking of walls, and swinging of suspended objects. Specific parts of Central Iowa could sustain different levels of damage based on the soundness of the structures.	**1**

Evaluation Criteria	Description	Score
	Ground shaking would be very minor and would have very few if any threat to human health and safety. Responding to damaged structures would be limited. Damages would be light, usually not affecting the structural integrity of the structure. Property, facilities, and infrastructure would suffer only minor damages because the facilities are not built to earthquake standards. Delivery of services such as water, wastewater, electricity, communications, etc. may suffer minor, short-term impacts. Life threatening impacts from these services would not be likely. Economic and financial impacts would be limited resulting from disruption of the flow of goods and services. Business disruption would likely be very short if any. Due to the relatively low magnitude of earthquakes that would occur in the state, and the distance from the epicenter of an earthquake that would occur in the New Madrid Fault Zone, Iowans would likely see only minor impacts. Fatalities would be very rare, injuries limited to falls and injury from small-unsecured objects, property loss would likely be minimal, and economic loss could occur due to short disruptions in commercial and industrial activities.	
Warning Time	Earthquake prediction is an inexact science. Even in areas that are well monitored with instruments, such as California's San Andreas Fault Zone, scientists only very rarely predict earthquakes.	**4**
Duration	Due to the limited effects to Iowa, response to the occurrence of an earthquake would likely be in support of nearby States utilizing mutual aid agreements, in-State response would likely be very limited.	**1**
	Worksheet Total	**1.45**

Sources for Earthquake	
Iowa Geological Survey Bureau	http://www.igsb.uiowa.edu/service/hazards.htm
United States Geological Survey	http://earthquake.usgs.gov/earthquakes/
Federal Emergency Management Agency	http://www.fema.gov/hazard/earthquake/index.shtm
National Earthquake Hazards Reduction	http://training.fema.gov/EMIweb/EarthQuake/resources.htm
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=1c4e1b655eb3b110VgnVCM10000089f0870aRCRD&vgnextfmt=default
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/
Disaster Center.com	http://www.disastercenter.com
Local Media and Newspapers	Varies

2.5 Expansive Soils

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

Soils and soft rock that tend to swell or shrink excessively due to changes in moisture content are commonly known as expansive soils. The effects of expansive soils are most prevalent in regions of moderate to high precipitation, where prolonged periods of drought are followed by long periods of rainfall. The hazard occurs in many parts of the southern, central, and western

United States. Estimates conducted in 1980 put the annual damage from expansive soils as high as $7 billion. However, because the hazard develops gradually and seldom presents a threat to life, expansive soils have received limited attention, despite their costly effects. The estimated damages also state that damages to single-family and commercial buildings accounted for nearly one-third of the total amount of damages.

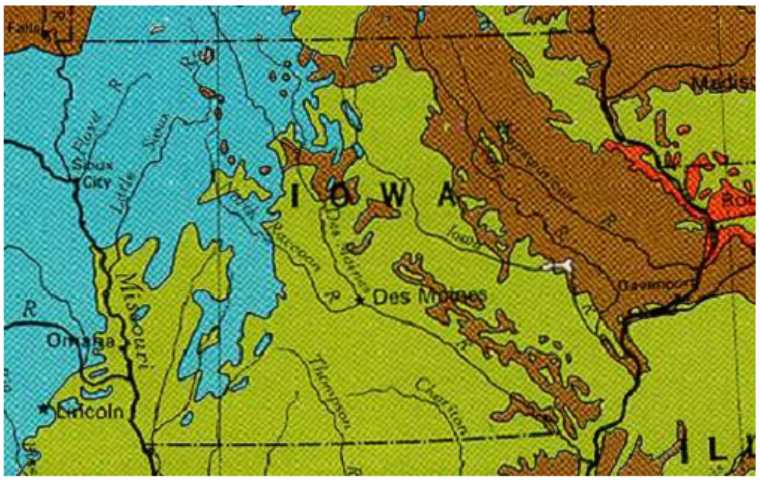
The availability of data on expansive soils varies greatly. In or near metropolitan areas and at dam sites, abundant information on the amount of clay generally is available. However, for large areas of the U.S., little information is reported other than field observations of the physical characteristics of clay.

Probability and frequency analyses have not been prepared because of the nature of occurrence of this hazard. This is consistent with other geologic hazards that occur slowly over time. As such, the duration of response to expansive soils and their associated risk to public property and loss of life.

The SHMT evaluated the probability of future expansive soils events in Iowa at between 10% and 25% chance in the next year. The following map depicts the potential swelling clay deposits in Iowa.

U.S. Geological Survey
Swelling Clays Map Of The Conterminous U.S.

Soil Map of Iowa



MAP LEGEND

- Unit contains abundant clay having high swelling potential
- Part of unit (generally less than 50%) consists of clay having high swelling potential
- Unit contains abundant clay having slight to moderate swelling potential
- Part of unit (generally less than 50%) consists of clay having slight to moderate swelling potential
- Unit contains little or no swelling clay
- Data insufficient to indicate clay content of unit and/or swelling potential of clay (Shown in westermost states only)

Source: “Swelling Clays Map of the Conterminous United States" by W. Olive, A. Chleborad, C. Frahme, J. Shlocker, R. Schneider and R. Schuster

Evaluation Criteria	Description	Score
Probability	Probability and frequency analyses have not been prepared because of the nature of occurrence of this hazard. This is consistent with other geologic hazards that occur slowly over time. However, based on information collected and the associated levels of severity, the probability of an event is evaluated as 10% to 25% in any given year.	**2**
Magnitude/Severity	Little if any direct human impacts. Impacts commonly involve swelling clays beneath areas covered by buildings and slabs of concrete and asphalt, such as those used in construction of highways, walkways, and airport runways. The availability of data on expansive soils varies greatly. In or near metropolitan areas and at dam sites, abundant information on the amount of clay generally is available. However, for large areas of the U.S., little information is reported other than field observations of the physical characteristics of clay. The most extensive damage from expansive soils occurs to highways and streets. Houses and one-story commercial buildings are more apt to be damaged by the expansion of swelling than are multi-story buildings, which usually are heavy enough to counter swelling pressures. The most obvious manifestations of damage to buildings are sticking doors, uneven floors, and cracked foundations, floors, walls, ceilings, and windows. The most extensive damage from expansive soils occurs to highways and streets. Houses and one-story commercial buildings are more apt to be damaged by the expansion of swelling than are multi-story buildings, which usually are heavy enough to counter swelling pressures. The most obvious manifestations of damage to buildings are sticking doors, uneven floors, and cracked foundations, floors, walls, ceilings, and windows.	**1**
Warning Time	The warning time for expansive soils is consistent with other geologic hazards that occur slowly over time.	**1**
Duration	The response to this hazard is limited in the State of Iowa with the most severe cases being washed out roads and access routes to rural towns. 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 in the State.	**1**
	Worksheet Total	**1.45**

Sources for Expansive Soils	
Iowa Department of Natural Resources	http://www.igsb.uiowa.edu/service/hazards.htm
Natural Resources Conservations Service	http://soils.usda.gov/use
NRCS Soil Survey	http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm
Soil Risks & Hazards	ftp://ftp-fc.sc.egov.usda.gov/NSSC/Soil_Risks/risks_print_version.pdf
Expansive Soils	http://geology.com/articles/expansive-soil.shtml
Surevoid.com	http://surevoid.com/soil_maps/ia.php
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com

2.6 Extreme Heat

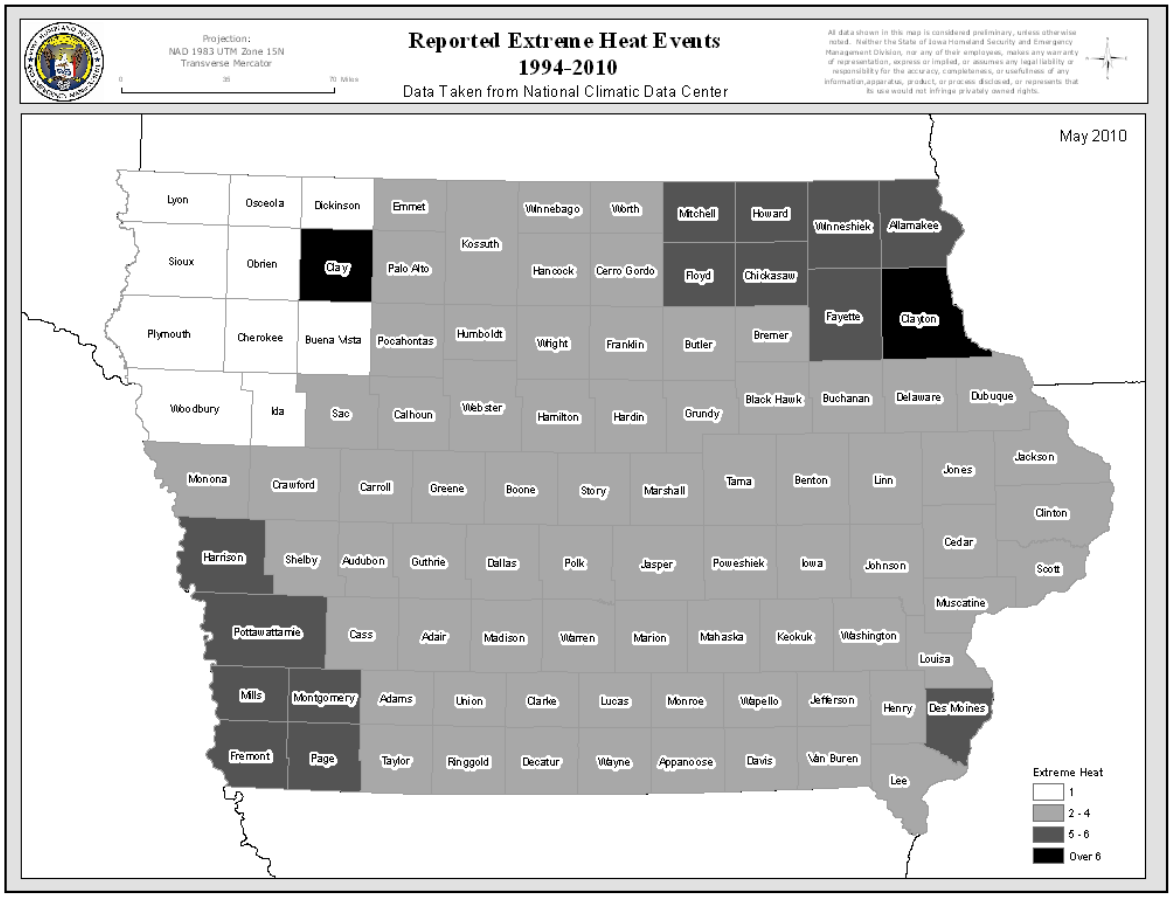
Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
2	**1**	**1**	**4**	**1.75**

Conditions for extreme heat are defined by summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. This includes temperatures (including heat index) in excess of 100 degrees Fahrenheit or at least three (3) successive days of 90+ degrees Fahrenheit. A heat advisory is issued when temperatures reach 105 degrees and a warning is issued at 115 degrees. The heat index is a number in degrees Fahrenheit that tells how hot it really feels when relative humidity is added to the actual air temperature. Exposure to full sunshine can increase the heat index by at least 15 degrees. Extreme heat can impose stress on humans and animals. Heatstroke, sunstroke, cramps, exhaustion, and fatigue are possible with prolonged exposure and/or physical activity due to the body's inability to dissipate the heat. Urban areas are particularly at risk because of air stagnation and large quantities of heat absorbing materials such as streets and buildings. Extreme heat can also result in distortion and failure of structures and surfaces such as roadways and railroad tracks.

During the period between 1995 and 2009 Iowa experienced nineteen (19) extreme heat events. The heat wave that occurred in July of 1995 had a major impact across the entire state, temperatures ranged from 98 degrees to 108 degrees with heat indices reaching a high of 131 degrees. This event lasted two (2) days causing 3.8 million dollars of property damage and resulted in three (3) fatalities. The figure relating to property damage with this event was based on a combination of livestock losses and transportation infrastructure damages. The following map depicts the number of extreme heat occurrences from 1994-2009.

During the summers of 1997 and 1998, there were a combined total of 31 days when the high temperature was 90 degrees Fahrenheit or higher. There were three (3) periods when temperatures were 90 degrees or above for at least three (3) consecutive days during the summers of 2005-2006. Based on historical information, Iowa will likely experience around 26 days a year with temperatures above 90 degrees. There is a very good chance that there will also be a period of at least three (3) consecutive days or more with temperatures in the 90s. It is also common for the temperature to hit 100 degrees or more once every three (3) years during the summer months.

The SHMT evaluated the probability of extreme heat in Iowa. The discussion focused around historical information and personal experiences dealing with extremely high temperatures. Discussion also included recent information released by the NOAA Office of Climate, Water, and Weather Services which states extreme heat has a high chance of causing fatalities and injuries in the United States and causing 5 fatalities and 22 injuries between 1995 and 2009. The SHMT agreed that Iowa has between a 10% and 20% probability of an extreme heat occurrence in any given year.



Evaluation Criteria	Description	Score
Probability	Based on historical information, Iowa will likely experience about 26 days a year with temperatures above 90 degrees. There is a very good chance that there will also be a period of 3 consecutive days or more with temperatures in the 90s. It is also common for the temperature to hit 100 degrees or more once every three years during the summer months. Based on the evaluation of this hazard, the SHMT determined that Iowa has between 10% and 20% chance of experiencing extreme heat events lasting at least three days or more in succession.	**2**
Magnitude/Severity	Elderly persons, small children, chronic invalids, those on certain medications or drugs (especially tranquilizers and anticholinergics), and persons with weight and alcohol problems are particularly susceptible to heat reactions. Healthy individuals working outdoors in the sun and heat are vulnerable as well. Individuals and families with low budgets as well as inner city dwellers can also be susceptible due to poor access to air-conditioned rooms. Most of the state would likely be impacted by extreme heat, but urban areas pose special risks. The stagnant atmospheric conditions of the heat wave trap pollutants in urban areas and add to the stresses of hot weather. Livestock and other animals are adversely impacted by extreme heat. High temperatures at the wrong time inhibit crop yields as well. Economic costs in transportation, agriculture, production, energy, and infrastructure. These direct costs could impact many other economic sectors indirectly.	**1**

Evaluation Criteria	Description	Score
	During past occurrences of this hazard coupled with advanced notice from weather reports has illustrated the importance of utilizing existing shelter systems set up around the state to protect vulnerable populations.	
Warning Time	As with other weather phenomena, periods of extreme heat are predictable within a few degrees within 3 days or so. Variations in local conditions can affect the actual temperature within a matter of hours or even minutes. The National Weather Service will initiate alert procedures when the heat index is expected to exceed 105 degrees Fahrenheit for at least two consecutive days.	**1**
Duration	The definition of an extreme heat event is an occurrence of 90+ degree weather for a minimum of 3 days. The SHMT evaluated this hazard as likely to exceed one week in duration based on a review of past extreme heat events in the State of Iowa.	**4**
	Worksheet Total	**1.75**

Sources for Extreme Heat	
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climate/severeweather/temperatures.html
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=8cc6a5f0f013b110VgnVCM10000089f0870aRCRD&vgnextfmt=default
Federal Emergency Management Agency	http://www.fema.gov/hazard/heat/index.shtm
Weather.com	http://www.weather.com/outlook/wxready/articles/id-71
Center for Disease Control	http://www.bt.cdc.gov/disasters/extremeheat/heat_guide.asp
Extreme Heat Guidebook	http://www.aclink.org/PublicHealth/health_topics/pdf_files/ExtremeHeat2.pdf
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Environmental Protection Agency	http://www.epa.gov/naturalevents/extremeheat.html
Environmental Protection Agency	http://www.epa.gov/heatisland/about/pdf/EHEguide_final.pdf
Local Sources	Varies

2.7 Flash Flood

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
4	**2**	**1**	**1**	**2.65**

A flash flood is an event that occurs with little or no warning where water levels rise at an extremely fast rate. Flash flooding results from intense rainfall over a brief period, sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil, or impermeable surfaces. 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.

Floods are the most common and widespread of all-natural disasters except fire. In Iowa, as much as 21 inches of rain has fallen in a 24 hour period. The latest significant event to affect Iowa occurred in June/July of 2008. This event resulted in a Presidential Disaster Declaration due to widespread personal and physical property losses. Since then, many flash flood events have occurred across Iowa though mostly localized events. The National Climatic Data Center lists 1,628 flash flooding/urban or small stream flooding events from 1993-2009. Between 1993 and 2006 there have been seven (7) deaths and thirteen (13) injuries related to flash flooding in Iowa.

As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization increases runoff two (2) to six (6) times over what would occur on natural terrain. Portions of Iowa are very developed with significant amounts of impervious surfaces, as more development occurs in the watersheds; the amount of runoff produced also increases. If measures are not taken to reduce the amount of runoff (or slow its movement), flash floods will continue to occur and may possibly increase.

In certain areas, aging storm sewer systems were not designed to carry the capacity currently needed to handle the increased storm runoff. This combined with rainfall trends (that are moving upwards) and rainfall extremes (that are patterning higher) all demonstrate the high likelihood yet, unpredictable nature of flash flooding in the state.

The SHMT evaluation concluded that it is highly likely that a flash flood will affect Iowa in any given year. All team members can relate to a flooding situation, making this easy to evaluate. Iowa experiences numerous flooding events yearly and all too often deaths and injuries occur.

Evaluation Criteria	Description	Score
Probability	Floods are the most common and widespread of all-natural disasters except fire. In Iowa, the National Climatic Data Center lists 1,628 flash flooding / urban or small stream flooding events from 1993-2009. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization increases runoff 2 to 6 times over what would occur on natural terrain. Portions of Iowa are very developed with significant amounts of impervious surfaces. As more development occurs in the watersheds, the amount of runoff produced also increases. Unless measures are taken to reduce the amount of runoff (or slow its movement), flash floods will continue to occur and possibly increase. Often, aging storm sewer systems are not designed to carry the capacity currently needed to handle the increased storm runoff in certain areas.	**4**
Magnitude/Severity	Flash floods occur in all 50 states in the U.S. Particularly at risk are those in low-lying areas; close to dry creek beds or drainage ditches; near water; or downstream from a dam, levee, or storage basin. People and property in areas with insufficient storm sewers and other drainage infrastructure can also be put at risk because the drains cannot rid the area of the runoff quickly enough. Nearly half of all flash flood fatalities are auto-related. Motorists often try to traverse water-covered roads and bridges and are swept away by the current. Six inches of swiftly moving water can knock persons off their feet and only two feet of water can float a full-sized automobile. Recreational vehicles and mobile homes located in low-lying areas can also be swept away by the water. Areas in a floodplain, downstream from a dam or levee, or in low-lying areas can certainly be impacted. People and property located in areas with narrow stream channels, saturated soil, or on land with large amounts of impermeable surfaces are likely to be impacted in the event of a significant	**2**

Evaluation Criteria	Description	Score
	rainfall. Unlike areas impacted by a river/stream flood, flash floods can impact areas a good distance from the stream itself. Flash flood prone areas are not particularly those areas adjacent to rivers and streams. Streets can become swift moving rivers, and basements can become deathtraps because flash floods can fill them with water in a manner of minutes. Rescuers are at significant risk when attempting to work in swift moving floodwaters associated with flash flooding. Special training in swift water rescue exists, but very few are trained in Iowa on this type of rescue. Personal property can be extensively damaged and destroyed by swift moving water. Facilities and infrastructure can be scoured around and degrading its structural integrity. Because flash flood water is off premises quickly, damages related to standing water are limited, but the current associated with flash floods causes abrasive type damages such as erosion and undercutting. Flash floods can quickly inundate areas thought to be out of flood-prone areas. Loss of life; property damage and destruction; damage and disruption of communications, transportation, electric service, and community services; crop and livestock damage and loss and interruption of business are common impacts from flash flooding.	
Warning Time	Flash floods are somewhat unpredictable, but there are factors that can point to the likelihood of flood's occurring in the area. Flash floods occur within a few minutes or hours of excessive rainfall, a dam or levee failure, or a sudden release of water held by an ice jam. Weather surveillance radar is being used to improve monitoring capabilities of intense rainfall. Knowledge of the watershed characteristics, modeling, monitoring, and warning systems increase the predictability of flash floods. Depending on the location in the watershed, warning times can be increased. The NWS forecasts the height of flood crests, the data, and time the flow is expected to occur at a particular location.	**1**
Duration	The response to the effects of flash flooding in Iowa is short in duration due to the nature of the hazard.	**1**
	Worksheet Total	**2.65**

Sources for Flash Floods	
FEMA Map Service Center	http://www.msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1&userType=G
Federal Emergency Management Agency	http://www.fema.gov/hazard/flood/index.shtm
Public NFIP Data	http://www.floodsmart.gov/floodsmart/
FEMA NFIP Data	http://www.fema.gov/business/nfip/
Iowa Department of Natural Resources	http://www.iowadnr.gov/water/floodplain/index.html
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=fdb4510f935ea110VgnVCM10000030f3870aRCRD&vgnextfmt=default
National Climactic Data Center	http://www.ncdc.noaa.gov/oa/climateresearch.html#dandp
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Local Sources	Varies
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/

2.8 Grass or Wildland Fire

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
2	**2**	**1**	**1**	**1.75**

A grass or wild-land fire is an uncontrolled fire that threatens life and property in either a rural or a wooded area. Grass and wild-land fires can occur when conditions are favorable, such as during periods of drought when natural vegetation would be drier and subject to combustibility.

According to the National Interagency Fire Center there have been 1,244 wildfires spanning 30,370 acres and 1,274 prescribed fires spanning 8,951 acres from 2002- May 31, 2010 in Iowa. These numbers, along with those reported in the Rocky Mountain region consists of only 3-4% of the reported national incidents and encompasses 2-4% of the total acres burned.

	Reporting Agency	Wildfire		Prescribed		Wildland Fire Use	
Year	-	# Fires	# Acres	# Fires	# Acres	# Fires	# Acres
2002	-	5	1,045	17	2,617	0	0
2003	-	34	3,417	6	457	0	0
2004	-	26	585	86	7,727	0	0
2005	-	94	10,566	142	12,058	0	0
2006	-	15	827	131	10,433	0	0
2007	Bureau of Indian Affairs	0	0	0	0	0	0
-	Fish & Wildlife Service	5	104	87	7,438	0	0
-	National Park Service	0	0	1	223	0	0
-	State	49	580	129	4,570	0	0
2007 Total		54	684	217	12,231	0	0
2008	Bureau of Indian Affairs	0	0	0	0	0	0
-	Fish & Wildlife Service	2	30	3	303	0	0
-	National Park Service	0	0	2	20	0	0
-	State	175	2,187	0	0	0	0
2008 Total		177	2,217	5	323	0	0
2009	Bureau of Indian Affairs	0	0	0	0	0	0
	Fish & Wildlife Service	5	134	96	10,789	0	0
	National Park Service	0	0	6	285	0	0
	State	713	8,431	519	22,265	0	0
2009 Total		718	8,565	621	33,339	0	0
2010	-	121	2,464	49	1,371	NA	NA
Total	-	1,244	30,370	1,274	80,556	0	0
Annualized	-	138	3,374	142	8,951	0	0
Year	Comments						
2007	Rocky Mountain Region 4% of National Incidents & 2% of Acres Burned						
2008	Rocky Mountain Region 3% of National Incidents & 4% of Acres Burned						
2009	Rocky Mountain Region 3% of National Incidents & 2% of Acres Burned						

No event that has been reported has been a historically significant wildfire; due to the nature of this hazard the SHMT determined that the probability in any given year is occasional (10-20%) due to the amount of fires reported and the low amount of historically significant wildland fires as determined and maintained by the National Interagency Fire Center (none are on record since the first recorded event in 1804).

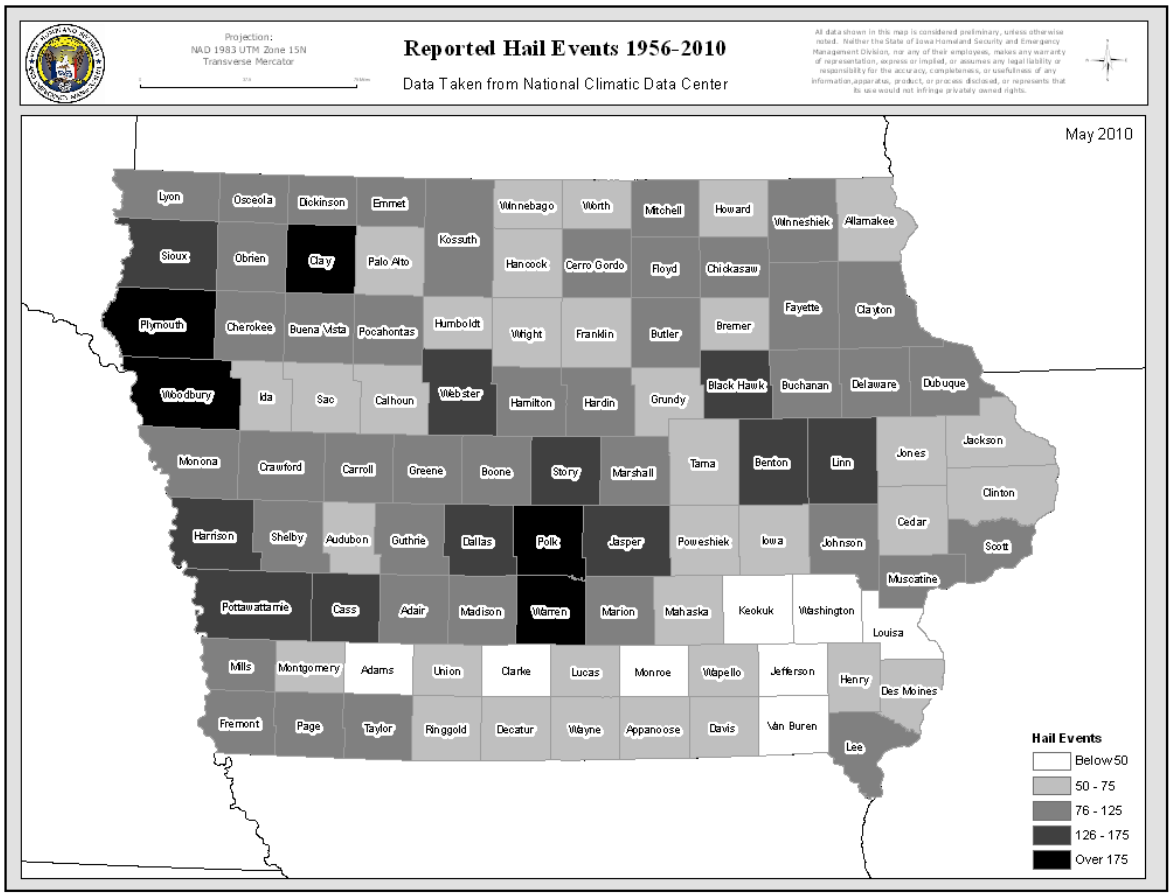
Evaluation Criteria	Description	Score
Probability	The SHMT determined that the probability in any given year is occasional (10-20%) due to the amount of fires reported and the low amount of historically significant wildland fires as determined and maintained by the National Interagency Fire Center.	**2**
Magnitude/Severity	While wildfires have proven to be most destructive in the Western States, they have become an increasingly frequent and damaging phenomenon nationwide. People choosing to live in wild-land settings are more vulnerable to wildfires, and the value of exposed property is increasing at a faster rate than population. Iowa is less vulnerable to wild-land fire because of the extremely large percentage of land that is developed. Grass fires are often more easily contained and extinguished before there is damage to people or developed property. Fires often burn large portions of field crops in the fall when the crops are dry and the harvesting equipment overheats or throws sparks. This can be quite costly to the farmer in terms of lost production. Most grass fires are contained to highway right-of-way and rail right-of-way ditches and are less than a few acres in size. High winds can turn a small flame into a multi-acre grassfire within a matter of minutes. The extent is dependent upon conditions such as land use/land cover, moisture, and wind.	**2**
Warning Time	As mentioned above, most grassfires occur without warning and travel at a moderate rate. This situation depends upon conditions at the time such as moisture, wind, and land cover. However, methods for forecasting the probability of occurrence of conditions most suitable for wild-fires to occur has increased with the use of the national wildland significant fire potential outlook issued by the National Interagency Fire Center and the NOAA Storm Prediction Center.	**1**
Duration	The majority of Iowa wildfires occur in short duration on in areas of brush and forest lands with approximately half of the fires being prescribed fires and controlled burns supervised by trained experts.	**1**
	Worksheet Total	**1.75**

Sources for Grass or Wild land Fire	
Firehouse.com	http://www.firehouse.com/topic/wildland
Iowa Department of Natural Resources	http://www.iowadnr.gov/forestry/fire.html
National Interagency Fire Center	http://www.nifc.gov/
National Interagency Fire Center Statistics	http://www.nifc.gov/fire_info/fire_stats.htm
Iowa Division of State Fire Marshal	http://www.dps.state.ia.us/fm/
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Local Sources	Varies

2.9 Hailstorm

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
4	**1**	**3**	**1**	**2.65**

Hailstorms are an outgrowth of a severe thunderstorm in which pellets or irregularly shaped lumps of ice greater than 1 inch in diameter fall with rain. Hail is produced in many strong thunderstorms by strong rising currents of air carrying water droplets to a height where freezing occurs, the ice particles grow in size until they are too heavy to be supported by the updraft and fall back to earth. Hail can be smaller than a pea or as large as a softball and can be very destructive to plants and crops; pets and livestock are particularly vulnerable to hail. The following map depicts a geographic breakdown of the number of hailstorms in Iowa since 1956.



According to the National Climatic Data Center (NCDC), Iowa experienced 9,307 hailstorm events from 1950-2009. One hundred twenty-three (123) injuries and four (4) deaths resulted from these hailstorms in Iowa. NCDC website data lists events by county and one event may be counted several times if the event affects a large region in the state.

Data on the probability and frequency of hailstorms is limited, but research indicates that at any given point; Iowa can expect, on average, two (2) to three (3) hailstorms a year. This average

based on recorded historical data and input from experts at the National Weather Service. Based on the best available data the SHMT determined that a hail event is highly likely to occur in any given year.

Evaluation Criteria	Description	Score
Probability	Data on probability and frequency of occurrence of hailstorms is limited, but research indicates that any given point in Iowa can expect on average two to three hailstorms in a year.	**4**
Magnitude/Severity	Agricultural crops such as corn and beans are particularly vulnerable to hailstorms stripping the plant of its leaves. Hail can also do considerable damage to vehicles and buildings. Hail only rarely results in loss of life directly although injuries can occur. The land area affected by individual hail events is not much smaller that that of parent thunderstorm, an average of 15 miles in diameter around the center of the storm. Damage to property, facilities, and infrastructure is usually limited to broken windows and damaged roofs. Hailstorms cause nearly $1 billion dollars annually in property and crop damage in the United States. The peak hail activity coincides with the Midwest's peak agricultural season. Financial impacts resulting from damage to property is in the millions of dollars every year, most of which is covered by crop and hazard insurance.	**1**
Warning Time	Forecasting hailstorms as with their parent thunderstorms, and forecasting the conditions suitable for developing storms with the potential to create hail is becoming quite accurate due to the advancement in Doppler Radar and other technologies operated by the National Weather Service and many televisions weather departments.	**3**
Duration	The occurrence of hailstorms is short term in nature and usually limited to less than 6 hours per event.	**1**
	Worksheet Total	**2.65**

Sources for Hailstorms	
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climateresearch.html#dandp
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=014b5d795323b110VgnVCM10000089f0870aRCRD&vgnextfmt=default
Federal Emergency Management Agency	http://www.fema.gov/hazard/thunderstorm/index.shtm
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/
Disaster Center.com	http://www.disastercenter.com
Local Sources	varies

2.10 Hazardous Materials

This hazard encompasses the following consolidated hazards from the 2007 mitigation plan: fixed hazardous materials, pipeline transportation, and transportation hazardous materials. This includes the accidental release of flammable or combustible, explosive, toxic, noxious, corrosive, oxidizable, an irritant or radioactive substances or mixtures that can pose a risk to life, health or property possibly requiring evacuation.

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

A fixed hazardous materials incident is the accidental release of chemical substances or mixtures, which presents a danger to the public health or safety, during production or handling at a fixed facility. 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 ever-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 and the use of planning and zoning can minimize the area of impact.

During the period 2000-2010, fixed facilities experienced 4,972 incidents according to the Iowa Department Natural Resources (DNR). Fixed facility releases accounted for 57.6% of total releases. (Note: the number of trips to drug related operations has risen sharply in the state.) There are 4,057 sites in Iowa that because of the volume or toxicity of the materials on site are designated as Tier Two facilities under the Superfund Amendments and Reauthorization Act.

Despite increasing safeguards, more and more potentially hazardous materials are being used in commercial, agricultural, and domestic activities. This situation is made worse by the density of people and hazardous materials in Iowa.

The SHMT analysis evaluated the probability that a high impact occurrence of a fixed hazardous materials incident has a 10-20% probability to occur in any given year. A high impact occurrence is one defined as an environmental emergency by the Environmental Protection Agency. An environmental emergency is a sudden threat to the public health or the well being of the environment, arising from the release or potential release of oil, radioactive materials or hazardous chemicals into the air, land, or water.

Data tables for each county are maintained by the Iowa Department of Natural Resources in the identification of the hazard by jurisdiction; data for this is presented below.

	Substance				Mode					
Year	Total Incidents	Agri-Chemical	Petroleum Products	Other Chemicals	Transport	Fixed Facility	Pipeline	Railroad	Fire	Other*
2000	890	142	462	286	279	535	8	15	7	50
2001	947	171	548	228	274	552	18	25	12	66
2002	995	169	614	212	265	644	18	16	12	42
2003	744	133	416	195	223	406	19	20	10	66
2004	751	122	422	207	215	447	17	18	5	52
2005	785	116	461	208	237	408	16	29	12	83
2006	705	106	423	176	191	395	12	26	9	74
2007	806	113	447	246	224	442	18	22	11	89
2008	888	110	549	229	228	504	26	36	8	87
2009	774	109	434	231	215	450	12	23	5	79
2010**	320	35	184	101	89	189	15	8	2	23
Total	8,605	1,326	4,960	2,319	2,440	4,972	179	238	93	711
% of Total	-	15.4%	57.6%	26.9%	28.3%	57.6%	2.1%	2.8%	1.1%	8.2%
Annualized	826.1	127.3	476.2	222.6	234.2	477.3	17.2	22.8	8.9	68.3
*Other includes dumping, theft, vandalism, and unknown						**Information as of May of 2010				

*Source: Iowa Department of Natural Resources, Hazardous Substance Database

Year	Field Office 1	Field Office 2	Field Office 3	Field Office 4	Field Office 5	Field Office 6	Total
2000	141	103	123	90	272	164	893
2001	162	111	117	86	276	189	941
2002	158	106	148	112	308	160	992
2003	124	118	101	74	205	118	740
2004	115	134	87	82	198	138	754
2005	119	144	101	85	182	150	781
2006	85	129	92	87	169	144	706
2007	129	158	102	85	189	143	806
2008	127	159	125	126	193	159	889
2009	89	117	131	112	160	174	783
2010**	35	57	54	40	72	67	325
Total	1,284	1,336	1,181	979	2,224	1,606	8,610
% of Total	15%	16%	14%	11%	26%	19%	-
Annualized	123.3	128.3	113.4	94.0	213.5	154.2	826.6
-Reported field office events include unknown substance events not classified above							

Month	Incidents	Annualized	% of Total
January	552	53.0	6%
February	555	53.3	6%
March	777	74.6	9%
April	1,069	102.6	12%
May	931	89.4	11%
June	878	84.3	10%
July	757	72.7	9%
August	740	71.0	9%
September	627	60.2	7%
October	614	58.9	7%
November	633	60.8	7%
December	477	45.8	6%
Total	8,610	827	-

*Source: Iowa Department of Natural Resources, Hazardous Substance Database

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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 to the pipelines.

According to the Iowa Utilities Board (IUB) and the United State Department of Transportation Pipeline and Hazardous Materials Safety Administration, 43 pipeline accidents, incidents, or service outages were reported between 2000 and 2009, resulting in a total of six (6) injuries.

Across the nation, hundreds of deaths and many more injuries have been caused by underground pipeline incidents.

The vast majority of pipeline incidents that occur are caused by third party damage to the pipeline, often due to construction or some other activity that involves trenching or digging operations. With development occurring at an unprecedented rate and the ground becoming more and more congested with utilities, the probability of an underground pipeline incident is significant. Petroleum and natural gas pipeline accidents occur with some regularity, but they usually have a limited impact and are quickly and adequately handled by pipeline company emergency crews and local and state responders. Pipeline operators are required to coordinate all safety preparedness and response activities with the communities. Continuing to plan, train, and exercise emergency procedures help to limit the occurrence and severity of incidents.

The SHMT evaluated the probability that a serious pipeline transportation incident (enough to cause death and/or large amounts of property damage) will occur in Iowa is a likely chance of occurrence in any given year.

Commodity	Pipeline Miles	%
Anhydrous Ammonia	661	5.5%
Crude Oil	235	1.9%
Empty Liquid	2	0.0%
Highly Volatile Liquid	1,317	10.9%
Natural Gas	7,837	64.7%
Natural Gas Liquids	362	3.0%
Nitrogen	114	0.9%
Refined Products	1,586	13.1%
Totals	**12,114**	**100%**

Pipeline Mileage Overview	
Pipeline System	Mileage
Hazardous liquid line mileage	4,161
Gas transmission line mileage	7,926
Gas Gathering line mileage	0
Gas distribution mileage (918,525 total services)	17,437
Total pipeline mileage	**29,524**

Iowa All Pipeline Systems: Significant Incidents						
Year	Number	Fatalities	Injuries	Property Damage	Gross Barrels Lost	Net Barrels Lost
2000	3	0	0	$1,741,723.00	769	203
2001	4	0	1	$2,450,199.00	1,784	1,784
2002	6	0	0	$1,196,716.00	300	71
2003	1	0	1	$0.00	0	0
2004	4	0	1	$752,572.00	52	52
2005	8	0	1	$1,268,340.00	191	110
2006	3	0	0	$508,789.00	0	0
2007	1	0	0	$220,716.00	100	100
2008	5	0	2	$1,391,383.00	9,103	9,102
2009	3	0	0	$510,247.00	36	0
Totals	38	0	6	$10,040,685.00	12,335	11,422
10 Year Average	**3.8**	**0**	**0.6**	**$1,004,068.50**	**1,233.5**	**1,142.2**

Iowa All Pipeline Systems: Serious Incidents						
Year	Number	Fatalities	Injuries	Property Damage	Gross Barrels Lost	Net Barrels Lost
2000	0	0	0	$0.00	0	0
2001	1	0	1	$2,429,548.00	1,442	1,442
2002	0	0	0	$0.00	0	0
2003	1	0	1	$0.00	0	0
2004	1	0	1	$1,159.00	0	0
2005	1	0	1	$340,879.00	0	0
2006	0	0	0	$0.00	0	0
2007	0	0	0	$0.00	0	0
2008	1	0	2	$0.00	0	0
2009	0	0	0	$0.00	0	0
Totals	5	0	6	$2,771,586.00	1,442	1,442
10 Year Average	**0.5**	**0**	**0.6**	**$277,158.60**	**144.2**	**144.2**

Source: Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety, Iowa Significant Incidents and Mileage Overview

Evaluation Criteria	Description	Score
Probability	The SHMT analysis evaluated the probability that a high impact occurrence of a hazardous materials incident has a 10% - 20% probability to occur in any given year. A high impact occurrence is one defined as an environmental emergency by the Environmental Protection Agency. An environmental emergency is a sudden threat to the public health or the well being of the environment, arising from the release or potential release of oil, radioactive materials or hazardous chemicals into the air, land, or water.	**2**
Magnitude/Severity	A hazardous materials accident can occur almost anywhere, so any area is considered vulnerable to an accident. 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, a larger area may be in danger from explosion, absorption, injection, ingestion, or inhalation. Occupants of areas previously contaminated by a persistent material may also be harmed either directly or through consumption of contaminated food and water. Facilities are required to have an off-site consequence plan that addresses the population of the surrounding area. Responding personnel are required to be trained to HAZMAT Operations Level to respond to the scene, and those personnel that come into direct contact with the substances released are required to have HAZMAT Technician level training. Most of the hazardous materials incidents are localized and are quickly contained or stabilized by the highly trained fire departments and hazardous materials teams. 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 a river, lake, or aquifer. The release of some toxic gases may cause immediate death, disablement, or sickness if absorbed through the skin, injected, ingested, or inhaled. Some chemicals may cause painful and damaging burns to skin if they come in direct contact with your body.	**2**

Evaluation Criteria	Description	Score
	Specialized training is needed to respond to these types of incidents. If inadequately trained personnel attempt to respond, the impacts could be the same as those for the general public exposed to the toxic materials. Proper training and equipment greatly reduce the risk to response personnel.	
Warning Time	When managed properly under regulations, hazardous materials pose little risk. However, when handled improperly or in the event of an accident, hazardous materials can pose a significant risk to the population. Hazardous materials incidents usually occur very rapidly with little or no warning. Even if reported immediately, people in the area of the release have very little time to be warned and evacuated. During some events, sheltering in-place is the best alternative to evacuation because the material has already affected the area and there is no time to evacuate safely. Public address systems, television, radio, and the NOAA Weather Alert Radios are used to disseminate emergency messages about hazardous materials incidents.	**4**
Duration	Response to a hazardous materials release is generally limited to the immediate effects of a release of dangerous materials and their threat to life and property. However, due to the laws surrounding hazardous materials and the duty of the public to inform and protect citizens from the effects of hazardous materials in their vicinity, response is expanded for environmental emergencies.	**4**
	Worksheet Total	**2.50**

Sources for Hazardous Materials	
U.S. Environmental Protection Agency	http://www.epa.gov/epahome/commsearch.htm
Iowa Department of Natural Resources	https://programs.iowadnr.gov/hazardousspills/Introductory.aspx
Iowa Workforce Development	http://www.iowaworkforce.org/labor/serc.htm
U.S. Department of Transportation	http://www.phmsa.dot.gov/incident-report
Iowa Department of Transportation	http://www.iowadot.gov/mvd/omve/hazmat.htm
Iowa Pipeline Data	http://primis.phmsa.dot.gov/comm/StatePages/Iowa.htm?nocache=4138
Iowa Significant Pipeline Incidents	http://primis.phmsa.dot.gov/comm/reports/safety/IA_detail1.html?nocache=3508
Iowa Pipeline Enforcement	http://primis.phmsa.dot.gov/comm/reports/stenforce/StateEnfDet_state_IA.html?nocache=2235
Iowa Pipeline Regulations	http://primis.phmsa.dot.gov/comm/FactSheets/States/IA_State_PL_Safety_Regulatory_Fact_Sheet.htm?nocache=724
U.S. Office of Pipeline Safety	http://www.phmsa.dot.gov/pipeline
Iowa Utilities Board Pipeline Information	http://www.state.ia.us/government/com/util/energy/pipeline_permits.html
National Transportation Safety Board	http://www.ntsb.gov/Surface/pipeline/pipeline.htm
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Local Sources	Varies

2.11 Human Disease

This hazard encompasses the following consolidated hazards from the 2007 mitigation plan: human disease incident, and pandemic human disease. This includes a medical, health, or sanitation threat to the general public (such as contamination, epidemics, plagues, insect infestations, and pandemics).

Hazard Score Calculation				
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score
1	4	2	4	2.35

An incident related to human disease is defined as a medical, health, or sanitation threat to the general public (such as contamination, epidemics, plagues, and insect infestation). Public health action to control infectious diseases in the 21st century is based on the 19th century discovery of microorganisms as the cause of many serious diseases (e.g., cholera and TB). Disease control resulted from improvements in sanitation and hygiene, the discovery of antibiotics, and the implementation of universal childhood vaccination programs. Scientific and technologic advances played a major role in each of these areas and are the foundation for today's disease surveillance and control systems. Scientific findings have contributed to a new understanding of the evolving relationship between humans and microbes. As of January 1, 2010, sixty (60) infectious diseases were designated as notifiable at the national level. A notifiable disease is one for which regular, frequent, and timely information regarding individual cases is considered necessary for the prevention and control of the disease.

The Iowa Department of Public Health tracks epidemiological statistics in Iowa. Public health agencies work to protect Iowans from infectious diseases and preserve the health and safety of Iowans through disease surveillance, investigation of suspect outbreaks, education and consultation to county, local, and health agencies.

Public health agencies also work to reduce the impact of communicable diseases in Iowa and to eliminate the morbidity associated with these diseases. Programs guide community-based prevention planning, monitor current infectious disease trends, prevent transmission of infectious diseases, provide early detection and treatment for infected persons, and ensure access to health care for refugees in Iowa. While vaccines are available for many diseases, Iowans remain vulnerable to other diseases known and unknown.

A pandemic human disease is defined as a disease that has spread around the world to many people. The word, “pandemic”, means that a disease has caused illness in a person on nearly every continent. Many diseases throughout the history of the world have been pandemic. Examples are HIV/AIDS/Influenza. A pandemic will have wide spread economic and societal implications for our state. Response and recovery to a pandemic will likely be lengthy.

From 1900-2000, there were three (3) influenza pandemics, all about 30 years apart. This seems to follow the same trend with the next occurrence to affect Iowa beginning in 2009 with the H1N1 influenza virus causing 659 hospitalizations with lab confirmed H1N1 since 9/1/09 and resulting in 41 fatalities. Typically people who become ill are the elderly, the very young and people with chronic medical conditions and high risk behaviors. Approximately 22% of Iowa’s population is considered high risk.

The SHMT had much discussion of the Speed of Onset to the disease. If the disease is highly infectious by the time it is discovered, it will likely have already spread across the state or nation. This will put us at a severe disadvantage during the response and recovery.

The SHMT analysis evaluated the probability of a human disease incident less than 10% in any given year.

Evaluation Criteria	Description	Score
Probability	From 1900-2000, there were three (3) influenza pandemics, all about 30 years apart. This seems to follow the same trend with the next occurrence to affect Iowa beginning in 2009 with the H1N1 influenza virus causing 659 hospitalizations with lab confirmed H1N1 since 9/1/09 and resulting in 41 fatalities. Typically people who become ill are the elderly, the very young and people with chronic medical conditions and high risk behaviors. Approximately 22% of Iowa's population is considered high risk. Public health agencies work to protect Iowans from infectious diseases and preserve the health and safety of Iowans through disease surveillance, investigation of suspect outbreaks, education and consultation to county, local and public/private health agencies. Historically pandemics occur every 30 years.	**1**
Magnitude/Severity	Public health agencies also work to reduce the impact of communicable diseases in Iowa and to eliminate the morbidity associated with these diseases. Programs guide community-based prevention planning, monitor current infectious disease trends, prevent transmission of infectious diseases, provide early detection and treatment for infected persons, and ensure access to health care for refugees in Iowa. While vaccines are available for many diseases, Iowans remain vulnerable to other diseases known and unknown. Because of our highly mobile society, these diseases can move rapidly across the state and across the nation within days, weeks, or months. Many of the diseases on the national notification list result in serious illness if not death. Some are treatable, other only the symptoms are treatable. Influenza (flu) happens every year in nearly every country in the world. It spreads through a population for a few months and then will disappear or will move onto another country. Influenza usually occurs in the fall and winter months. Typically people who usually become ill are the elderly, the very young and people with chronic medical conditions and high risk behaviors. The individuals that travel internationally and have high exposure to potential vectors of disease are the most susceptible. Greater than 20% of Iowa's population is considered high risk.	**4**
Warning Time	The private practitioner is the first line of defense and will undoubtedly be the first to witness the symptoms of human disease incidents. The Iowa Department of Public Health and the U.S. Centers for Disease Control monitor reports submitted by doctors, hospitals, and labs to identify patterns. The Department and CDC are proactive in providing information to the health care community on medical concerns. Conditions related to scope and magnitude can escalate quickly and area resources can be drained of personnel, medications, and vaccinations rather quickly.	**2**
Duration	Response to highly infectious diseases occurs continuously, although the direct effects of a pandemic influenza can occur for months at a time as evident with the H1N1 influenza in August of 2009.	**4**
	Worksheet Total	**2.35**

Sources for Human Disease	
Iowa Department of Public Health	http://www.idph.state.ia.us/hpcdp/default.asp
Iowa Department of Public Health	http://www.idph.state.ia.us/adper/default.asp
Iowa DPH Influenza	http://www.idph.state.ia.us/pandemic/
Iowa Bureau of Health Statistics	http://www.idph.state.ia.us/apl/health_statistics.asp
Centers for Disease Control	http://www.cdc.gov/DataStatistics/
CDC Prevention	http://www.cdc.gov/flu/pandemic/healthprofessional.htm
CDC Emergency Preparedness & Response	http://emergency.cdc.gov/
National Center for Health Statistics	http://www.cdc.gov/nchs/
Flu.gov	http://www.pandemicflu.gov/
World Health Organization	http://www.who.int/research/en/
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Local Sources	Varies

2.12 Infrastructure Failure

This hazard encompasses the following consolidated hazards from the 2007 mitigation plan: Communication Failure, Energy Failure, Structural Failure, and Structural Fire. This includes an extended interruption, widespread breakdown, or collapse (part or all) of any public or private infrastructure that threatens life and property.

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
1	**2**	**4**	**4**	**2.05**

Communication failure is the widespread breakdown or disruption of normal communication capabilities. This could include major telephone outages, loss of local government radio facilities, long-term interruption of electronic broadcast services, 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 communication systems to effectively protect citizens. Business and industry rely heavily on various communication media as well. Mechanical failure, traffic accidents, power failure, line severance, and weather can affect communication systems and disrupt service. Disruptions and failures can range from localized and temporary to widespread and long-term. If switching stations are affected, the outage could be more widespread. Thus, the SHMT supports developing interoperability throughout the state.

No widespread communication failures have occurred in Iowa. Local incidents; due to weather conditions, equipment failure, excavation incidents, or traffic accidents have been reported, the outages were usually resolved in a timely manner. Widespread communication losses are unlikely due to backup systems and redundant system designs. Local communication failures are likely to affect small areas of a county.

The SHMT evaluated the probability that a serious communication failure in Iowa at less than 10% probability in any given year.

An extended interruption of service either electric, petroleum or natural gas, which by an actual or impending acute shortage of usable energy could create a potential health problem for the population and possibly mass panic.

International events could potentially affect supplies of energy producing products while local conditions could affect distribution of electricity, petroleum or natural gas. The magnitude and frequency of energy shortages are associated with international markets. Local and state events such as ice storms can disrupt transportation and distribution systems; if disruptions are long lasting, public shelters may need to be activated to provide shelter from extreme cold or extreme heat. Stockpiles of energy products eliminate short disruptions but can increase the level of risk to the safety of people and property near the storage site.

The energy crisis of the 1970s had significant impact on many consumers in Iowa. High inflation and unemployment were associated with the excessive dependence on foreign oil during the early and mid 1970s. An energy shortage of that magnitude has not affected Iowa in recent years. Only when free market forces cease to provide for the health, welfare, and safety of the citizens can governments can take appropriate actions to limit the effects of an energy shortage.

The State of Iowa has three (3) strategies to limit the likelihood of an energy shortage and keep energy supply and demand in check. These strategies include:

- Through voluntary and mandatory demand reduction mechanisms;
- the substitution of alternative energy sources when possible;
- state government programs to curtail excessive use,

The federal government has a strategic petroleum reserve to supplement the fuel supply during energy emergencies. Shortages, especially electrical shortages, can be unpredictable with immediate effects. Natural events, human destruction, price escalation, and national security energy emergencies can cause unavoidable energy shortages.

The SHMT evaluated the probability an energy transportation failure will occur in Iowa is less than 10% in any given year.

The collapse (part or all) of any public or private structure including roads, bridges, towers, and buildings is considered a structural failure. A road, bridge, or building may collapse due to the failure of the structural components or because the structure was overloaded. Natural events such as heavy snow may cause the roof of a building to collapse (under the weight of snow). Heavy rains and flooding can undercut and washout a road or bridge. The age of the structure is sometimes independent of the cause of the failure. Enforcement of building codes can better guarantee that structures are designed to hold-up under normal conditions. Routine inspection of older structures may alert inspectors to “weak” points. The level of damage and severity of the failure is dependent on factors such as the size of the building or bridge, the number of occupants of the building, the time of day, day of week, amount of traffic on the road or bridge, and the type, and amount of products stored in the structure.

There have been several sporadic structural failures across the state. They have included homes, commercial structures, and communications towers. There is no central collection point for this information. Local records will have to support this area.

Civil structures may fail in a variety of modes. The unprecedented growth in technology has resulted in a host of problems related to complex structures, special materials, and severe operational and environmental loads, such as fire, excessive vibrations, explosion, high-energy piping failures, missiles, and earthquakes. With the possible exception of misuse, accidental or environmental loads, the causes of failure may be found in deficiencies of design, detailing, material, workmanship, or inspection. With the aging structures in the country along with problems with new materials discussed above, structural failures will continue to occur. Efforts to inspect and maintain these structures will lessen the probability of a failure, but not guarantee that it will not happen in the future. Internal weaknesses can be hidden from inspectors and not be realized until it is too late.

The SHMT analysis has evaluated the probability that structural failures will occur in Iowa is less than 10% in any given year.

A structural fire is an uncontrolled fire in populated areas that threatens life and property and is beyond normal day-to-day response capability. Structural fires present a far greater threat to life and property and the potential for much larger economic losses. Modern fire codes and fire suppression requirements in new construction and building renovations, coupled with improved fire-fighting equipment, training, and techniques lessen the chance and impact of a major urban fire. Most structural 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 volume or type of the material involved.

Structural fires are almost a daily occurrence in some communities. Nearly all are quickly extinguished by on-site personnel or local fire departments. There have been 1,535 deaths in Iowa from fires between the years 1974-2002 (this does not include the years 1978-79). From 2006 through April of 2010, there have been 167 recorded fire fatalities.

Much of the fire prevention efforts have gone into non-residential fires and the results have been highly effective. Even with an increase in the prevention efforts in residential fires, both residential and non-residential fires will continue to occur. During colder months, clogged chimneys and faulty furnaces and fireplaces can increase the probability of structural fires.

The SHMT analysis has evaluated the probability that a major structural fire will occur in Iowa has an occasional probability in any given year.

Evaluation Criteria	Description	Score
Probability	No widespread communications failures have occurred in Iowa. Local incidents due to weather conditions, equipment failure, excavation incidents, and traffic accidents have been reported, but outages have usually been resolved in a timely manner. Widespread communications losses are unlikely due to backup systems and redundant system designs. Local communications failures are likely to affect small areas of the county.	**1**

Evaluation Criteria	Description	Score
	The energy crisis of the 1970s had significant impacts on many consumers in Iowa. High inflation and unemployment were associated with the excessive dependence on foreign oil during the early and mid 1970s. An energy shortage of that magnitude has not affected Iowa in recent years. There have been several sporadic structural failures across the state. They have included homes, commercial structures, and communications towers. There is no central collection point for this information. Local records will have to support this area. Structural fires are almost a daily occurrence in some communities. Nearly all are quickly extinguished by on-site personnel or local fire departments. Much of the fire prevention efforts have gone into nonresidential fires and the results have been highly effective. 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. Structural fires with the potential to exceed city and county response resources are unlikely in any given year.	
Magnitude/Severity	Most communication systems that are highly necessary have backup and redundant designs to provide continuity of service. Most communications failures would be limited to localized areas. In the event of a widespread communications failure, only portions of Iowa would be impacted, but this is highly unlikely due to the support of other jurisdictions and secondary communication devices. Because Iowa is almost entirely dependent on out-of-state resources for energy, Iowans must purchase oil, coal, and natural gas from outside sources. World and regional fuel disruptions are felt in Iowa. It is likely that increasing prices will occur as market mechanisms are used to manage supply disruptions. This will disproportionately affect the low-income population because of their lower purchasing power. Agricultural, industrial, and transportation sectors are also vulnerable to supply, consumption, and price fluctuations. In Iowa, petroleum represents 97% of transportation fuel. Individual consumers such as commuters are also vulnerable. The effects of an energy shortage would be felt throughout the state. Because the distribution systems are very developed, local shortages can quickly be covered. There are many buildings in Iowa that are very old or which may become hazardous in the event of an earthquake, fire, high winds, or other natural events. All bridges are vulnerable to the effects of the elements and the deterioration that results. Increases in the amount and weight of traffic they are expected to support increase their vulnerability to failure. The impacts of the failed structure would be contained to the immediate area and adjacent properties. This could be as small as the house and yard of a fallen chimney, or the area could be relatively extensive if the structure that failed was a multi-story building of a downtown high-rise or a tall communication tower. Dam and levee failures would affect a much larger area and are discussed as separate hazards. Older structures with outdated electrical systems not built to current fire codes are particularly vulnerable to fire. Combustible building materials obviously are more vulnerable than structures constructed of steel or concrete. Structures without early detection devices are more likely to be completely destroyed before containment by response agencies. Structures in areas served by older, smaller, or otherwise inadequate water distribution infrastructure such as water mains and hydrants are also at significant risk. Problems vary from region to region, often because of climate, poverty, education, and demographics. The fire death risk for the elderly and children under 5 years of age is more than two times that of the average population. With modern training, equipment, fire detection devices, and building	**2**

Evaluation Criteria	Description	Score
	regulations and inspections, most fires can be 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.	
Warning Time	A communications failure would likely occur with little or no warning. It is usually impossible to predict a communications failure. Some communications may be shut down for a short while for improvements or maintenance. These disruptions are usually made during periods of low demand and those who rely on them are given previous notice that the system will be out of service. The Iowa Department of Natural Resources Energy Bureau monitors domestic and international energy situations and has developed a plan to deal with an energy crisis. Signs that an energy shortage may be developing can be recognized even months in advance, but energy shortages/emergencies can rise suddenly and unexpectedly. Supply distribution problems in other countries and local weather situations can lead to low supply coupled with high demand in a matter of a day or two. The actual failure of the structure would likely occur suddenly with little or no warning. There are several events that could lead up to the failure, and these have various warning times and are discussed in separate hazard worksheets. Casual hazards can include fire, explosion, overloading of ice and snow, vibration, earthquakes, flooding, high wind, erosion, chemical corrosion, subsidence, and lack of general upkeep. While fires usually start with little or no warning time, alert devices can allow time for responders to contain the fire and allow occupants to evacuate the area.	**4**
Duration	With the exception of structural fires which are largely handled by local response personnel, the response to the hazards of communication failure, energy failure, and structural failure are widespread in nature and are likely to required outside resources to assist the state in emergency response.	**4**
	Worksheet Total	**2.05**

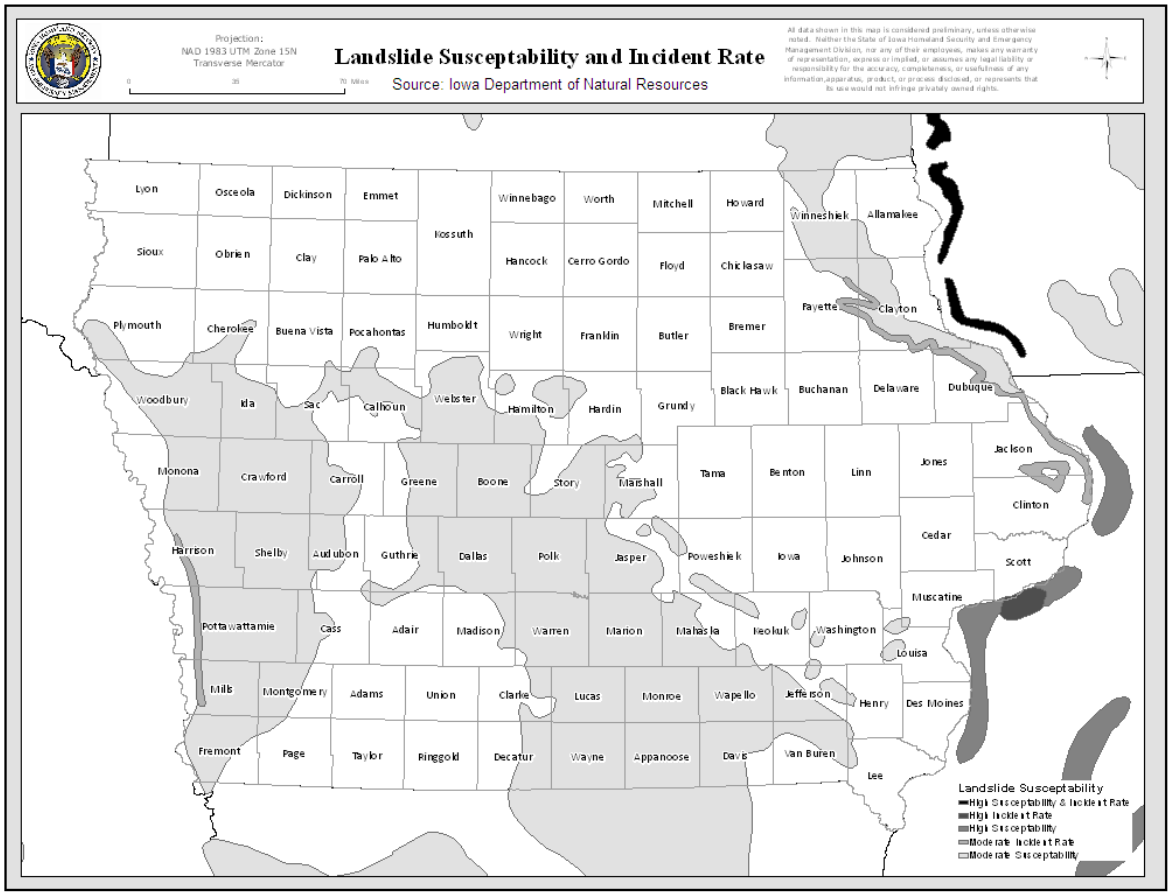
Sources for Infrastructure Failure	
Federal Communications Commission	http://www.fcc.gov
Iowa Utility Board	http://www.iowa.gov/iub/
Iowa Utilities Links	http://www.state.ia.us/government/com/util/links/regulatory_links.html
Communications Failure	http://www.ci.kent.wa.us/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=8084
U.S. Department of Energy	http://www.energy.gov/pricestrends/index.htm
Alliant Energy	http://www.alliantenergy.com/UtilityServices/UtilityRatesFacts/index.htm
MidAmerican Energy	http://www.midamericanenergy.com/
Iowa Office of Energy Independence	http://www.alliantenergy.com/UtilityServices/UtilityRatesFacts/index.htm
Iowa Department of Public Safety	http://www.dps.state.ia.us/fm/building/energy/index.shtml
Iowa Department of Natural Resources	http://www.iowadnr.gov/energy/index.html
Iowa Rural Electric Cooperatives	http://www.iowarec.org/
Energy Information Administration	http://www.eia.doe.gov/state/state_energy_profiles.cfm?sid=IA
FEMA Urban Search & Rescue	http://www.fema.gov/emergency/usr/
Iowa Urban Search & Rescue	http://www.iowausar.org/default.asp

National Institute of Standards & Technology	http://www.nist.gov/bfrl/investigations/bfrl-investigations.cfm
Institute for Business and Home Safety	http://www.disastersafety.org/building_codes/map.asp?state=IA#results
Citizen Corps	http://www.citizencorps.gov/cc/CertIndex.do?reportsForState&cert=&state=IA
Iowa Division of State Fire Marshall	http://www.dps.state.ia.us/fm/
U.S. Fire Administration	http://www.usfa.dhs.gov/
National Fire Protection Association	http://www.nfpa.org/categoryList.asp?categoryID=951&URL=Research/Fire%20statistics
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Local Sources	Varies

2.13 Landslide

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
2	**1**	**2**	**1**	**1.60**

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. A natural phenomenon, small scale landslides have been occurring in slide-prone areas of Iowa long before human occupation. New landslides can occur because of rainstorms, fires, earthquakes, and various human activities that modify slope and drainage.



There have been numerous small-scale landslide events in Iowa, none resulting in injury or death. The geographic extent of the historic events has been limited to less than a city block in size and has "run out" over the stretch of less than 100 yards. A portion of the state is moderately susceptible to landslides; in northeastern Iowa, along the Silurian Escarpment you can find blocks of dolomite slumped onto the underlying Maquoketa Shale and, in the hilly terrain of central Iowa; areas of Pennsylvanian Shale are susceptible to slides where it is overlain by loess or till. Lastly, susceptible areas are found along the adjacent steep terrain associated with the major river valleys such as the Mississippi, Missouri, Des Moines and Iowa River valleys and in the Loess Hills of western Iowa.

The SHMT evaluated the probability of a significant landslide event in Iowa and decided between 10% and 25% probability in any given year. The best available data was personal knowledge of the SHMT. The group discussed known occurrences around the state but no known agency documents historical data on landslides. The above map depicts landslide susceptibility and incident rates in Iowa.

Evaluation Criteria	Description	Score
Probability	A natural phenomenon, small-scale landslides have been occurring in slide-prone areas of Iowa long before human occupation. A portion of Iowa is moderately susceptible to landslides. In northeastern Iowa, it is not uncommon along the Silurian Escarpment to find blocks of dolomite slumped onto the underlying Maquoketa Shale. And, in the hilly terrain of central Iowa, areas of Pennsylvanian shale are susceptible to slides where overlain by loess or till. Lastly, susceptible areas are found along the adjacent steep terrain associated with the major river valleys such as the Mississippi, Missouri, Des Moines and Iowa River valleys and in the Loess Hills of western Iowa.	**2**
Magnitude/Severity	Those occupying structures overlooking river valleys and steep ravines are most vulnerable. These constitute a very small number of homes and commercially occupied structures in the state. The geographic extent of the historic events has been limited to less than a city block in size and has "run out" over the stretch of less than 100 yards. The maximum extent is very limited because of Iowa's gently rolling hills as opposed to steeper slopes. Very limited. Injuries and deaths are very unlikely except in the case of undetected slope failure warning signs in structures overlooking steep slopes.	**1**
Warning Time	Landslides are often involved in or triggered by other natural hazards. Landslides and flooding are often related because precipitation, runoff, and ground saturation combine to destabilize soil and rock. For this reason, landslides can be detected if high potential landslide areas are monitored.	**2**
Duration	The response to the effects of landslides are limited and mainly associated with restoration of public infrastructure routes (roads, bridges, etc.).	**1**
	Worksheet Total	**1.60**

Sources for Landslides	
United States Geological Survey	http://landslides.usgs.gov/
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=8ef85d795323b110VgnVCM10000089f0870aRCRD&vgnextfmt=default
Federal Emergency Management Agency	http://www.fema.gov/hazard/landslide/index.shtm
Iowa Department of Natural Resources	http://www.igsb.uiowa.edu/service/hazards.htm
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/
Disaster Center.com	http://www.disastercenter.com
Local Sources	Varies

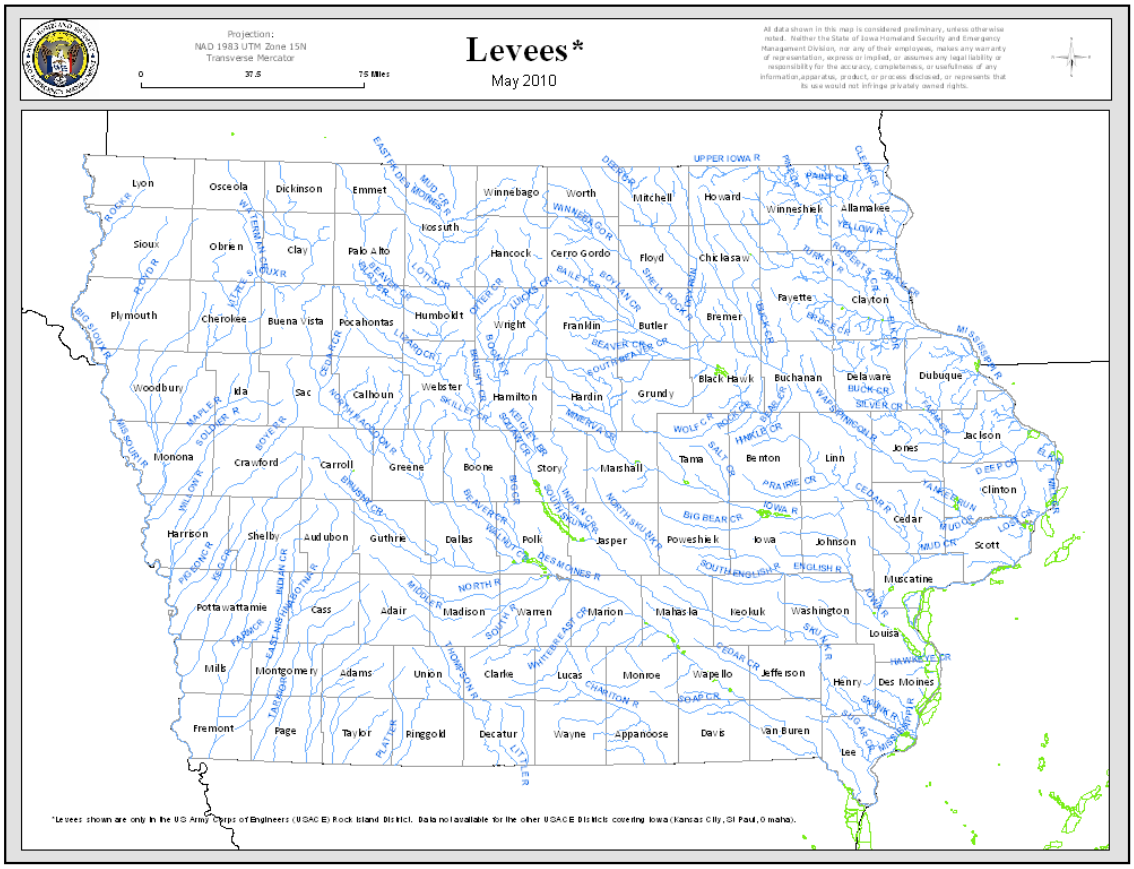
2.14 Levee Failure

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
3	**3**	**4**	**4**	**3.25**

The failure of a levee can be attributed to the loss of structural integrity of a wall, dike, berms, or elevated soil by erosion, piping, saturation, or under seepage causing water to inundate normally dry areas. Levees constructed of compacted clay with a high plasticity tend to crack during cycles of long dry spells, during heavy rainfalls that follow the dry spells; water fills the cracks and fissures. In addition to increasing the hydrostatic forces, the water is slowly

absorbed by the clay causing an increase in the unit weight of the clay as well as a decrease in its shear strength. This results in a simultaneous increase of the slide (driving) forces and a decrease of the resisting (shear strength) forces.

The following map shows geographic locations of levees collected in the State of Iowa.



Furthermore, in levee failure the cyclic shrink/swell behavior of the cracked clay zone results in a progressive reduction of the shear strength of the clay, perhaps approaches its residual strength. It also results in the deepening of the cracked clay zone; cracks may reach a depth of 9 ft (2.74 m) or more, especially for clays with a plasticity index greater than 40. The end-result may be a sloughing failure following a heavy rainfall. It is believed that fast removal of the runoff water from the interconnected network of cracks could alleviate this surface instability problem.

The Flooding of 1993 and again in 2008 was so great that the limit of many levees were tested and sometimes exceeded. Of the 275 Corps of Engineers levees affected by the 1993 flood, 85% held, of the 15% that failed, 31 overtopped (11%), eight (8) eroded and ruptured (3%), and three (3) breached (1%). The performance of non-federal levees was much worse: only 43% withstood the trauma, and 800 of 1,400 failed.

The levee information provided by FEMA Region VII listed 35 federally constructed and sponsor operated or levees congressionally incorporated into the Federal Levee System in urban

areas and 17 in rural-agricultural areas. The following tables show the Planning District, County, City (if applicable), River and Level of Protection for federal levees.

Urban Levees - Federal

Planning District	County	City	River	Level of Protection
1	Dallas	Van Meter	North River	100 - 500 year flood
1	Marshall	Marshalltown	Iowa River; Lynn Creek	100 - 500 year flood
1	Polk	Carlisle	Des Moines	100 - 500 year flood
1	Polk	Des Moines	Des Moines	100 - 500 year flood
1	Polk	Des Moines	Des Moines	100 - 500 year flood
1	Polk	Des Moines	Des Moines	100 - 500 year flood
1	Polk	Des Moines	Des Moines	100 - 500 year flood
1	Polk	Des Moines	Des Moines	100 - 500 year flood
1	Polk	Des Moines	Des Moines	100 - 500 year flood
1	Polk	West Des Moines	Raccoon River	100 - 500 year flood
1	Tama	Tama	Iowa River; Deer Creek	100 - 500 year flood
2	Fayette	Oelwein	Otter Creek	0 - 24 year flood
2	Winneshiek	Decorah	Upper Iowa River	100 - 500 year flood
3	Ida	Ida Grove	Maple River	50 - 99 year flood
3	Plymouth	Hawarden	Dry Creek	50 - 99 year flood
3	Woodbury	Sioux City	Floyd River	100 - 500 year flood
3	Woodbury	Sioux City	Missouri	100 - 500 year flood
4	Fremont	Hamburg	Missouri	50 - 99 year flood
4	Mills	Emerson	Indian Creek	100 - 500 year flood
4	Montgomery	Red Oak	E. Nishnabotna	50 - 99 year flood
4	Pottawattamie	Council Bluffs	Missouri	100 - 500 year flood
4	Pottawattamie	Council Bluffs	Missouri	100 - 500 year flood
5	Des Moines	Burlington	Mississippi	25 - 49 year flood
5	Muscatine	Muscatine	Mad Creek/Mississippi	100 - 500 year flood
6	Black Hawk	Cedar Falls	Cedar River	100 - 500 year flood
6	Black Hawk	Evansdale	Cedar River	100 - 500 year flood
6	Black Hawk	Waterloo	Cedar River	100 - 500 year flood
6	Clayton	Elkader	Turkey River	50 - 99 year flood
6	Clayton	Guttenberg	Mississippi River	100 - 500 year flood
6	Clinton	Clinton	Mississippi River	100 - 500 year flood
6	Dubuque	Dubuque	Mississippi River	100 - 500 year flood
6	Iowa	Amana	Iowa River; Price Creek	100 - 500 year flood
6	Iowa	Marengo	Iowa River; Big Bear Creek	100 - 500 year flood
6	Jackson	Sabula	Mississippi River	50 - 99 year flood
6	Scott	Bettendorf	Mississippi	100 - 500 year flood

Rural Agriculture Levees – Federal

Planning District	County	City	River	Population	Level of Protection
3	Monona	n/a	Missouri	Agriculture	50 - 99 year flood
3	Monona	n/a	Little Sioux	Agriculture	100 - 500 year flood
3	Woodbury	n/a	Little Sioux	Agriculture	50 - 99 year flood
4	Fremont	n/a	Missouri	Agriculture	100 - 500 year flood

4	Fremont	n/a	Missouri	Agriculture	50 - 99 year flood
4	Fremont	n/a	Missouri	Agriculture	50 - 99 year flood
4	Fremont	n/a	Missouri	Agriculture	50 - 99 year flood
4	Mills	n/a	Missouri	Agriculture	100 - 500 year flood
4	Mills	n/a	Missouri	Agriculture	100 - 500 year flood
4	Mills	n/a	Missouri	Agriculture	100 - 500 year flood
5	Clayton	Volga	Volga	Rural	0 - 24 year flood
5	Des Moines	n/a	Mississippi	Agriculture	50 - 99 year flood
5	Des Moines	n/a	Mississippi	Agriculture	50 - 99 year flood
5	Des Moines	Oakville	Mississippi	Agriculture	50 - 99 year flood
5	Lee	n/a	Mississippi	Agriculture	50 - 99 year flood
5	Louisa	Muscatine	Mississippi	Agriculture	100 - 500 year flood
6	Jackson	None	Mississippi	Agriculture	0 - 24 year flood

In addition, the FEMA Region VII levee list identified 7 non-federal levees.

Non-federal Levees

Planning District	County	City	River	Population	Level of Protection
4	Fremont	Crops	Nishnabotna	Agriculture	0 - 24 year flood
4	Fremont	Crops	Nishnabotna	Agriculture	0 - 24 year flood
5	Lee	Keokuk	Mississippi	Urban	100 - 500 year flood
5	Louisa	none	Iowa	Agriculture	0 - 24 year flood
5	Wapello	Ottumwa	Des Moines	Urban	100 - 500 year flood
6	Clayton	Elkport	Volga	Urban	50 - 99 year flood
6	Dubuque	Cascade	Maquoketa	Urban	0 - 24 year flood

The rate of failure of a levee or floodwall is difficult to predict with sudden failure a possibility. Proper design and construction can limit the probability of a levee failure. Development in the watershed can raise flood levels and make a levee designed and constructed under previous characteristics inadequate for current runoff conditions.

The SHMT evaluated the probability that a levee failure associated with heavy flooding occurring in Iowa is likely to occur in any given year.

Evaluation Criteria	Description	Score
Probability	The Flood of 1993 was so great that the limits of many levees were tested and sometimes exceeded. Of 275 Corps of Engineers levees affected by the flood, 85% held, but 31 were overtopped, 8 were eroded and ruptured, and 3 were breached. The performance of nonfederal levees was much worse: only 43% withstood the trauma, and 800 of 1,400 failed. The rate of failure of a levee or floodwall is difficult to predict, and sudden failure is a possibility. Proper design and construction can limit the probability of a levee failure. Development in the watershed can raise flood levels and make a levee designed and constructed under previous characteristics inadequate for current runoff conditions.	**3**
Magnitude/Severity	People, property, and utilities in the floodplain are most at risk. Levees and floodwalls give a false sense of security. People feel that levees will protect them and their property against any future flooding. While this is usually true, the hazard is only temporarily contained.	**3**

Evaluation Criteria	Description	Score
	Floodwaters breaching a levee are usually contained in the historic floodplain. Interestingly enough, levee failure in one area may prevent flooding in another area. A levee breach or overtopping occurring along one segment may drop the level of water along other segments of the stream. For initial overtopping, the overriding concern is choosing the least hazardous location for initial inundation of the interior. The least hazardous location could be a golf course, an oxbow lake, a ponding area, undeveloped area such as agricultural land, or a downstream reach. Sudden failure in an urban setting could cause a catastrophe as was demonstrated in the severe flooding that occurred in Cedar Rapids in 2008. In an urban setting the severity and duration may be important for health reasons but in an agricultural area for economic reasons. Residents behind levees often have a false sense of security. If the actual risk is not communicated to the residents by the jurisdiction, there may be impacts to the reputation of the community if the levee fails. Impacts would be similar to those experienced during a river or flash flood.	
Warning Time	The amount of warning time depends on the type of levee failure. Local flood warning systems can help in determining the maximum water surface and the timing of a flood situation. Hours or days of warning may be available for high water that may overtop levees, but this does not provide complete security from a rupture in the levee itself. A sudden failure of a portion of the levee may send floodwaters gushing from this break within seconds. Normally, occupants of the floodplain can be warned about potential levee breaches or breaks when high water encroaches upon the levee.	**4**
Duration	The effects of a levee failure and its association with river flooding are extensive and require substantial response efforts.	**4**
	Worksheet Total	**3.25**

Sources for Levee Failure	
U.S. Army Corps of Engineers	http://www.usace.army.mil/
Iowa Department of Natural Resources	http://www.iowadnr.gov/water/floodplain/index.html
Federal Emergency Management Agency	http://www.fema.gov/plan/prevent/fhm/lv_state.shtm
Federal Emergency Management Agency	http://www.fema.gov/plan/prevent/fhm/lv_ctp.shtm
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Local Sources	Varies

2.15 Radiological

This hazard encompasses the following consolidated hazards from the 2007 mitigation plan: fixed radiological incident, and transportation radiological incident. This includes an incident resulting in a release of radiological material in transport or at a fixed facility to include power plants, hospitals, laboratories, and the like.

Hazard Score Calculation				
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score
1	4	4	4	2.65

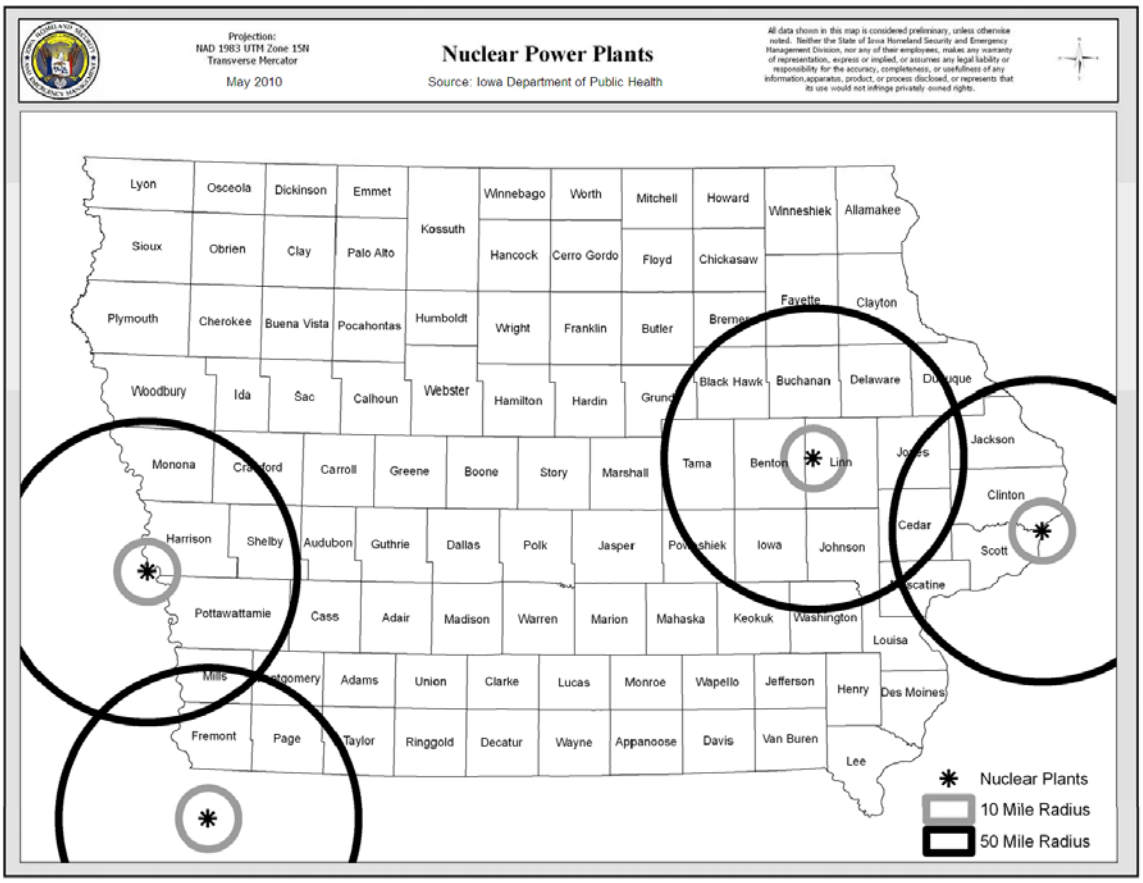
An incident resulting in a release of radiological material at a fixed facility to include power plants, hospitals, laboratories and the like is a fixed radiological incident. Although the term "nuclear accident" has no strict technical definition, it generally refers to events involving the release of significant levels of radiation. Most commercial nuclear facilities in the United States were developed in the mid-1960s and are designed to withstand aircraft attack. Therefore, they should withstand most natural hazards even though they may not have been specifically designed for those forces.

Emergency classifications are divided into four (4) categories. Each calls for a certain level of response from plant and government personnel. From least to most severe, the classifications are:

- Unusual Event
- Alert
- Site Area Emergency
- General Emergency

Since 1990, the Quad Cities Nuclear Power Plant has had 17 Unusual Events, 7 Alerts, and no Site Area Emergencies or General Emergencies. Since 1990, the Duane Arnold Energy Center has had 6 Unusual Events, 0 Alerts, and no Site Area Emergencies or General Emergencies. Since 1990, the Cooper Nuclear Power Plant has had 18 Unusual Events, 1 Alert, and no Site Area Emergencies or General Emergencies. Since 1990, the Ft. Calhoun Nuclear Power Plant has had 17 Unusual Events, 2 Alerts, and no Site Area Emergencies or General Emergencies.

Iowa has one (1) nuclear power plant located within its borders; the Duane Arnold Energy Center (DAEC) is located near Palo in Linn County. Three (3) additional nuclear facilities border Iowa. These facilities are located across the Missouri River north of Omaha, NE and south of Nebraska City, NE, as well as across the Mississippi River at the Quad Cities Nuclear Power Plant. The map below identifies the location of each facility as well as the 10-mile and 50-mile planning buffers.



Operators of facilities that use radioactive materials and transporters of radioactive waste are circumspect in the packaging, handling, and shipment of the radioactive waste and since they are closely regulated by a variety of federal, state, and local organizations, the likelihood of an incident is remote.

The SHMT analysis has evaluated that the probability of a fixed radiological incident occurring in Iowa is unlikely in any given year.

Radiological incidents related to transportation are described as an incident resulting in a release of radioactive material during transportation. Transportation of radioactive materials through Iowa over the interstate highway system is considered a radiological hazard. The transportation of radioactive material by any means of transport is licensed and regulated by the federal government.

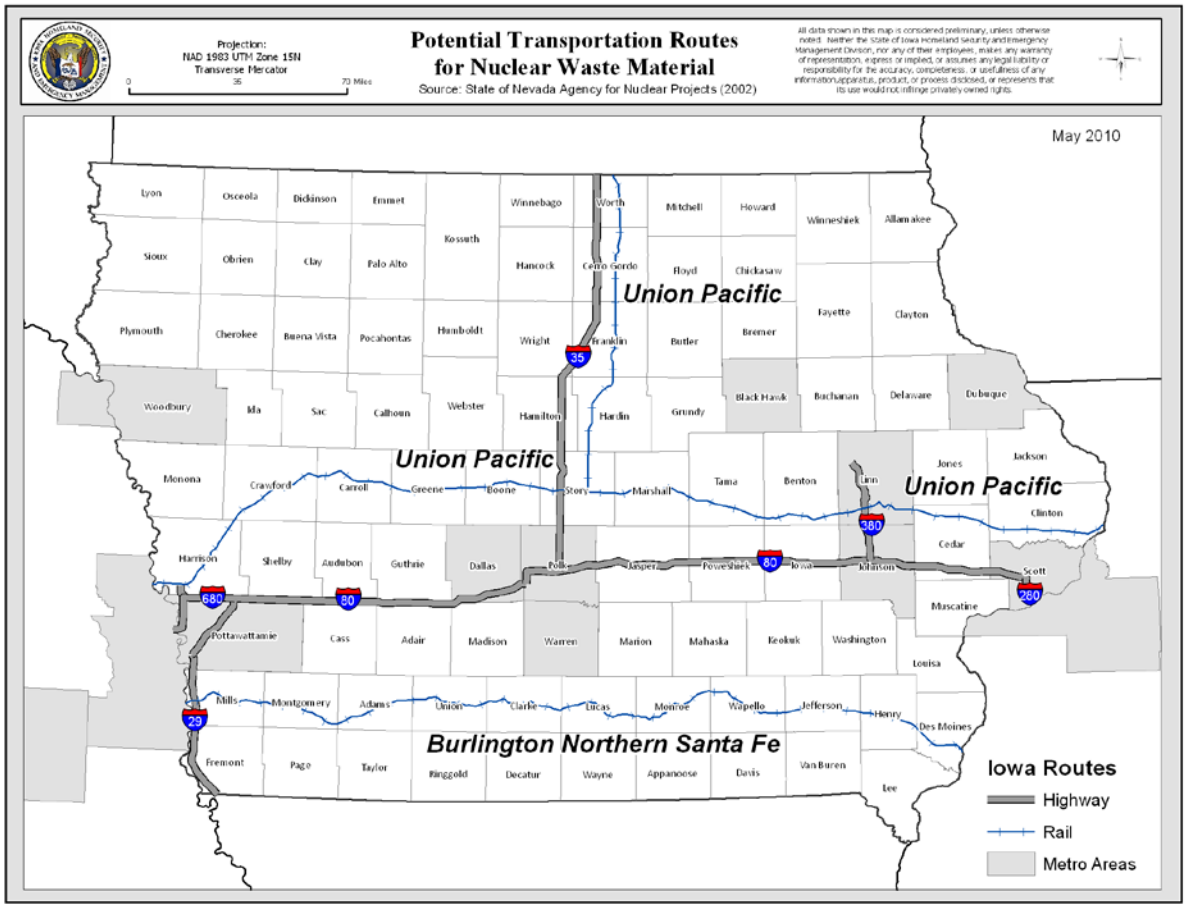
When these materials are moved across Iowa highways, Iowa officials are notified and appropriate escorts are provided. As a rule there are two (2) categories of radioactive materials that are shipped over the interstate highways. Low level waste consists primarily of materials that have been contaminated by low level radioactive substances, but pose no serious threat except through long term exposure. These materials are shipped in sealed drums within

placarded trailers. The danger to the public is no more than a wide array of other hazardous materials. High-level waste, usually in the form of spent fuel from nuclear plants, is transported in specially constructed casks that are built to withstand a direct hit from a locomotive.

Since 1990, hundreds of shipments have been made through Iowa. There have been no occurrences of a radiological incident in Iowa. Transportation accidents are the most common type of incident involving radioactive materials because of the sheer number of radioactive shipments. Rail and highway routes for the shipment of radioactive waste have been identified and mapped below.

Operators of facilities that use radioactive materials and transporters of radioactive waste are circumspect in the packaging, handling, and shipment of the radioactive waste and, since they are closely regulated by a variety of federal, state, and local organizations, the likelihood of an incident is remote.

Potential transportation routes for nuclear waste material are shown in the map below. The routes largely follow the interstate highway system; however state highways are also used in the transportation of this material.



The SHMT has evaluated the probability that a transportation radiological incident is unlikely in any given year.

Evaluation Criteria	Description	Score
Probability	Historically there has been zero, significant, releases of radiation from fixed facilities in the State of Iowa, or even the United States. Iowa has one nuclear power plant located within its borders. Duane Arnold Energy Center (DAEC) is located near Palo in Linn County. Three other nuclear facilities boarder Iowa. Facilities are located across the Missouri River north of Omaha, NE, and south of Nebraska City, NE. Across the Mississippi River is the Quad Cities Nuclear Power Plant. Operators of facilities that use radioactive materials and transporters of radioactive waste are trained in the packaging, handling, and shipment of the radioactive waste; and, since they are closely regulated by the state, the likelihood of an incident is remote. Since 1990, hundreds of shipments have been made through Iowa. There have been no occurrences of radiological incidents in Iowa. Transportation accidents are the most common type of incident involving radioactive materials because of the sheer number of radioactive shipments. Operators of facilities that use radioactive materials and transporters of radioactive waste are trained in the packaging, handling, and shipment of the radioactive waste; and, since they are closely regulated by a variety of federal, state, and local organizations, the likelihood of an incident is remote.	**1**
Magnitude/Severity	Sources of radioactive materials include medical products, industrial products, nuclear power plant fuel, nuclear weapons, and radioactive waste from hospitals, laboratories, nuclear reactors, and military facilities. Both the Duane Arnold and the Fort Calhoun Nuclear Power Plants have completed construction of on-site storage facilities for spent nuclear fuel. In over 50 years of nuclear power production in the U.S., no deaths or injuries from radiation have been recorded among the general public. Each of the nuclear facilities in the country identifies a 10 mile radius Emergency Planning Zone and a 50-mile radius Ingestion Pathway Zone. Depending on the level of exposure, radiation can cause loss of life and long and short term health effects. Time, distance, and shielding minimize radiation exposure to the body. Nuclear radiation above normal levels could be a health and safety consideration because of its ability to damage human cells biologically. Specialized training is needed to respond to these types of incidents. If inadequately trained personnel attempt to respond, the impacts could be the same as those for the general public exposed to the toxic materials. Proper training and equipment greatly reduce the risk to response personnel. If the land and facilities cannot be used for weeks, months, or even years, the loss of production would be devastating. Economic impacts would be multi-sector and long-lasting, especially in and around the affected region. The danger to the public is less than a wide array of other hazardous materials. Those working with or near sources of radiation are at a greater risk than the general citizens of the state. Those responding to a radiological incident should be trained in recognizing a radiological incident and minimizing exposure to radioactive materials. Other than a transportation incident involving large amounts of high-level radioactive materials, radiation exposure will be limited to much localized areas. Time, distance, and shielding minimize radiation exposure to the body. Nuclear radiation above normal levels could be a health and safety consideration because of its ability to damage human cells biologically as well as its long-lasting effect on the environment.	**4**
Warning Time	Ionizing radiation cannot be detected with human senses. Detection instruments are needed to indicate the existence of radiation. Distance from the incident would dictate the amount of time needed to avoid exposure from	**4**

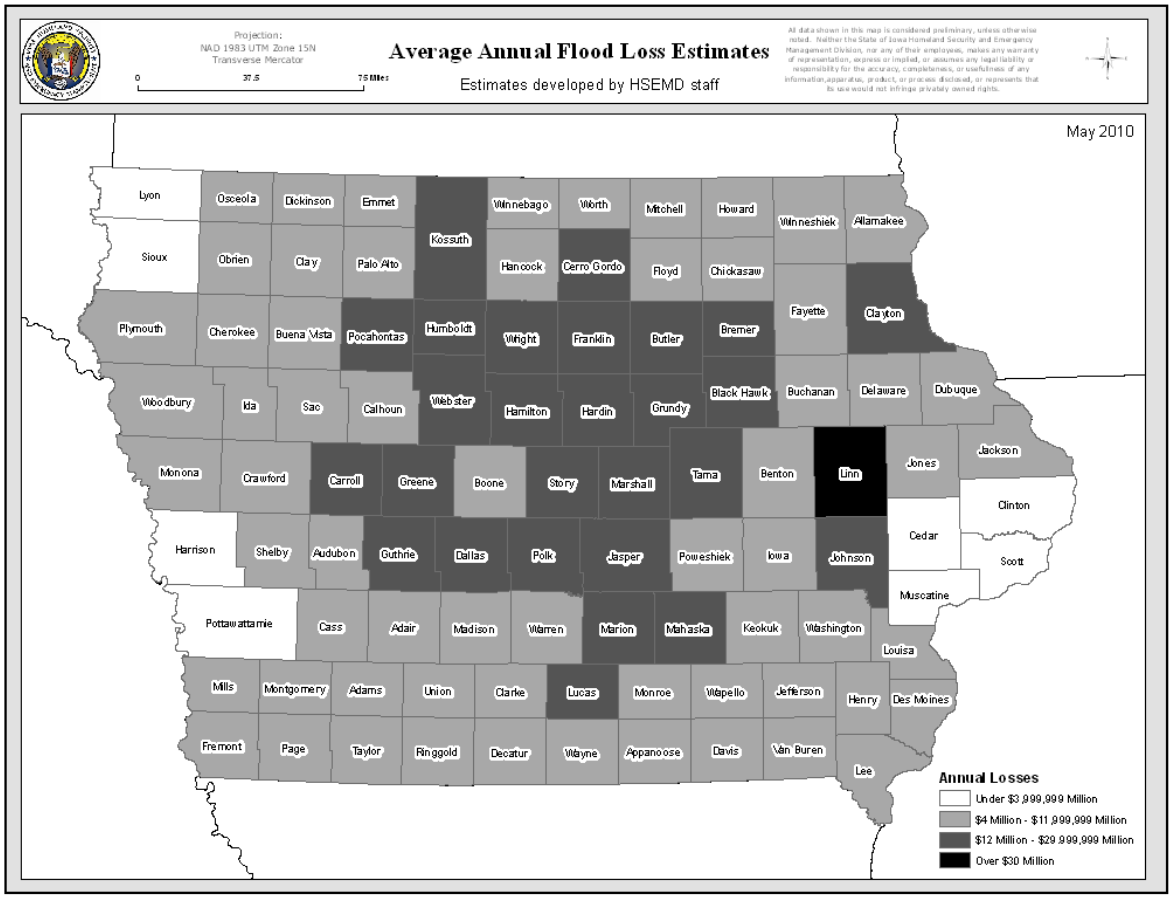
Evaluation Criteria	Description	Score
	damaging radiation. A radiological incident in Iowa could result from an incident in handling or transporting radioactive materials. This accident could occur with little or no warning. Ionizing radiation cannot be detected with human senses. Detection instruments are needed to indicate the existence of radiation. Distance from the incident would dictate the amount of time needed to avoid exposure from damaging radiation.	
Duration	Responding to the effects of a radiological release in Iowa is extensive and will require resources and assistance from several Federal agencies to determine and evaluate the threat to life and the environment in the affected sub-areas.	**4**
	Worksheet Total	**2.65**

Sources for Radiological	
U.S. Environmental Protection Agency	http://www.nrc.gov/about-nrc/emerg-preparedness.html
Iowa Department of Public Health	http://www.idph.state.ia.us/eh/radiological_health.asp
Energy Information Administration	http://www.eia.doe.gov/fuelnuclear.html
Energy Information Assurance	http://www.eia.doe.gov/overview_hd.html
Nuclear Regulatory Commission	http://www.nrc.gov/waste/spent-fuel-transp.html
Nuclear Regulatory Commission	http://www.phmsa.dot.gov/hazmat
Iowa Department of Public Health	http://www.idph.state.ia.us/eh/radiological_health.asp
Federal Railroad Administration	http://www.fra.dot.gov/Pages/337.shtml
Federal Railroad Administration	http://www.fra.dot.gov/downloads/safety/scopfnl.pdf
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Local Sources	Varies

2.16 River Flooding

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
4	**4**	**1**	**4**	**3.55**

River flooding is a rising or overflowing of a tributary or body of water that covers adjacent land, not usually covered by water, when the volume of water in a stream exceeds the channel's capacity. Floods are the most common and widespread of all natural disasters, except fire. Most communities may experience some kind of flooding after spring rains, heavy thunderstorms, winter snow thaws, waterway obstructions, or levee or dam failures. Winter snow thaws, waterway obstructions, or levee or dam failures snow thaws, waterway obstructions, or levee or dam failures. The following map depicts the estimated loss associated with river flooding in Iowa since 1993.



Floodwaters can be extremely dangerous; the force of six (6) inches of swiftly moving water can knock people off their feet and two (2) feet of water can float a car. Floods can be slow or fast-rising but generally develop over a period of days. Flooding is a natural and expected phenomenon that occurs annually, usually restricted to specific streams, rivers or watershed areas.

The National Flood Insurance Program (NFIP) Repetitive Loss Properties (REP) report identifies properties vulnerable to multiple flood losses. The following table identifies unmitigated Repetitive Loss Properties by county as of April 2010.

County	Number of Properties	Total Paid
Audubon	1	$5,263.82
Benton	1	$45,298.09
Blackhawk	105	$5,771,343.00
Bremer	78	$3,692,899.56
Buchanan	24	$628,164.44
Butler	21	$852,872.34
Carroll	1	$285,698.66
Cerro Gordo	14	$639,650.11
Clayton	8	$369,831.97

County	Number of Properties	Total Paid
Clinton	9	$205,377.73
Crawford	9	$647,104.97
Dallas	3	$23,692.92
Decatur	1	$14,557.99
Delaware	24	$1,756,122.14
Des Moines	13	$1,479,725.14
Dubuque	6	$77,453.82
Fayette	5	$66,445.65
Floyd	14	$623,992.77
Fremont	2	$120,671.22
Hancock	1	$6,597.66
Harrison	6	$93,018.61
Humboldt	3	$34,278.98
Jackson	1	$38,818.74
Jasper	1	$100,966.66
Johnson	8	$3,731,433.65
Jones	9	$469,353.91
Lee	5	$283,068.25
Linn	19	$1,509,182.27
Louisa	4	$153,747.35
Lyon	3	$56,852.02
Mills	3	$62,248.52
Mitchell	3	$46,444.45
Montgomery	4	$31,212.38
Muscatine	26	$1,190,203.40
Polk	17	$1,664,596.52
Pottawattamie	13	$293,379.27
Scott	170	$9,982,341.31
Shelby	1	$74,367.68
Story	16	$1,540,136.88
Tama	1	$4,198.89
Union	1	$8,486.53
Warren	1	$39,993.79
Webster	6	$160,221.21
Woodbury	2	$19,405.32

The Floods of 2008 and the ongoing recovery from the losses associated with it as well as the devastating flooding that occurred in 1993 continuously stress the importance of mitigation against river flooding in the State of Iowa. Even the losses associated with smaller flooding events, such as the floods in 2004, resulted in 65 counties declared state disaster areas and 14 of the 65 counties declared presidential disaster areas.

The most recent serious flooding event in May and June of 2008 resulted in 86 of the State's 99 counties included in Governor's disaster declarations, and 84 being declared as presidentially declared. The event resulted in 18 fatalities and 106 injuries, the evacuation of approximately 38,000 Iowans and impacting 21,000 housing units.

Iowa has been involved in 35 Presidential Declarations for major disasters related to flooding since 1953.

Given the history of river flooding in Iowa, it is likely that there will be many minor events in any given year and a high likelihood that a major flooding event requiring federal assistance will occur in the next five (5) years. While hundreds of homes and businesses have been removed from the floodplain over the last decade, many remain.

The SHMT analysis has evaluated the probability that a flooding event will occur in Iowa is classified as highly likely in any given year.

Evaluation Criteria	Description	Score
Probability	The Floods of 1993 and 2008 are still fresh in the minds of Iowans. Flooding has been a regular and frequent hazard in Iowa. Iowa has been involved in 35 Presidential Declarations of a major disaster related to flooding since 1953. Given the history of this hazard, it is likely that there will be many minor events each year and a high likelihood that a major flooding event requiring federal assistance will occur in the next 5 years. While hundreds of homes and businesses have been removed from the floodplain over the last decade, many remain.	**4**
Magnitude/Severity	The vulnerability from river flooding is quite delineated. Much work in the area of flood hazard mapping has allowed many communities to restrict development in hazardous areas. The Federal Emergency Management Agency has delineated the probable extent of the 100-year flood hazard areas in most areas. These Flood Insurance Rate Maps (FIRMs) show properties affected by the floods that have at least a 1% chance of occurring in any particular year. Generally, these areas are in the floodplain or adjacent areas. Much of these areas are parkland, agricultural areas, or conservation land, but residential and commercial areas are impacted by river flooding as well. Flooding impacts include potential loss of life. River flooding does not have as high of risk as does flash flooding because of the slower onset of the river flood. Personal property can be extensively damaged and destroyed by swift moving water. Facilities and infrastructure can be scoured around and degrading its structural integrity. Damage and disruption of communications, transportation, electric service, and community services are likely in severe cases. Water treatment and wastewater treatment facilities are often located in or near the floodplain and are at high risk of flooding and eventually being taken offline.	**4**
Warning Time	Gages along streams and rain gages throughout the state provide for an early flood warning system. River flooding usually develops over the course of several hours or even days depending on the basin characteristics and the position of the particular reach of the stream. The National Weather Service provides flood forecasts for Iowa. Flood warnings are issued over emergency radio and television messages as well as the NOAA Weather Radio. People in the paths of river floods may have time to take appropriate actions to limit harm to themselves and their property.	**1**

Evaluation Criteria	Description	Score
Duration	The response to the effects of river flooding in Iowa are extensive and required many days to adequately respond to the needs of Cities and Counties.	**4**
	Worksheet Total	**3.55**

Sources for River Floods	
FEMA Map Service Center	http://www.msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1
FEMA NFIP Information	http://www.fema.gov/business/nfip/
Floodsmart.gov	http://www.floodsmart.gov/floodsmart/
Iowa Department of Natural Resources	http://www.iowadnr.gov/water/floodplain/index.html
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=fdb4510f935ea110VgnVCM10000030f3870aRCRD&vgnextfmt=default
NCDC - Weather/Climate Data & Products	http://www.ncdc.noaa.gov/oa/climateresearch.html#dandp
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/
Local Sources	Varies

2.17 Severe Winter Storm

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
4	**2**	**3**	**4**	**3.25**

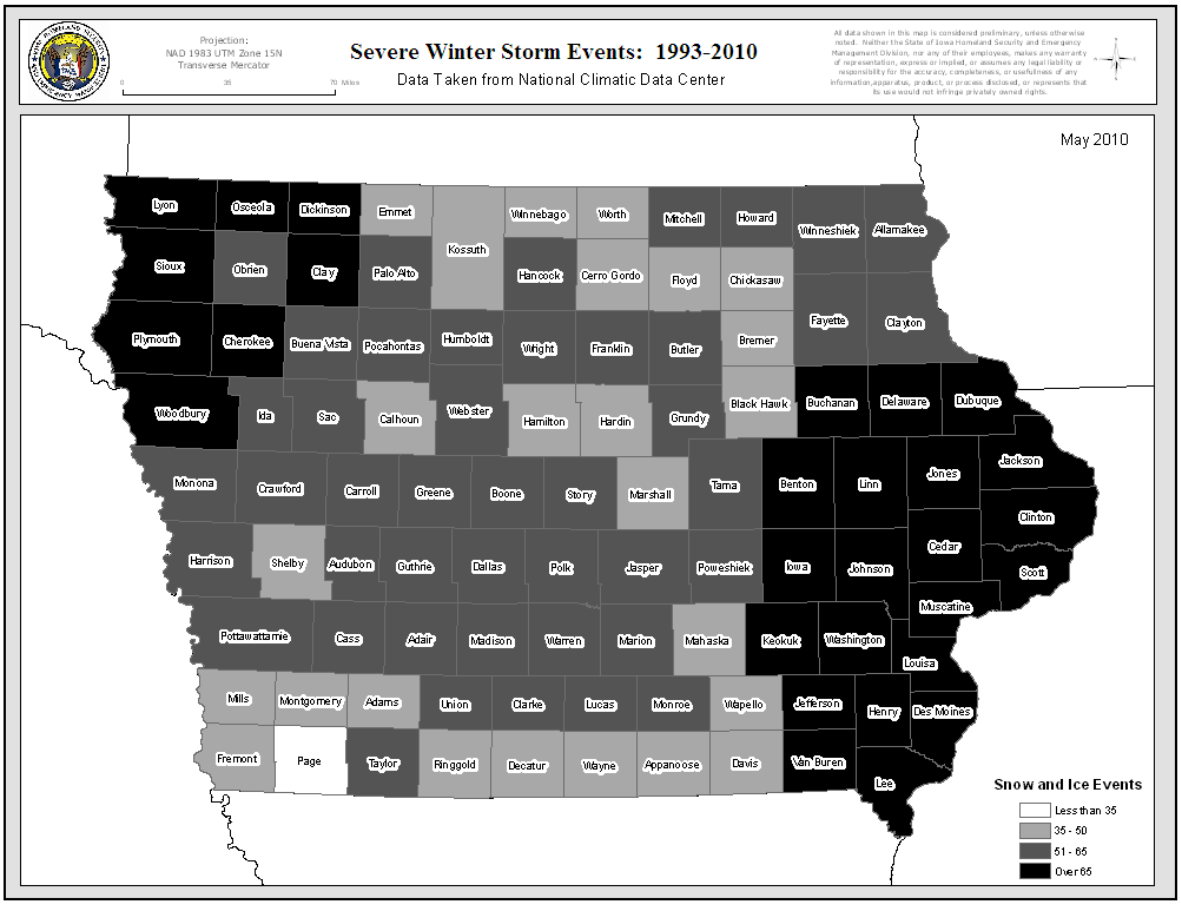
Severe winter weather conditions that affect day-to-day activities can include blizzard conditions, heavy snow, blowing snow, freezing rain, heavy sleet, and extreme cold. Winter storms are common during the months of October through April.

The various types of severe winter weather can cause considerable damage. Heavy snows can immobilize transportation systems, down trees and power lines, collapse buildings, and the loss of livestock and wildlife. Blizzard conditions are winter storms lasting at least three (3) hours with sustained winds of 35 mph or more, reduced visibility of 1/4 mile or less, and white out conditions. Heavy snows of more than six (6) inches in a 12 hour period or freezing rain greater than 1/4 inch accumulation causing hazardous conditions in the community can slow or stop the flow of vital supplies as well as disrupting emergency and medical services.

Loose snow begins to drift when wind speed reaches a critical speed of 9 to 10 mph under freezing conditions. The potential for drifting is substantially higher in open country than in urban areas where buildings, trees, and other features obstruct the wind.

Ice storms have resulted in fallen trees, broken tree limbs, downed power lines and utility poles, fallen communications towers, and impassable transportation routes. Severe ice storms have caused total electric power outages over large areas of Iowa and rendered assistance unavailable to those in need due to impassable roads.

Since 1993, Iowa has had 1,221 recorded winter storms; including, heavy snow, ice storm, blizzards or extreme wind-chill events. In Iowa's history, there are many accounts where large numbers of deaths are due to the cold and blizzards. While we are not as vulnerable as the early settlers were, there are recent accounts of multiple deaths from snowstorms and extreme cold around the state. Between 1993 and March of 2010, there have been 25 injuries and 12 deaths due to winter weather (data provided by the National Climactic Data Center). The following map indicates areas with the most snow and ice events from 1993 to March of 2010. The East Central portion and Northeast regions of the state has experienced over the majority of these events.



Seven winter storm related Presidential Declarations for Major Disaster have been declared in Iowa since 1990, the first declaration occurred in 1991 resulting from an ice storm that affected 16 counties. Extensive damage occurred to power lines, including the collapse of numerous high-tension towers in north-central Iowa. The second declaration occurred in 1997 resulting from a severe winter storm that affected 13 counties.

The third and fourth declaration occurred in 2007 affecting 66 counties. The third declaration affected 48 counties and the fourth declaration affected 23 counties with five (5) counties counted in both declarations. These declarations resulted from a major winter storm with ice and heavy snow combined with strong winds gusting to 50-55 mph causing blizzard conditions. Some areas in Iowa received 16 inches of snow, and coupled with the strong winds caused already weakened ice lined power lines to crumble and interstate highways to close due to drifting snow. This situation left approximate 250,000 plus Iowa citizens without electricity for

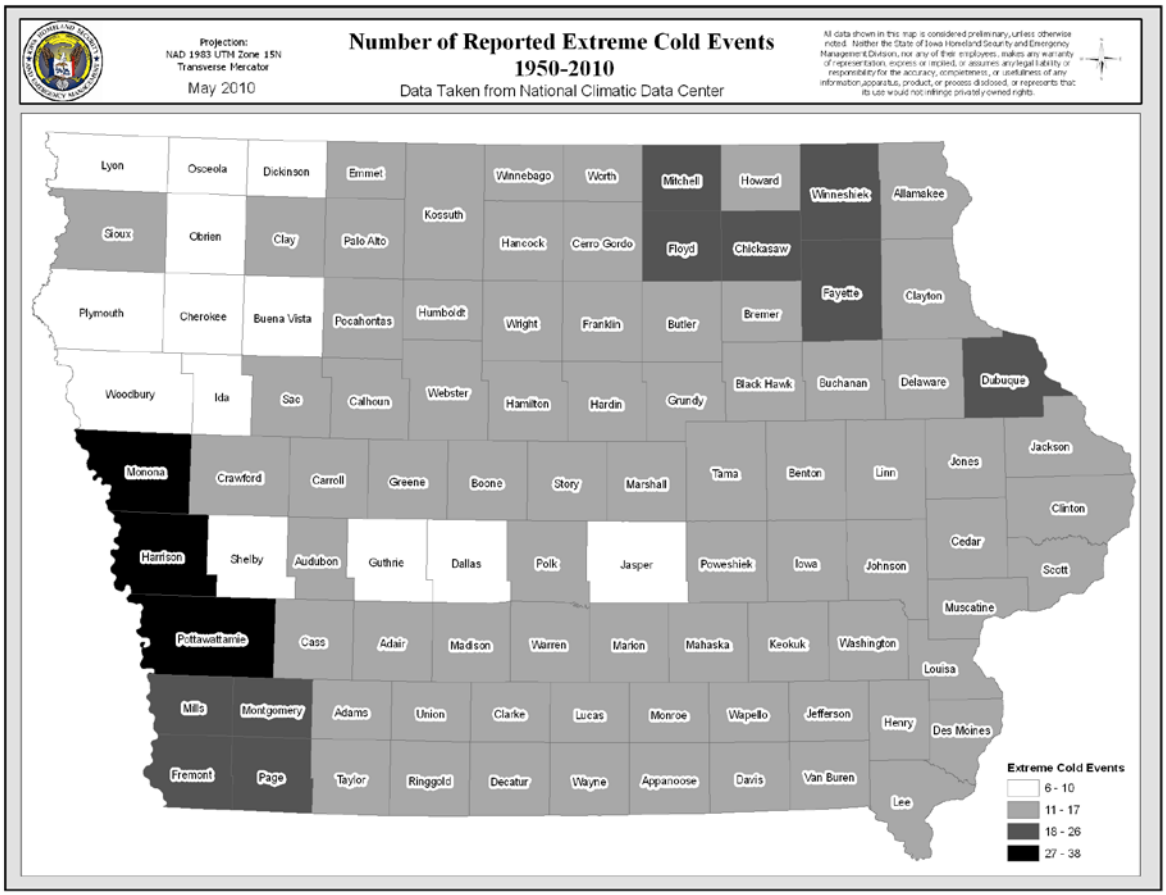
ten (10) plus days. In central Iowa, one county had twenty (20) miles of downed power poles that snapped due to the power lines being coated with inches of ice coupled with the strong winds; high-tension towers collapsed. Due to the severity of the winter blizzard, the Governor signed a Governor's Emergency Declaration for all 99 counties in Iowa.

The remaining three declarations occurred in January of 2008, affecting 30 counties in southern Iowa and the remaining two occurred in late February 2010, impacting 27 counties, in early March of 2010, impacting 27 counties in western Iowa.

The map below depicts the number of extreme cold events in Iowa and the number of reported snow and ice events since 1950.

Winter storms regularly move easterly and use both the southward plunge of arctic cold air from Canada and the northward flow of moisture from the Gulf of Mexico to produce heavy snow and sometimes blizzard conditions in Iowa and other parts of the Midwest. Most Iowa counties can expect two (2) or three (3) winter storms a season with an extreme storm, on average, every three (3) to five (5) years (more in the northwest, fewer in the southeast). A six (6) inch snowfall or more from one (1) storm occurs only in 49% of Iowa winters, while a large winter storm event of ten (10) inches or more will occur about once every three (3) years.

Frigid temperatures and wind chills are dangerous to people, particularly the elderly and the very young, dangers include hypothermia. Water pipes, livestock, fish, wildlife, and pets are also affected by the dangers from extreme cold weather. The following map shows extreme cold events over the last 60 years. The extreme Southwestern portion of Iowa represents the most concentrated area of the State affected by extreme cold events.



Based on the state's geographic location, personal knowledge, and historical data; the SHMT has evaluated the probability on winter storms and determined that a winter storm event is highly likely to occur in any given year.

Evaluation Criteria	Description	Score
Probability	Since 1993, Iowa has had 1,221 recorded winter storms; including, heavy snow, ice storm, blizzards or extreme wind-chill events. In Iowa's history, there are many accounts where large numbers of deaths are due to the cold and blizzards. While we are not as vulnerable as the early settlers were, there are recent accounts of multiple deaths from snowstorms and extreme cold around the state. Between 1993 and March of 2010, there have been 25 injuries and 12 deaths due to winter weather. From 1953-2010, seven Presidential Declarations of Major Disaster have been declared in Iowa that were related to severe winter storms, with the first disaster in December of 1991, and the latest occurring in March of 2010. Winter storms regularly move easterly and use both the southward plunge of arctic cold air from Canada and the northward flow of moisture from the Gulf of Mexico to produce heavy snow and sometimes blizzard conditions in Iowa and other parts of the Midwest. The cold temperatures, strong winds, and heavy precipitation are the ingredients of winter storms. Most counties can usually expect 2 or 3 winter storms a season with an extreme storm every 3 to 5 years on average (more in the northwest, fewer in the southeast). A snowfall of six inches or more from one storm only occurs in 49% of Iowa winters, while a large winter storm event of 10 inches or more will occur about once every 3 years.	**4**

Evaluation Criteria	Description	Score
Magnitude/Severity	Hazardous driving conditions due to snow and ice on highways and bridges lead to many traffic accidents. The leading cause of death during winter storms is transportation accidents. About 70% of winter-related deaths occur in automobiles and about 25% are people caught out in the storm. The majority of these are males over 40 years of age. 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. 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 or very young. 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. Winter storms are quite vast and would likely impact multiple counties. Certain areas may experience local variations in storm intensity and quantity of snow or ice. The Iowa Department of Transportation, county road departments, and local public works agencies are responsible for the removal of snow and treatment of snow and ice with sand and salt on the hundreds of miles of streets and highways in the area.	**2**
Warning Time	The National Weather Service (NWS) has developed effective weather advisories that are promptly and widely distributed. Radio, TV, and Weather Alert Radios provide the most immediate means to do this. Accurate information is made available to public officials and the public up to days in advance. Notifications made by the National Weather Service include winter storm watch, winter storm warning, blizzard warning, winter weather advisory, and a frost/freeze advisory.	**3**
Duration	Severe winter storms in Iowa and the response to these declared events are tied to multiple storms necessitating large expenses to cities for snow removal and road service. The associated losses and dangers of electrical outages to rural areas further compounds the duration of responding to major storm events.	**4**
	Worksheet Total	**3.25**

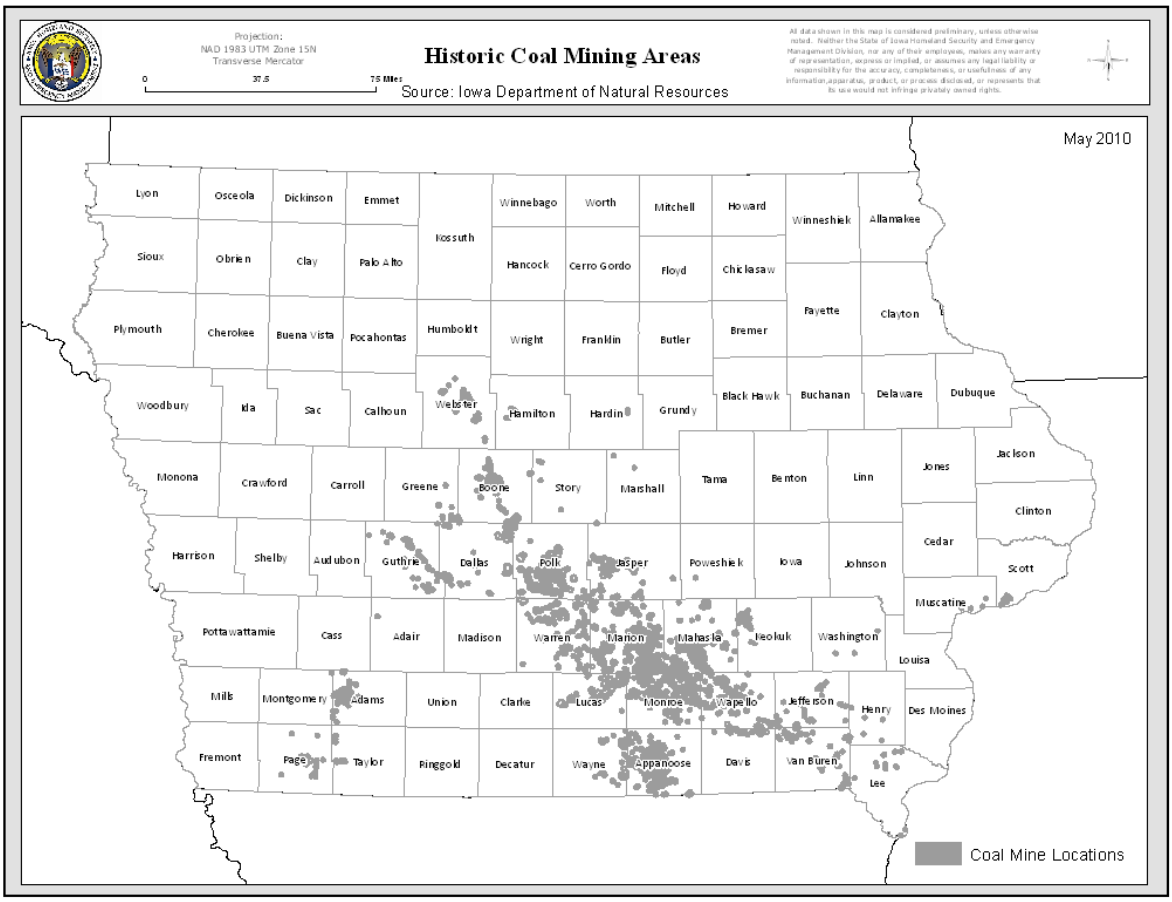
Sources for Severe Winter Storm	
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climateresearch.html#dandp
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=91435d795323b110VgnVCM10000089f0870aRCRD&vgnextfmt=default
Federal Emergency Management Agency	http://www.fema.gov/hazard/winter/index.shtm
Iowa Department of Transportation	http://www.iowadot.gov/maintenance/index.html
Iowa DOT Weather View	http://weatherview.iowadot.gov/
Iowa Travel Information	http://www.511ia.org/
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/
Iowa Disaster History	http://www.fema.gov/femaNews/disasterSearch.do
Local Sources	Varies

2.18 Sinkholes

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
2	**1**	**2**	**1**	**1.60**

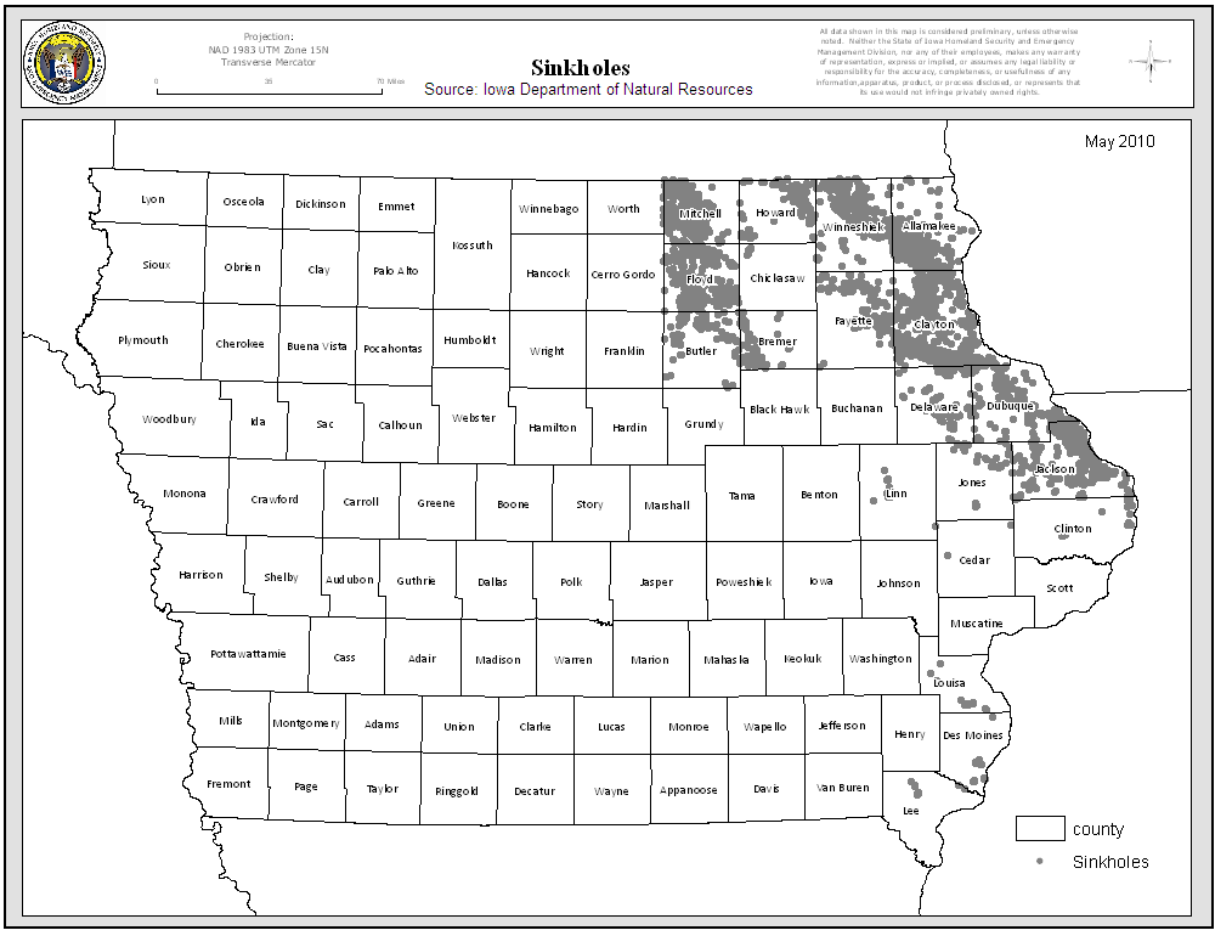
The loss of surface elevation due to the removal of subsurface support defines a sinkhole. Sinkholes range from broad, regional lowering of the land surface to localized collapse. The primary causes of most subsidence are human activities: Underground mining of coal, groundwater or petroleum withdraw, and drainage of organic soils. In addition, this is due to the erosion of limestone of the subsurface.

Land subsidence occurs slowly and continuously over time or on occasion abruptly, as in the sudden formation of sinkholes. Sinkholes can aggravate flooding potential, collapses such as the sudden formation of sinkholes or the collapse of an abandoned mine may destroy buildings, roads and utilities. The relative risk of occurrence without taking appropriate actions to mitigate against the effects of sinkholes relative to mine locations is illustrated below in the historic coal mining areas map.



Historic inventories have estimated approximately 2,596 sinkholes in the Upper Iowa River Watershed. However, there is no central collection point for this information. Iowa DNR

however, did compile sinkhole occurrences in the State of Iowa based from field reports. That information is presented in the map below.



*Sinkhole field office occurrences as recorded by Iowa DNR (2008)

The SHMT analysis evaluated the probability that a high impact sinkhole event will the potential to cause damage to infrastructure (roads, bridges, and buildings) would affect Iowa in any given year as occasional (between 10% and 20% probability).

Evaluation Criteria	Description	Score
Probability	Historic inventories estimate 2,596 sinkholes in the Upper Iowa River Watershed. However, there is no central collection point for this information. Local records will have to support this area. Land subsidence occurs slowly and continuously over time or on occasion abruptly, as in the sudden formation of sinkholes. The major risk associated with sinkholes in Iowa is threatened infrastructure such as roads, bridges, and public buildings.	**2**
Magnitude/Severity	Sinkholes can aggravate flooding potential, collapses such as the sudden formation of sinkholes or the collapse of an abandoned mine may destroy buildings, roads and utilities. Damage consists primarily of direct structural damage and property loss and	**1**

Evaluation Criteria	Description	Score
	depreciation of land values, but also includes business and personal losses that accrue during periods of repair. Generally, land subsidence poses a greater risk to property than to life. Damage to property, facilities and infrastructure would only occur if the event undermined foundations.	
Warning Time	Regional lowering occurs gradually over time, while the collapse of abandoned mines can occur suddenly. Collapse is one that can be properly mitigated provided that measures are taken structurally below the ground to compensate for the presents of mine caverns.	**2**
Duration	The response tied to sinkholes is related to securing the immediate threat to life and property including immediate reroute of traffic from the affected infrastructure and search and rescue in the case of structural collapse.	**1**
	Worksheet Total	**1.60**

Sources for Sinkholes	
Federal Emergency Management Agency	http://www.fema.gov/pdf/fhm/mhira_in.pdf
Iowa Sinkholes Map	http://maker.geocommons.com/maps/new?overlay_id=7746
Iowa DNR Geological Survey Bureau	http://www.igsb.uiowa.edu/service/hazards.htm
Sources	Varies

2.19 Terrorism

This hazard encompasses the following consolidated hazards from the 2007 mitigation plan: enemy attack, biological terrorism, agro-terrorism, chemical terrorism, conventional terrorism, cyber terrorism, radiological terrorism, and public disorder. This includes the use of multiple outlets to demonstrate unlawful force, violence, and/or threat against persons or property causing intentional harm for purposes of intimidation, coercion or ransom in violation of the criminal laws of the United States. These actions may cause massive destruction and/or extensive casualties.

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
1	**4**	**4**	**4**	**2.65**

The following table consists of information collected from the State's Metro Special Tactics and Response team for occurrences of terrorism related incidents in Iowa from January of 2007 - December of 2009.

Category (Examples)	Threat	Actual	Total
Enemy Attack (None)	0	0	0
Public Disorder (threats – none / actual - riot or protest where damage, injuries or arrests occurred) Note #1	0	9	9
Biological Terrorism (threat - white powder responses with threatening letter / actual – known biological event) Note #2	16	0	16
Agro-Terrorism (threat – threatened activity / actual – loss of crops or livestock or chickens or animals)	0	0	0
Chemical Terrorism (threat – unknown release of material requiring response / actual intentional release) Note #3	2	0	2
Conventional Terrorism (threat – threat or suspicious package / actual – improvised explosive device or material) Note #4	90	59	149
Radiological Terrorism (threat – threat of use / actual – improvised device or material recovered)	0	0	0
Notes:			
This information is based on primarily Des Moines events for the period 01/2007-12/2009.			
(1) These are events whish were for the most part, peaceful protests against military, financial or insurance companies, or state and federal government. When asked to disperse or be arrested, small groups of individuals choose to be arrested to make their political statement through media coverage. One event did involve a riotous situation, where two people were run over and killed as some tried to flee the scene at 21st and Forest in Des Moines.			
(2) We responded to a number of suspicious powder / granular substance calls. Most events were materials delivered through the postal system, with an accompanying threat letter. A few were suspicious powders found dumped in the various locations of the city such as the skywalk system, malls, or a major business, where the target itself raised the level of concern. None were found to contain a hazardous or toxic substance.			
(3) The events were in locations and of a nature that the bomb squad was called to assess the material and take render-safe actions to eliminate the risk. Neither proved to be an intentional or criminal act.			
(4) The "Actual" numbers include both items recovered and rendered-safe by the bomb squad and post blast scenes. Several of the events were involved the use of improvised over-pressure explosive devices (chemical reaction pop bottle bombs), some were military ordnance, Molotov cocktails and many were pipe bombs.			

Enemy attack is an incident that would cause massive destruction and extensive casualties. An all-out war would affect the entire population. Some areas would experience direct weapons' effects: blast, heat, and nuclear radiation; others would experience indirect weapons' effect, primarily radioactive fallout.

The federal government monitors the international political and military activities of other nations and would notify the State of Iowa of escalating military threats. There are many small military installations in Iowa; most are Iowa National Guard assets spread throughout the state comprised of various military units and functions. There have been no enemy attacks on or in Iowa in modern times. The only history of enemy attack dates back to the days of settlement and the Civil War in the 1800s. The breakup of the Soviet Union and other Soviet-Bloc nations has ended the Cold War. However, an enemy attack is still a possibility due to international conflicts and the large number of weapons still in existence throughout the world.

Although Des Moines is the state capitol, county seat, and most populous city and thus a potential target in an all-out attack on the United States, it is unlikely that Iowa would be a primary target during an enemy attack. The U.S. federal government monitors global political

situations and provides security from international attacks. World events in recent years have greatly changed the nature of enemy attack/war.

The SHMT has evaluated the probability that an enemy attack will occur in Iowa is unlikely in any given year.

Mass demonstrations, or direct conflict by large groups of citizens, as in marches, protest rallies, riots, and non-peaceful strikes are examples of public disorder. These are assembling of people together in a manner to substantially interfere with public peace to constitute a threat, and with use of unlawful force or violence against another person, or causing property damage or attempting to interfere with, disrupting, or destroying the government, political subdivision, or group of people. Labor strikes and work stoppages are not considered in this hazard unless they escalate into a threat to the community. Vandalism is usually initiated by a small number of individuals and limited to a small target group or institution. Most events are within the capacity of local law enforcement.

Large-scale civil disturbances rarely occur, but when they do they are usually an offshoot or result of one or more of the following events: 1) labor disputes where there is a high degree of animosity between the participating parties; 2) high profile/controversial laws or other governmental actions; 3) resource shortages caused by a catastrophic event; 4) disagreements between special interest groups over a particular issue or cause; or 5) a perceived unjust death or injury to a person held in high esteem or regard by a particular segment of society. There have been numerous labor disputes and protests in Iowa, but these have remained fairly non-violent. Other non-peaceful incidents have occurred in the state, but within the response capabilities of local law enforcement.

Although large-scale destructive civil disturbances are rare, the potential is always there for an incident to occur. This is even more true today, where television, radio, and the internet provide the ability to instantly broadcast information (factual or not), in real time, to the entire community. Often times that coverage helps to spread the incident to other, uninvolved or unaffected areas, exacerbating an already difficult situation. This also allows insightful people, previously not involved, to participate in the disturbance for no other reason than to riot, loot, burn, and destruct. Alcohol is often involved in public disorder, especially related to college campuses, sporting events, and concerts.

The SHMT has evaluated the probability that a serious public disorder event is unlikely to occur in Iowa in any given year.

Use of biological agents against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom can be described as biological terrorism. Liquid or solid contaminants can be dispersed using sprayers/aerosol generators or by point of line sources such as munitions, covert deposits and moving sprayers. Biological agents may pose viable threats from hours to years depending upon the agent and the conditions in which it exits. Depending on the agent used and the effectiveness with which it is deployed, contamination can be spread via wind and water. Infections can be spread via human or animal vectors.

Iowa has not been immune to acts of terrorism or sabotage, the state has experienced many threats in the past. Most incidents have been limited to reported "suspect" powders, actual threats, and hoaxes. Beginning in October 2001, following the original "Amerithrax" scares, we experienced a large number of responses for suspicious powders. Following the development of a threat assessment / response protocol the number of responses was reduced; and now averages a few responses each month.

The SHMT analysis evaluated the probability that a biological terrorism will possibly occur in Iowa with a probability of unlikely in any given year.

Causing intentional harm to an agricultural product or vandalism of an agricultural/animal related facility is agro-terrorism. Activities could include the following examples: animal rights activists who release mink or lab animals; disgruntled employees who intentionally contaminate bulk milk tanks or poison animals; eco-terrorists who destroy crops/facilities; theft of agricultural products, machinery, or chemicals; or criminals who vandalize agricultural facilities.

This category covers a large variety of incidents from potential to intentional introduction of disease; vandalism of facilities; theft of agricultural products, machinery, or chemicals; release of animals; and contamination of agricultural products. Depending upon the type of action taken, the implications will vary greatly.

Incidents such as this have occurred in the state of Iowa. Over the past 10 years Iowa has experienced at least ten (10) incidents in which animal rights activists have vandalized or released animals in our agricultural facilities. Additionally, there has been vandalism to agricultural facilities or incidents of disgruntled employees causing damage to animals and animal products. There are frequent cases of theft of agricultural machinery, products, and chemicals.

The SHMT analysis evaluated the probability that a serious agro terrorism event is unlikely to occur in Iowa in any given year.

Chemical terrorism involves the use or threat of chemical agents against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom. Liquid/aerosol or dry contaminants can be dispersed using sprayers or other aerosol generators; liquids vaporizing from puddles/containers; or munitions. Chemical agents may pose viable threats for hours to weeks depending on the agent and the conditions in which it exists. Contamination can be carried out of the initial target area by persons, vehicles, water and wind. Chemicals may be corrosive or otherwise damaging over time if not mitigated.

Iowa has not been immune to acts of terrorism or sabotage. The chemical terrorism history, fortunately, has been limited. We experienced at least one (1) event in 2005, where a subject mailed "rat poison" to a number of state and local officials. One of the letters was torn open in a mail-sorting machine in Des Moines, which led to the closure of the Main Post Office and the Emergency Room of Mercy Medical Center. We have experienced at least one (1) event were subjects broke into a city's water supply and it was suspected that chemicals may have been deposited in the water supply. We have experienced many releases of anhydrous ammonia by

persons engaged in clandestine drug manufacturing. At least two (2) events occurred in Des Moines between 2007 and 2009 but were later assessed as non-threatening and non-criminal.

The SHMT analysis evaluated the probability that chemical terrorism will occur in Iowa as unlikely in any given year.

Use of conventional weapons and explosives against persons or property in violation of the criminal laws of the United States for purposes of intimidations, coercion, or ransom is conventional terrorism. Hazard affects are instantaneous; additional secondary devices may be used, lengthening the time duration of the hazard until the attack site is determined to be clear. The extent of damage is determined by the type and quantity of explosive. Effects are generally static other than cascading consequences, incremental structural failures, etc. Conventional terrorism can also include tactical assault or sniping from remote locations.

Iowa has not been immune to acts of terrorism or sabotage. The state has experienced many bomb threats in the distant and recent past. During the spring of 2002, eighteen (18) pipe bombs were found in mailboxes in five (5) states stretching from Illinois to Texas, including Iowa. Six (6) people were injured in the bombings in Iowa and Illinois. In 2005 and 2006, pipe bombs were used in attempted murder cases in two (2) Iowa cities.

Unfortunately, there will never be a way to totally eliminate all types of these clandestine activities. If person or persons are inclined to cause death and destruction, they are usually capable of finding a way to carry out their plans. As perpetrators of terrorism improve their ability to collect information, raise money, and issue rhetoric, implementation of effective counter measures becomes even more important.

The SHMT analysis evaluated the probability of a high impact conventional terrorism incident occurring in Iowa in any given year to be unlikely.

Electronic attack using one computer system against another in order to intimidate people or disrupt other systems is a cyber attack. Cyber terrorism may last from minutes to days depending upon the type of intrusion, disruption, or infection. Generally, there are no direct effects on the built environment, but secondary effects may be felt depending upon the system being terrorized. Inadequate security can facilitate access to critical computer systems, allowing them to be used to conduct attacks.

Cyber-security and critical infrastructure protection are among the most important national security issues facing our country today, and they will only become more challenging in the years to come. Recent attacks on our infrastructure components have taught us that security has been a relatively low priority in the development of computer software and internet systems. These attacks not only have disrupted electronic commerce, but have also had a debilitating effect on public confidence in the internet.

The SHMT analysis evaluated the probability that a serious impact intrusion will occur in Iowa as unlikely in Iowa in any given year.

Radiological terrorism is the use of radiological materials against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom. Radioactive contaminants can be dispersed using sprayers/aerosol generators, or by point of line sources such as munitions, covert deposits and moving sprayers or by the detonation of a nuclear device underground, at the surface, in the air or at high altitude.

There is no history of radiological terrorism in Iowa. Since there is almost no record of acts of nuclear terrorism, an approach other than the traditional approach to probability of occurrence is needed to estimate the probability of occurrence. With no prior events by which to judge probability, it becomes necessary to consider the technical feasibility of radiological terrorism. Given that the radiation would kill anyone before they could amass enough material to produce a weapon, the threat is relatively low. Technical feasibility is important because whatever is feasible might also be realized, and might happen. The threat is relatively low because it is technically infeasible to construct such a weapon for terrorist uses.

The SHMT analysis evaluated the probability that radiological terrorism is unlikely to happen or has an unlikely probability in any given year.

Evaluation Criteria	Description	Score
Probability	Iowa has not been immune to acts of terrorism or sabotage. The state has experienced many threats in the past. Most incidents have been limited to reported "suspect" powders, actual threats and hoaxes. Beginning in October 2001, following the original "Amerithrax" scares, we experienced a large number of responses for suspicious powders. Following the development of a threat assessment/response protocol the number of responses was reduced, and now averages a few responses each month. Internationally, such acts have, unfortunately, become quite commonplace, as various religious, ethnic, and nationalistic groups have attempted to alter and dictate political and social agendas, seek revenge for perceived past wrongdoing, or intentionally disrupt the political, social, and economic infrastructure of individual businesses, units of government, or nations. Unfortunately, there will never be a way to totally eliminate all types of these clandestine activities. Persons inclined to cause death and destruction, are usually capable of finding a way to carry out their plans. As perpetrators of terrorism improve their ability to collect information, raise money and issue rhetoric, implementation of effective counter measures becomes even more important. Because Iowa serves as the breadbasket to the world, there is an increased risk to agro-terrorist activity. Over the past 10 years Iowa has experienced at least 10 incidents in which animal rights activists have vandalized or released animals in our agricultural facilities. Additionally, vandalism to agricultural facilities or incidents of disgruntled employees causing damage to animals and animal products. There are frequent cases of theft of agricultural machinery, products, and chemicals. Law Enforcement agencies respond to barricaded subject calls and deliver high risk warrants against armed persons, with a few each year involving an exchange of gunfire. While statewide statistics are not easily found, the City of Des Moines averages one bomb threat investigation every 6.9 days, generally targeting government agencies and schools. The state experienced several major bombings during 1969 – 1970, which represented the most bombings per capita in the Continental U.S. During 1993 the Midwest Bank Bombers (Aryan Republic Army) struck in Des Moines, and West Des Moines, with investigative ties to the bombing in Oklahoma City. During 1999 Harry Barber terrorized Des Moines with different pipe bombings injury one person. During the spring of 2002, 18 pipe bombs were found in mailboxes in five states stretching from Illinois to Texas, including Iowa. Six people were	**1**

Evaluation Criteria	Description	Score
	injured in the bombings in Iowa Illinois. In 2005 and 2006, pipe bombs were used in attempted murder cases in Forest City and Altoona. Cyber-security and critical infrastructure protection are among the most important national security issues facing our country today, and they will only become more challenging in the years to come. Recent attacks on our infrastructure components have taught us that security has been a relatively low priority in the development of computer software and Internet systems. These attacks not only have disrupted electronic commerce, but also have had a debilitating effect on public confidence in the Internet. Large-scale civil disturbances rarely occur; but when they do, they are usually an offshoot or result of one or more of the following events: 1) labor disputes in which there is a high degree of animosity between the participating parties; 2) high profile/controversial laws or other governmental actions; 3) resources shortages caused by a catastrophic event; 4) disagreements between special interest groups over a particular issue or cause; or 5) a perceived unjust death or injury to a person held in high esteem or regard by a particular segment of society. There have been numerous labor disputes and protests in Iowa, but these have remained fairly nonviolent. Other non-peaceful incidents have occurred in the state, but were within the response capabilities of local law enforcement. Although destructive civil disturbances are rare, the potential is always there for an incident to occur. This is even more true today, where television, radio, and the internet provide the ability to instantly broadcast information (factual or not), in real time, to the entire community. Oftentimes, that coverage helps to spread the incident to other, uninvolved or unaffected areas, exacerbating an already difficult situation. This also allows insightful people, previously not involved, to participate in the disturbance for no other reason than to riot, loot, burn, and destruct. Alcohol is often involved in public disorder, especially related to college campuses, sporting events, and concerts.	
Magnitude/Severity	Since the targets of attacks on critical infrastructure would likely include both facilities in the economy and those in the government. These critical infrastructures include information and communication systems; electrical power systems; gas and oil production, storage, and transportation systems; banking and finance organizations; transportation and distribution systems; water supply systems; emergency services; and government services. Nearly every citizen, business, and organization depends on these for normal operation as well safety and security. If not affected directly, the entire community would be vulnerable through indirect impacts. While the entire state would likely be affected in some way, areas near government buildings, military complexes, and transportation, communication, and fuel facilities would experience the largest impacts. A full-scale attack in the foreseeable future is not likely; however, a limited attack could take place that could potentially threaten target areas. Given the tremendous destructive capability of even one nuclear weapon, the devastation that could occur would be far worse than anything ever experienced in this country. Innocent people are often victims of terrorist activity targeted at certain organizations and activities. Based on the method of delivery, the general public is vulnerable to bioterrorism. State and local agencies developed the Biological Chemical Threat Agent (BCTA) Protocol Model to guide response agencies. The American public is not vaccinated for many of the agents used as weapons by Terrorist groups. Iowa vaccinated volunteers against smallpox at 15 hospitals in early 2003. The U.S. Postal Service installed Bio-Detection Systems (BDS) in 2005-2006 in several postal sorting facilities in Iowa, to address early detection since many of the threats have used the postal system for delivery. Because of the characteristics of the weapons terrorists use, the area can be limited to a room, building, or the entire community. Depending on the agent used and the effectiveness with which it is deployed, contamination can be spread via wind and water. Infections can be spread via human or animal vectors. Because of the variables described above, the geographic extent	**4**

Evaluation Criteria	Description	Score
	can become quite broad before the incident is recognized as a terrorist act. Chemical agents may pose viable threats for hours to weeks depending on the agent and the conditions in which it exists. Shielding in the form of sheltering in place can protect people and property from harmful effects. There are a limited number of antidotes available to reduce the vulnerability from chemical agents. Contamination can be carried out of the initial target area by persons, vehicles, water and wind. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. The extent is largely determined by the type of chemical, the method of dispersal, and the conditions at the time it is released. Cyber security professionals argue that current approaches are inadequate. With companies increasingly using the Internet to connect to suppliers and customers, they say organizations place too much faith in technology to protect their data, and do not pay enough attention to security education and awareness. Inadequate security can facilitate access to critical computer systems, allowing them to be used to conduct attacks. Our society is highly networked and interconnected. An attack could be launched from anywhere on earth and could cause impacts as small as a computer lab to as large as the world wide web. Duration of exposure to the effects of radiological terrorism, distance from the source of radiation, and the amount of shielding between source and target determine exposure to radiation. Initial effects will be localized to site of attack; depending on meteorological conditions, subsequent behavior of radioactive contaminants may be dynamic. Given the technical infeasibility of radiological terrorism, the severity of an incident would primarily be isolated to the detonation of explosive materials; however the discovery of slightly elevated radiation levels would incite hysteria amongst the uninformed public. Civil disturbances are often difficult for local communities to handle. There is a fine line between the Constitutional right of individuals and groups to assemble and air their grievances and the overall needs of the community to provide essential services, ensure personal safety of citizens, prevent property damage, and facilitate normal commerce. Fortunately, most demonstrations and large public gatherings are held in a peaceful, responsible manner. However, there never seems to be a shortage of groups (drugs and alcohol are often involved) whose primary objective is to disrupt normal activities and perhaps even cause injury and property damage. People at risk are mainly the willing participants and law enforcement officials. Innocent bystanders and their property can be at risk as well. The social rage that causes civil unrest often comes from racism, poverty, lack of economic opportunity, and unemployment. Events usually affect a localized area of the community. Often times only a couple of blocks or streets are affected. The local government units are left to pick up the pieces in the aftermath, cleaning up the area, reestablishing services, repairing or replacing damaged public facilities and infrastructure, and trying to restore some level of citizen and private investor confidence in the community. Civil unrest often results in injuries, deaths, and property damage. Perhaps even more tragic has been the lingering, negative impact and loss of investment in the communities ravaged by the uprisings. Many riot areas do not fully recover from the damage, destruction, and negative image brought on by such events. Looting, burning, and sniping can occur during severe civil disturbances. Fires can sometimes burn uncontrolled because firefighters and equipment are unable to respond due to resistance from rioters.	

Evaluation Criteria	Description	Score
Warning Time	As mentioned above, the United States federal government monitors worldwide political and military activity. The citizens and states of the U.S. would be put on heightened alert during periods of intense political or military conflict. With Iowa's position in the interior of the U.S., there would likely be significant warning of an impending enemy attack. Acts of terrorism can be immediate and often come after little or no warning. There are occasions when terrorists have warned the targeted organization beforehand, but often the attack comes without previous threat. Terrorists threaten people and facilities through "bomb threats" and other scare tactics. Even if it is a shallow threat, precautions must be taken to ensure the safety of the people and property involved. In most incidents we would have no warning time. The only exception would be if someone called in a threat. Acts of terrorism can be immediate and often come after little or no warning. There are occasions where terrorists have warned the targeted organization beforehand, but often the attack comes without previous threat. Even if it is a shallow threat, precautions must be taken to ensure the safety of the people and property involved. Explosions are usually instantaneous; additional secondary devices may be used, lengthening the duration of the hazard until the attack site is determined to be clear. Because of the networks (formal and informal) that exist to share intrusion attempts and impacts, warnings can be put out in advance to alert those in similar situations to take protective security recommendations such as updating virus detection software, making sure security patches are in place, etc. Warning times can range from no warning to days. Because of our highly evolved computer networks and data sharing, bugs, viruses, and worms can proliferate rapidly. Effects of hacking can be instantaneous. Events that incite public disorder can build up over hours, days, or years, and the violent disturbance is a culmination of the long-term situation. Civil disruptions can also escalate very rapidly following events where people are gathered such as sporting events, concerts, or speeches.	**4**
Duration	The response to all sources of terrorism are extensive and will result in the need for outside resources and response from Federal agencies in both the investigation of a crime scene and in the response to the direct threats to life and property.	**4**
	Worksheet Total	**2.65**

Additional Sources for Terrorism	
Department of Homeland Security	http://www.dhs.gov/index.shtm
Iowa Homeland Security	http://www.iowahomelandsecurity.org/
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com/
Federation of American Scientists, Biosecurity	http://www.fas.org/programs/bio/index.html
FBI Terrorism Information	http://www.fbi.gov/terrorinfo/counterrorism/waronterrorhome.htm
US Department of Justice	http://www.justice.gov
Centers for Disease Control	http://emergency.cdc.gov
US DOJ Counterterrorism	http://www.justice.gov/cjs/
Biological Terrorism	http://www.zkea.com/categories/category1.html
Centers for Disease Control Emergency Office	http://www.bt.cdc.gov/
Cyber Terrorism	http://csciwww.etsu.edu/gotterbarn/stdntppr/
Institute for Bio-Security	http://www.bioterrorism.slu.edu/chemical.htm

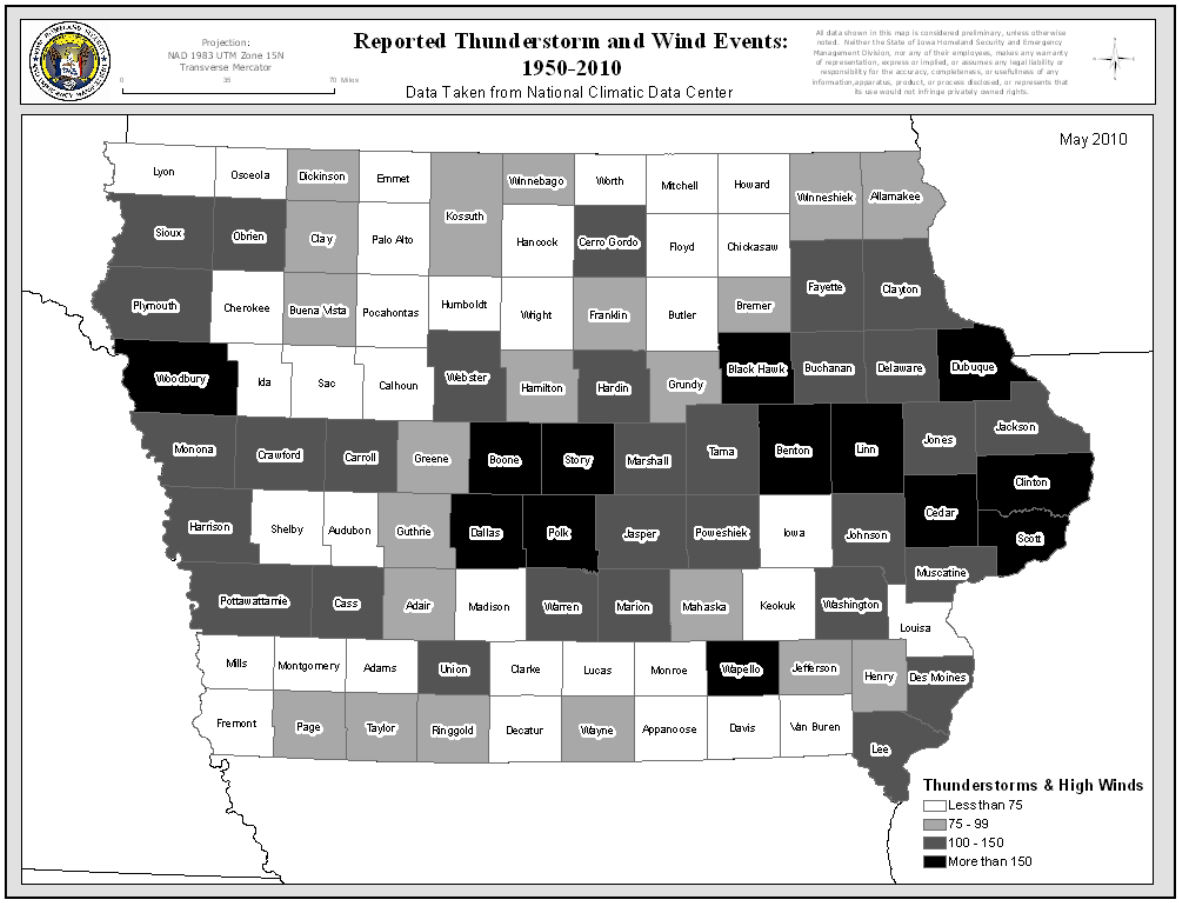
DHS Chemical Terrorism Vulnerability Info.	http://www.dhs.gov/files/programs/gc_1181835547413.shtm
Iowa Information Security Office	http://secureonline.iowa.gov/govt_resources/index.html
Iowa Information Technology Department	http://das.ite.iowa.gov/
DHS Cyber Security	http://www.dhs.gov/files/programs/cybersecurity.shtm
Iowa Department of Public Defense	http://www.state.ia.us/government/dpd/index.html
U.S. Department of Defense	http://www.defense.gov
DOD Defense Policy	http://policy.defense.gov/sections/policy_offices/hd/offices/dcip/index.html
U.S. State Department	http://www.state.gov/secretary/
Local Sources	Varies
Multi-State Partnership	IA Homeland Security
Iowa Law Enforcement Intelligence Network	Iowa Department of Public Safety

2.20 Thunderstorms and Lightning

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
4	**2**	**2**	**2**	**2.90**

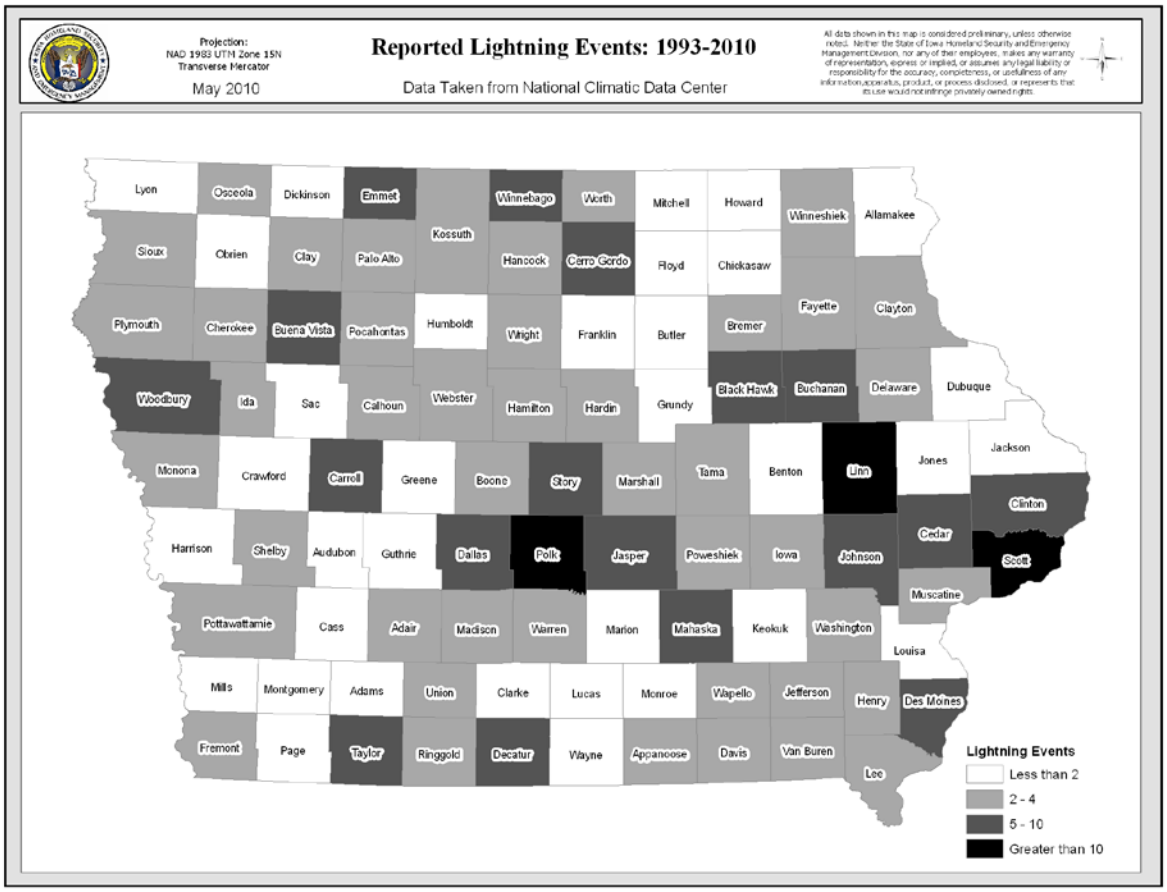
Thunderstorms are common in Iowa and can occur singly, in clusters, or in lines. Resulting in heavy rains, winds reaching or exceeding 58 mph, producing a tornado, or dropping surface hail at least 1.00 inch in diameter. They are created from a combination of moisture, rapidly raising warm air, and a lifting mechanism such as clashing warm and cold air masses.

Between 1955 and March of 2010, at least 10,090 severe thunderstorm events have impacted Iowa. Because thunderstorms may occur singly, in clusters, or in lines, it is possible that several thunderstorms may affect the same area in the course of a few hours. It is likely that more than 10,090 individual severe storms systems occurred in the state, one system may spawn multiple events. The map that follows indicates that thunderstorms and wind events occur across the State without significant pattern. The associated hazards related to thunderstorms are discussed further as individual hazards in Section 1.3 (hail, tornado, windstorms, and flooding).



Most thunderstorms produce only thunder, lightning, and rain; severe storms, however, can produce tornadoes, straight-line winds and microburst's above 58 mph, lightning, hailstorms, and flooding. The National Weather Service (NWS) considers a thunderstorm severe if it produces hail at least 1-inch in diameter, wind 58 mph or higher, or tornadoes. Straight-line winds can often exceed 60 mph, are common occurrences, and are often mistaken for tornadoes. A number of thunderstorms have caused other hazards such as flash flooding, river flooding, and tornadoes. There have been thirteen (13) Presidential Declarations for Major Disaster since 1990 related to severe storms. All of these disasters resulted from a severe storm system that produced tornadoes, river flooding, and/or flash flooding.

Lightning is an electrical discharge that results from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt", this flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning reaches temperatures approaching 50,000 degrees Fahrenheit in a split second, this rapid heating, expansion, and cooling of air near the lightning bolt creates thunder. The following map depicts a geographical breakdown of the number of reported lightning events in Iowa since 1993.



Data collected from the National Climatic Data Center (NCDC) shows Iowa experiences hundreds of thunderstorm and lightning events every year. With Iowa's location in the interior of the U.S., there is a very high likelihood that a few of these summer storms will become severe and cause damage. Because of the humid continental climate that Iowa experiences, ingredients of a severe thunderstorms are usually available (moisture to form clouds and rain, relatively warm and unstable air that can rise rapidly, and weather fronts and convective systems that lift air masses).

November 2005 the Governor signed a Proclamation of Disaster Emergency due to a strong line of thunderstorms that moved across portions of Iowa, these storms spawned high winds, hail and tornadoes, causing personal injury and a fatality, damages to private and public property including residences, businesses, infrastructure and agriculture. The severe line of storms occurred mostly in two (2) of Iowa's counties.

A similar event occurred in Iowa in July of 2009 due to strong thunderstorms across Iowa mainly affecting Black Hawk County and triggering a Presidential Declaration in August of 2009.

The SHMT analysis evaluated the probability that thunderstorms and lightning affect Iowa as highly likely in any given year.

Evaluation Criteria	Description	Score
Probability	Between 1955 and March of 2010, at least 10,090 severe thunderstorm, high wind, or lightning events events have impacted Iowa from 1980-2010. Because thunderstorms may occur singularly, in clusters, or in lines, it is possible that several thunderstorms may affect the area in the course of a few hours. It is likely that more than the 10,090 individual severe storms systems occurred in the state. One system may spawn multiple events. A number of these thunderstorms have caused other hazards such as flash flooding, river flooding, and tornadoes. There have been 30 Presidential Declarations of Major Disaster since 1953 related to Severe Storms. Iowa experiences between 30 and 50 thunderstorm days per year on average. With Iowa's location in the interior of the U.S., there is a very high likelihood that a few of these summer storms will become severe and cause damage. Because of the humid continental climate that Iowa experiences, ingredients of a severe thunderstorms are usually available (moisture to form clouds and rain, relatively warm and unstable air that can rise rapidly, and weather fronts and convective systems that lift air masses).	**4**
Magnitude/Severity	Those in unprotected areas, mobile homes, or automobiles during a storm are at risk. Sudden strong winds often accompany a severe thunderstorm and may blow down trees across roads and power lines. Lightning presents the greatest immediate danger to people and livestock during a thunderstorm. It is the second most frequent weather-related killer in the U.S. with nearly 100 deaths and 500 injuries each year. (Floods and flash floods are the number one cause of weather related deaths in the U.S.) Livestock and people who are outdoors, especially under a tree or other natural lightning rods, in or on water, or on or near hilltops are at risk from lightning. Hail can be very dangerous to people, pets, and livestock if shelter is not available. Flash floods and tornadoes can develop during thunderstorms as well. People who are in automobiles or along low-lying areas when flash flooding occurs and people who are in mobile homes are vulnerable to the impacts of severe thunderstorms. For more details on the vulnerabilities from the flooding and tornado hazards, see the specific hazard worksheet for that hazard. Severe thunderstorms can be quite expansive with areas of localized severe conditions. Most severe thunderstorm cells are 5 to 25 miles wide with a larger area of heavy rain and strong winds around the main cell. Most non-severe thunderstorms have a lifespan of 20 to 30 minutes, while severe thunderstorms last longer than 30 minutes. Like tornadoes, thunderstorms and lightning can cause death, serious injury, and substantial property damage. The power of lightning's electrical charge and intense heat can electrocute people and livestock on contact, split trees, ignite fires, and cause electrical failures. Thunderstorms can also bring large hail that can damage homes and businesses, break glass, destroy vehicles, and cause bodily injury to people, pets, and livestock. High winds can damage trees, homes (especially mobile homes), and businesses and can knock vehicles off of the road. Straight-line winds are responsible for most thunderstorm damage. One or more severe thunderstorms occurring over a short period (especially on saturated ground) can lead to flooding and cause extensive power and communication outages as well as agricultural damage.	**2**
Warning Time	Some thunderstorms can be seen approaching, while others hit without warning. The National Weather Service issues severe thunderstorm watches and warnings as well as statements about severe weather and localized storms. These messages are broadcast over NOAA Weather Alert Radios and area TV and radio stations. Advances in weather prediction and surveillance have increased warning times. The resolutions of radar and Doppler radar have increased the accuracy of storm location and direction. Weather forecasting and severe weather warnings issued by the National Weather Service usually provide residents and visitors alike adequate time to prepare. Isolated problems arise when warnings are ignored.	**2**
Duration	The immediate response related to severe thunderstorm and lightning events are more aptly associated with the cascading effects of multiple events	**2**

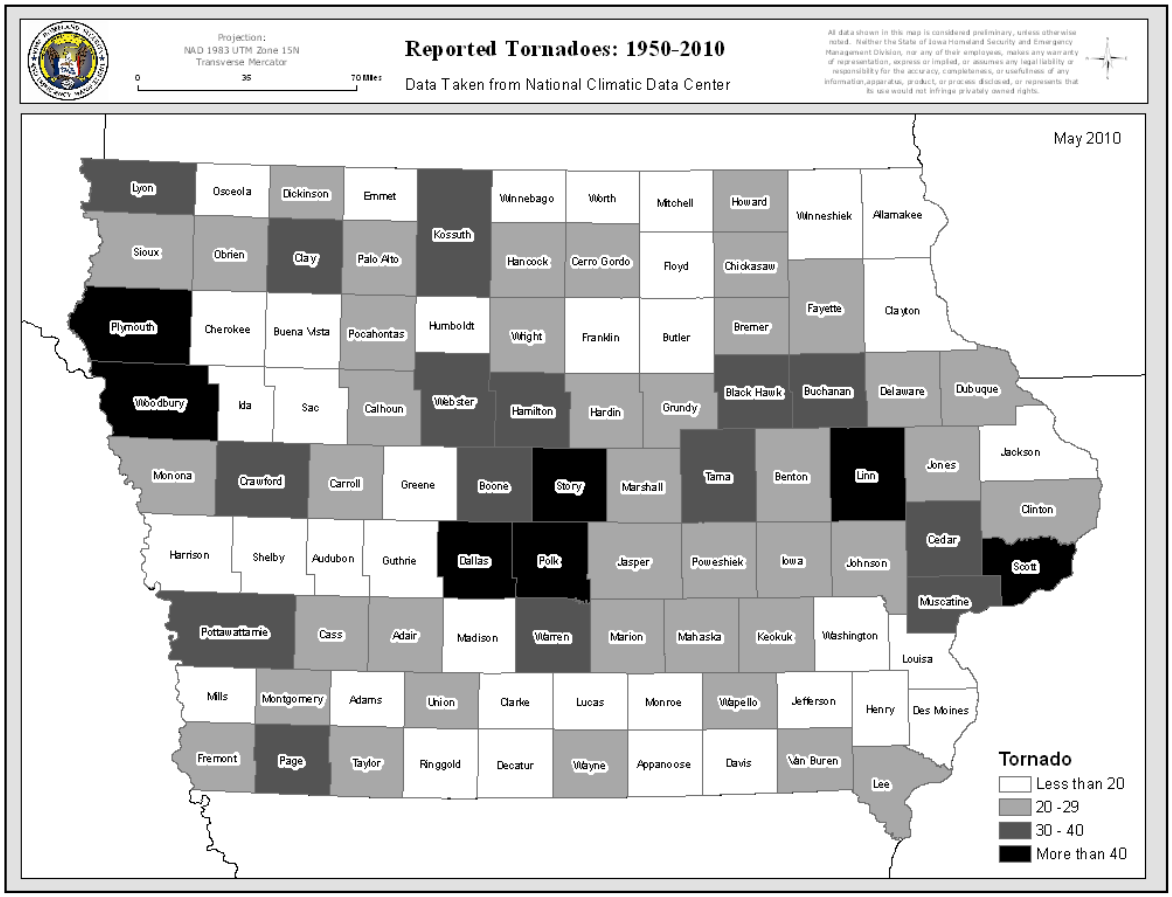
Evaluation Criteria	Description	Score
	occurring over a short amount of time in the case of flash and river flooding, and in particularly severe thunderstorm events in the case of tornados. Response to thunderstorm events is relatively minor in scope.	
	Worksheet Total	**2.90**

Sources for Thunderstorms and Lightning	
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climateresearch.html#dandp
NCDC Extreme Weather/Climate Events	http://www.ncdc.noaa.gov/oa/climate/severeweather/extremes.html
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=014b5d795323b110VgnVCM10000089f0870aRCRD&vgnextfmt=default
Federal Emergency Management Agency	http://www.fema.gov/hazard/thunderstorm/index.shtm
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/
FEMA Declared Disasters	http://www.fema.gov/femaNews/disasterSearch.do
Local Sources	Varies

2.21 Tornado

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
4	**4**	**3**	**1**	**3.55**

A tornado is a violent whirling wind characteristically accompanied by a funnel shaped cloud extending down from a cumulonimbus cloud that progress in a narrow, erratic path. Rotating wind speeds can exceed 300 mph and travel across the ground at average speeds of 25-30 mph. A tornado can be a few yards to about a mile wide where it touches the ground, however, an average tornado, is a few hundred yards wide. It can move over land for distances ranging from short hops to many miles, causing great damage wherever it descends. The funnel is made visible by the dust sucked up and condensation of water droplets in the center of the funnel. The following map depicts a geographic breakdown of reported tornadoes in Iowa since 1950.



In the U.S., Iowa is ranked third in the number of tornadoes per 10,000 square miles. Between 1950 and 2010, Iowa averaged approximately 40-50 “twisters” per year. In Iowa, most tornadoes occur in the spring and summer months, but can and have occurred in the fall and winter seasons. Late afternoon to evening hour, tornadoes are the most common, but they can occur at any time of the day. Since 1950, Iowa has encountered eleven (11) Presidential Declarations for tornadoes.

The most recent tornado events to occur in Iowa coincides with the 2008 flooding and began on May 25, 2008 when an EF-5 tornado struck the cities of Parkersburg, Dunkerton, and New Hartford, killing eight (8) people. The tornado destroyed 296 buildings and cost estimated damages of more than $3 million. This was followed by an EF-2 tornado that struck the town of Attica on May 30, damaging dozens of homes and injuring at least eight (8) people. The final tornado to affect Iowa in this string of summer storms occurred on June 13 when an EF-3 tornado struck Boy Scout camp in the western Iowa town of Little Sioux, killing four Scouts and injuring dozens more. The latest event happened in a series of storms that occurred beginning June 1st of 2010.

The SHMT analysis evaluated the probability that damaging tornados will occur in Iowa is highly likely in any given year.

Evaluation Criteria	Description	Score
Probability	In the U.S., Iowa is ranked third in the number of tornadoes per 10,000 square miles. From 1950-2010, Iowa averaged 47 twisters per year. In Iowa most tornadoes occur in the spring and summer months, but twisters can and have occurred in every month of the year. Late afternoon to evening hour tornadoes are the most common, but they can occur at any time of the day. According to the National Climactic Data Center, Iowa has had 2,375 tornado events from 1980-2010. From 1950-2006, eleven Presidential Declarations of Major Disaster have been declared in Iowa that were related to tornadoes out of 1964 total events. Historically, 40 - 50 tornadoes are confirmed in Iowa per year. Developed areas occupy a growing portion of Iowa and stand a highly likely chance of having a tornado occur in any given year.	**4**
Magnitude/Severity	Those most at risk from tornadoes include people living in mobile homes, campgrounds, and other dwellings without secure foundations or basements. People in automobiles are also very vulnerable to twisters. The elderly, very young, and the physically and mentally handicapped are most vulnerable because of the lack of mobility to escape the path of destruction. People who may not understand watches and warnings due to language barriers are also at risk. Generally the destructive path of a tornado is only a couple hundred feet in width, but stronger tornadoes can leave a path of devastation up to a mile wide. Normally a tornado will stay on the ground for no more than 20 minutes; however, one tornado can touch ground several times in different areas. Large hail, strong straight-line winds, heavy rains, flash flooding, and lightning are also associated with severe storms and may cause significant damage to a wider area. Impacts can range from broken tree branches, shingle damage to roofs, and some broken windows; all the way to complete destruction and disintegration of well-constructed structures, infrastructure, and trees. Tornadoes can impact many critical services, mainly electrical power. Buried services are not as vulnerable, but can be affected by their system components that are above ground. Whole towns have been known to be “wiped off the map.” Economic impacts can result from direct damages to facilities or business disruption from the lack of critical services such as power, gas, or water. Currently the severity of tornadoes is measured by intensity based upon the Enhanced Fujita-Pearson scale. These scale rates tornadoes from 0-5 based on wind speed and the extent of damage at the site of impact. It is based on wind speed and extent of damage, but it will require some changes to the wind speed measurements and damage assessments. It breaks down each event by Damage Indicators (DI), and Degrees of Damage (DOD). DI’s are broken down into 28 categories of structures. Each individual type of structure is given an abbreviation code as well as a number code for easy reference. DOD’s are broken down into categories of possible damage that might occur. Each of these categories is also assigned a number.	**4**
Warning Time	Tornadoes strike with an incredible velocity. Wind speeds may exceed 300 miles per hour and the storm can travel across the ground at more than 70 mph. These winds can uproot trees and structures and turn harmless objects into deadly missiles, all in a matter of seconds. The advancement in weather forecasting has allowed watches to be delivered to those in the path of these storms up to hours in advance. The best lead-time for a specific severe storm and tornado 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 due to blowing dust or driving rain and hail.	**3**
Duration	The response to a tornado event is tied to responding to the immediate threat to life and property immediately following the tornado event and in the shelter of affected families and individuals.	**1**
	Worksheet Total	**3.55**

Sources for Tornadoes	
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climateresearch.html#dandp
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climate/severeweather/extremes.html
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html#maps
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=62a7da30df3ea110VgnVCM10000030f3870aRCRD&vgnextfmt=default
Federal Emergency Management Agency	http://www.fema.gov/hazard/tornado/index.shtm
Tornado Climatology of the Contiguous US	http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr4461/cr4461-r2.pdf
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/
Wind Science and Engineering Research Center	http://www.depts.ttu.edu/weweb/F_Scale/images/efsr.pdf
NOAA National Weather Service	http://www.crh.noaa.gov/images/dmx/IowaTorClimatology.pdf
FEMA Declared Disasters	http://www.fema.gov/femaNews/disasterSearch.do
Local Sources	Varies

2.22 Transportation Incident

This hazard encompasses the following consolidated hazards from the 2007 mitigation plan: air transportation, highway transportation, railway transportation, and waterway incident. This includes a transportation accident involving any mode of transportation that directly threatens life and which results in property damage and/or death(s)/injury(s) and/or adversely impacts a community's capabilities to provide emergency services.

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
2	**2**	**4**	**2**	**2.30**

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, helicopters, and other modes of air transportation 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 incident at or near the airport. Air transportation incidents can occur in remote unpopulated areas, residential areas, or downtown business districts, incidents involving military, commercial, or private aircraft can also occur while the aircraft is on the ground.

Iowa has eight (8) commercial airports, one (1) reliever airport, eight (8) private owned for public use airports, 101 public owned for general use airports, and 129 heliports. Anywhere in Iowa could experience a significant air transportation incident; the most likely scenarios exist near airports.

Since 1960, there have been 1,999 air transportation incidents/accidents in Iowa (National Transportation Safety Board). Of these incidents/accidents, 237 were fatal to at least one (1) person, totaling 530 fatalities. This figure does include the one hundred eleven (111) fatalities in the crash of United Flight 232 in Sioux City, Iowa.

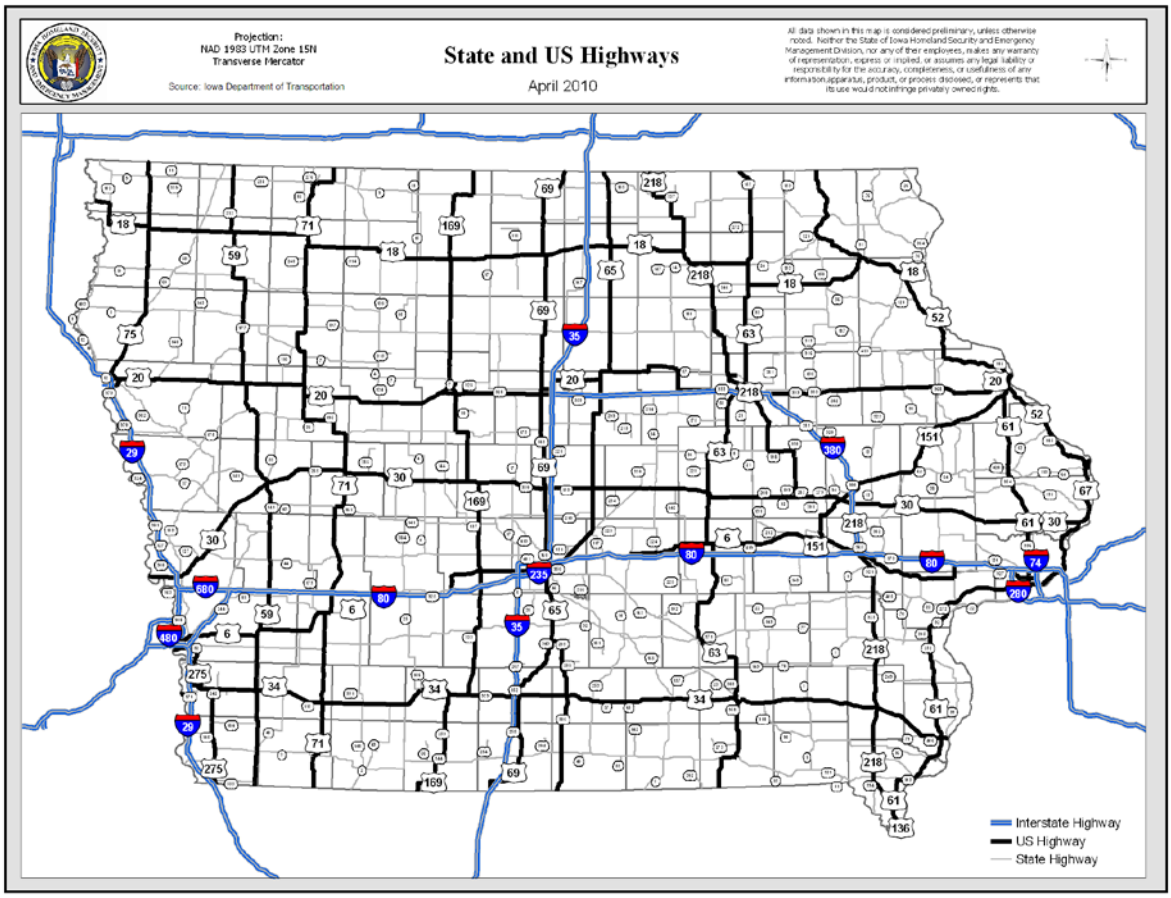
The greater the number of landings and takeoffs, the greater is the probability of a crash or an accident. More and more people are utilizing air travel now than in the past; the trend of increasing numbers of people flying is likely to continue as will the crowdedness of airports and the skies above Iowa.

Between 1990 and 2006, Iowa has handled more than 5.9 million flights at the five (5) major airports, Waterloo (ALO), Sioux City (SUX), Dubuque (DBQ), Des Moines (DSM), and Cedar Rapids (CID). These numbers do not include Burlington (BRL), Fort Dodge (FOD), Mason City (MCW), or any private or public general aviation airports and the Ankeny Regional Airport. Despite the increase in the number of people using air travel, incidents that require response personnel and involve casualties are likely to continue to decrease in number due to increases in the quality of training, equipment, and safety. Proper land-use near the airport will also decrease the chance that people and property on the ground will suffer significant impacts in the event of an air transportation accident.

The SHMT evaluated the probability of a serious transportation incident (crash of a major airliner) is unlikely in any given year.

A highway transportation incident can be single or multi-vehicle requiring responses exceeding normal day-to-day capabilities. An extensive surface transportation network exists in Iowa; local residents, travelers, business, and industry rely on this network on a daily basis. Hundreds of thousands of trips a day are made on the streets, roads, highways, and interstates in the state; if the designed capacity of the roadway is exceeded, the potential for a major highway incident increases. Weather conditions play a major factor in the ability of traffic to flow safely in and through the state as does the time of day (rush hour) and day of week. Incidents involving buses and other high-occupancy vehicles could trigger a response that exceeds the normal day-to-day capabilities of response agencies.

Numerous major and minor traffic accidents occur daily in Iowa and result in property damage and injury, major accidents involving multiple vehicles and serious injury are not uncommon. According to the Iowa Department of Motor Vehicles (http://www.iowadot.gov/mvd/ods/crashhistory.xls), in the 77-year period that Iowa has tracked crash statistics from 1932 through 2008, there were 4,295,017 traffic accidents resulting in 1,856,643 injuries and 44,036 deaths. See the map below depicting Iowa's state and U.S. highways.



Although traffic engineering, inspection of traffic facilities, land use management of adjacent areas to roads and highways, and the readiness of local response agencies has increased, highway incidents continue to occur. As the volume of traffic on Iowa streets, highways, and interstates increase, the number of traffic accidents will increase. The combination of large numbers of people on the road, unpredictable weather conditions, potential mechanical problems, and human error create the potential for a transportation accident.

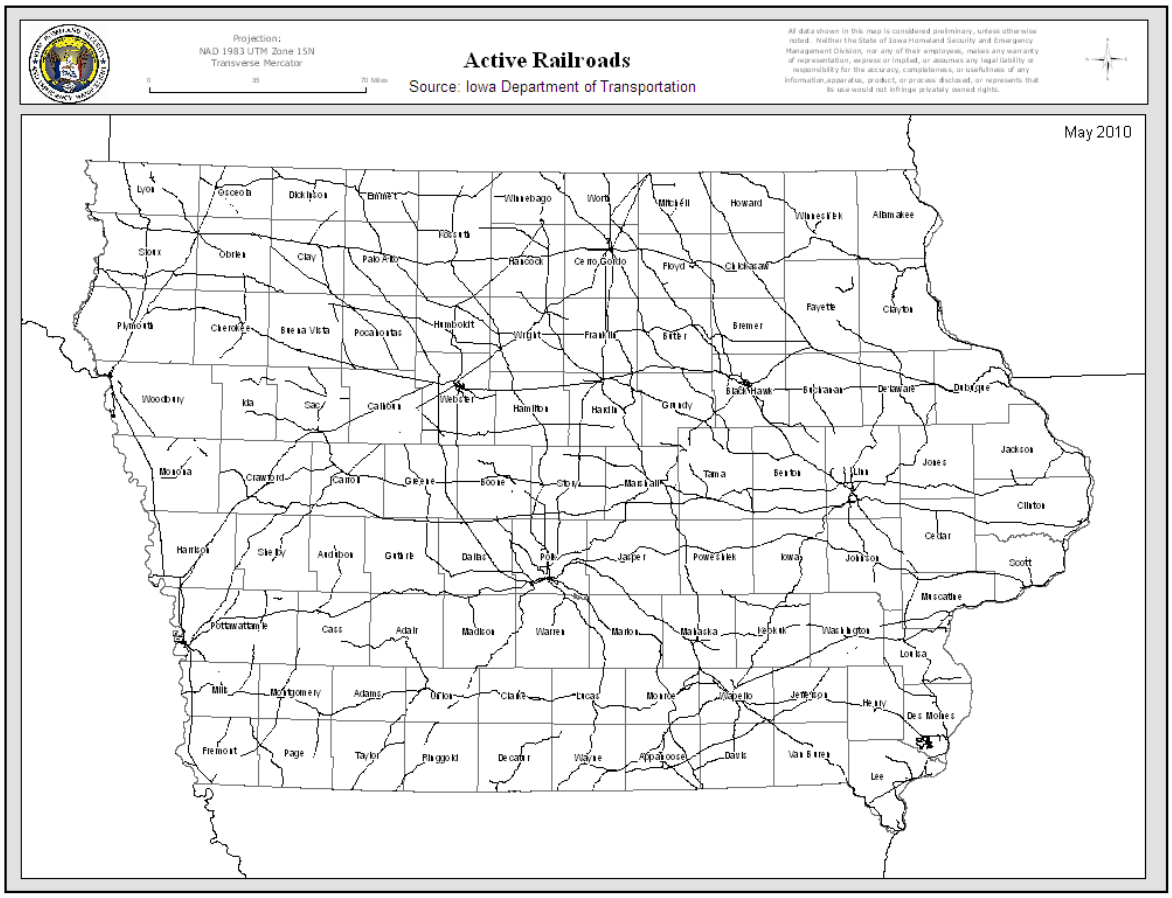
The SHMT analysis has evaluated the probability that a serious highway transportation incident occurring in Iowa is likely to occur in any given year.

A railway transportation incident is a train accident that directly threatens life and/or property, or adversely impacts a community's capabilities ability 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 the many miles of track in Iowa, vehicles must cross the railroad tracks at numerous at-grade crossings.

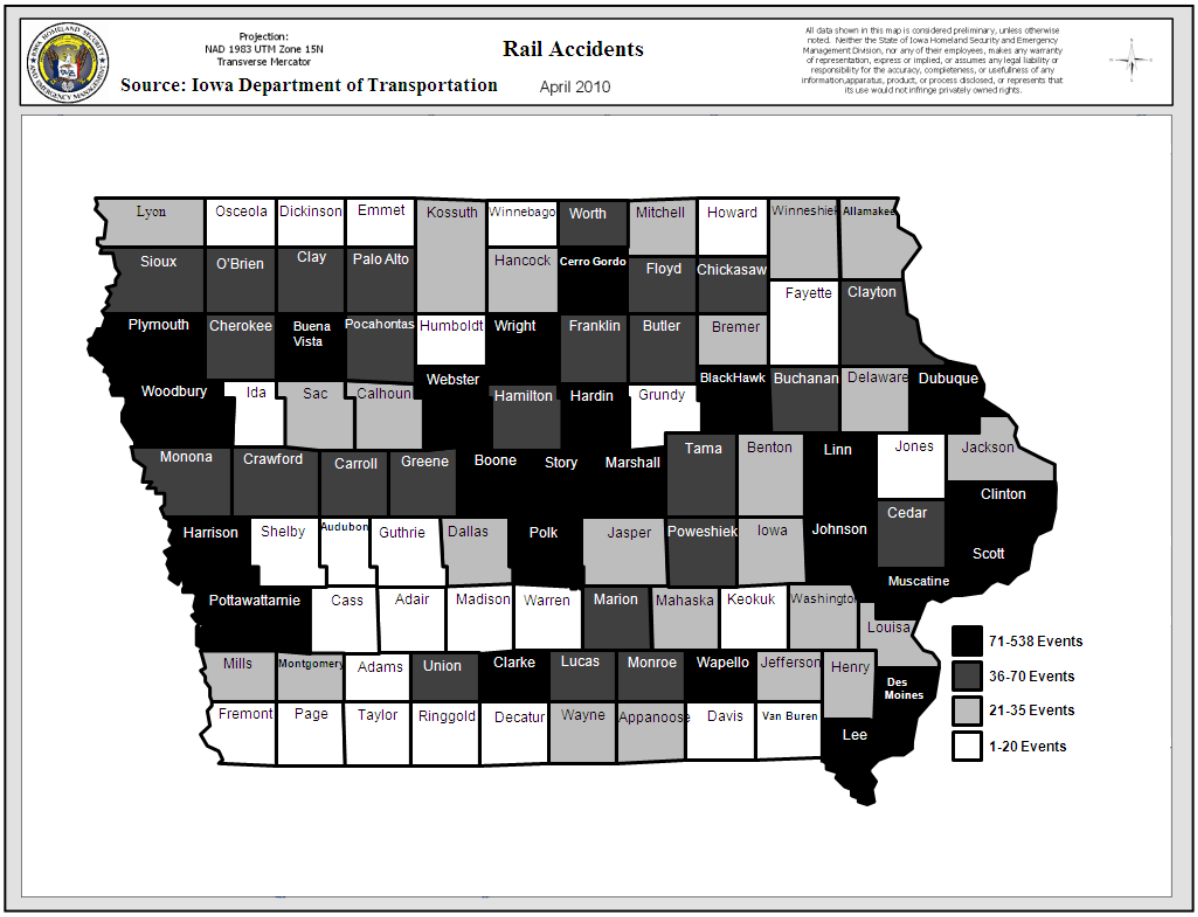
From 1975 to April 2010, there have been 7,087 documented rail incidents in Iowa, these incidents range from minor "rail jumps" to passenger train derailments. With reported data

from 1995 to April 2010 there have been 2,203 injuries and 161 deaths related to these incidents.

There are 7,870 railroad crossings in Iowa with 4,470 public crossings, 3,400 private crossings, and hundreds of railroad track miles, combined with the many street and highway crossings make the probability of an incident more likely to happen. Derailments are also possible, while a major derailment would occur less frequently. The following map depicts the active rail lines to illustrate the areas in the State most at risk for rail accidents.



In addition, rail accident data has been collection from the Iowa Department of Transportation by county and is presented in the map below.



The SHMT evaluated the probability of a severe railroad accident (causing loss of life and/or release of hazardous materials) to be likely to occur in any given year.

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 will primarily involve pleasure craft on rivers and lakes. In the event of an incident involving a water vessel, the greatest threat would be drowning, fuel spillage, and/or property damage. Water rescue events would largely be handled by first responding agencies. Waterway incidents may also include events in which a person, persons, or object falls through the ice on partially frozen bodies of water.

There have been no disasters causing waterway incidents in Iowa. There have been numerous search and rescue events involving a single person or small boats with only a few people on board. Small-scale incidents on the state's lakes and rivers have resulted in the loss of life from pleasure craft collisions and/or falls from vessels. The only waterways navigable for commercial purposes in Iowa are the Mississippi and Missouri Rivers.

Each summer thousands of Iowans and visitors take to pleasure crafts across the state. Thousands of visitors to the state's riverboat casinos board watercraft annually. The casinos make regular trips up and down the rivers during the summer months.

The SHMT has evaluated the probability a serious waterway incident to be unlikely in any given year.

Evaluation Criteria	Description	Score
Probability	Since 1962 there have been 1,999 aviation incidents/accidents in the State of Iowa. Of these incidents/accidents, only 237 were fatal to one or more people, with a total of 530 fatalities in that timeframe. This does include the one hundred eleven fatalities occurred during the crash of United Flight 232 in Sioux City, Iowa in 1989. The greater the number of landings and takeoffs, the greater the probability of a crash or accident. More and more people are utilizing air travel now than in the past. The trend of increasing numbers of people flying is likely to continue as will the crowdedness of airports and the skies above Iowa. From 1990-2006 Iowa has handled more than 5.9 million flights at the 5 major airports, including Waterloo (ALO), Sioux City (SUX), Dubuque (DBQ), Des Moines (DSM), and Cedar Rapids (CID). These numbers do not include Burlington (BRL), Fort Dodge (FOD), Mason City (MCW), or any private or public general aviation airports and the Ankeny Regional Reliever Airport. Despite the increase in the number of people using air travel, incidents that require response personnel and involve casualties are likely to continue to decrease in number due to increases in the quality of training, equipment, and safety. Proper land use in the vicinity of the airport will also decrease the chance that people and property on the ground will suffer significant impacts in the event of an air transportation accident. Numerous major and minor traffic accidents occur every day in Iowa and result in property damage and/or death(s)/ injury(s). Major accidents involving multiple vehicles and serious injury unfortunately are not uncommon either. In the 77-year period that Iowa has tracked crash statistics from 1932 through 2008, there were 4,295,017 traffic accidents resulting in 1,856,643 injuries and 44,036 deaths. Although traffic engineering, inspection of traffic facilities, land use management of areas adjacent to roads and highways, and the readiness of local response agencies have increased, highway incidents continue to occur. As the volume of traffic on the state's 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 open the potential for a transportation accident. From 1975 to April 2010, there have been 7,087 documented rail incidents in Iowa, these incidents range from minor "rail jumps" to passenger train derailments. With reported data from 1995 to April 2010 there have been 2,203 injuries and 161 deaths related to these incidents. There are 7,870 railroad crossings in Iowa. The miles of railroad track in the state, combined with the large number of street and highway crossings, makes the probability of a highway/rail collision significant statewide. Derailments are also possible, while a major derailment would occur less frequently. There have been few significant waterway incidents in Iowa. There have been numerous search and rescue events involving a single person or small boats with only a couple people on board. Small scale incidents on the state's lakes and rivers have resulted in loss of life from pleasure craft collisions and falls from vessels. The only waterways navigable for commercial purposes are the Mississippi and Missouri Rivers. Each summer thousands of Iowans and visitor take to pleasure craft across the state. Thousands of visitors to the state's riverboat casinos board craft annually. The casinos make regular trips up and down the rivers during summer months.	**2**
Magnitude/Severity	People aboard airplanes are the most vulnerable. Statistics from the National Transportation Safety Board and the airline industry show that the majority	**2**

Evaluation Criteria	Description	Score
	(over 75%) of airplane crashes and accidents occur during the takeoff or landing phases of a flight. As a result, developed areas adjacent to the airports and in airport flight paths are particularly vulnerable to this hazard. For areas away from the airport, a smaller percentage of the population would be directly in the area of impact. Because of the infrequency of aircraft in the skies above areas away from the airport, these areas would not be considered as vulnerable. As mentioned above, most accidents occur during takeoffs and landings. Accordingly, the spatial extent of the majority of incidents would occur on airport grounds or adjacent areas. Compared to many other hazards, an air transportation accident would occupy a relatively small area. The extent to which the impacts would be felt would depend on the materials involved. For example, if a cargo plane transporting volatile or hazardous substances were involved in an accident, the area of concern would be significantly larger than the area for an accident involving a small personal aircraft carrying stable materials. The largest share of accidents would likely affect only a few city blocks. Those who use the surface transportation system are most vulnerable. Travelers, truckers, delivery personnel, and commuters are at risk at all times that they are on the road. During rush hours and holidays the number of people on the road in Iowa is significantly higher. This is also true before and after major gatherings such as sporting events, concerts, and conventions. Pedestrians and citizens of the community are less vulnerable but still not immune from the impacts of a highway incident. Iowa is crisscrossed by thousands of miles of roads, highways, and interstates. Highway incidents are usually contained to areas on the roadway or directly adjacent to the roadway. Very few highway incidents affect areas outside the traveled portion of the road and the right-of-way. Extensive segments of the transportation system can be impacted during significant weather events, such as a large snowstorm, when multiple separate accidents occur. The area of impact can extend beyond the localized area if the vehicle(s) involved transporting hazardous materials. People and property in close proximity to the railway lines, crossings, sidings, switching stations, and loading/unloading points are most at risk. Those away from railroad tracks and facilities are vulnerable only to large-scale incidents including those in which hazardous materials are involved. Numerous railways crisscross Iowa. Vehicle/train collisions are usually limited to areas in and near intersections. Rarely, the incident will result in widespread effects. The direct area of impact is usually quite small, but depending on the products and materials involved, the area could become extensive. If hazardous materials are involved, the effects could reach areas up to 1.5 miles from the scene. Harmful products may contaminate streams, rivers, water distribution systems, and storm water systems. If this occurs, a large portion of the community could be affected. The ability of response agencies to contain the product on-scene usually limits the area affected. Passengers of pleasure craft and riverboat casinos are vulnerable to a waterway incident. Operators of barges are also vulnerable. The environment is vulnerable to potentially damaging materials aboard the numerous barges that normally operate year-round on the Mississippi and Missouri Rivers. The maximum extent of a waterway incident would be limited. Impacts would not extend beyond the immediate incident scene. The only exception would include a search and rescue event that could expand downstream. In the case of a hazardous material being released to the waterway, the impact could expand considerably.	
Warning Time	The amount of warning time prior to an aircraft accident could vary from tens of minutes to a matter of seconds. Crew aboard a troubled aircraft can radio to ground crew to prepare for the incident, but little can be done to lessen the direct effects of the impact. Rarely is there adequate time to do more than	**4**

Evaluation Criteria	Description	Score
	position on-site response personnel and alert mass casualty care providers of the possible event. There is usually no warning of highway incidents. During snow storms and other weather events that may impede travel, travelers, response agencies, and hospitals alike can be notified of hazardous travel conditions. Like other transportation incidents, a railway incident would occur with no warning. There may be a limited amount of time to warn those in the pathway of the harmful effects. Leading causes of waterway incidents are inclement weather and operator error and incidents would occur with little or no warning. Weather forecasts are usually available days in advance and would give ample time to take shelter off the water.	
Duration	Instances of transportation incidents, particularly rail, air, and waterway related hazards are likely to create more intensive response and resources to protect life and safety of those affected.	**2**
	Worksheet Total	**2.30**

Sources for Transportation Incident	
U.S. Department of Transportation	http://hazmat.dot.gov/
Federal Railroad Administration	http://www.fra.dot.gov/safety/hazmat.htm
National Transportation Safety Board -NTSB	http://www.ntsb.gov/
NTSB Aviation Information	http://www.ntsb.gov/aviation/aviation.htm
NTSB Rail Information	http://www.ntsb.gov/Surface/Railroad/railroad.htm
Federal Railroad Administration	http://safetydata.fra.dot.gov/officeofsafety/
Association of American Railroads	http://www.aar.org/Homepage.aspx
AAR - Iowa Specific Data	http://www.aar.org/~/media/AAR/InCongress_RailroadsStates/Iowa.ashx
Federal Aviation Administration	http://www.faa.gov/
Transportation Security Administration	http://www.tsa.gov/research/index.shtm
Iowa Department of Transportation	http://www.iowadot.gov/traffic/sections/safety.htm
Iowa Department of Natural Resources	http://www.iowadnr.gov/spills/index.html
Iowa DOT Rail Statistics	http://www.iowadot.gov/iowarail/index.htm
National Highway Traffic Safety Admin.	http://www.nhtsa.gov/NCSA
Traffic Safety Statistics	http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/STSI/USA%20WEB%20REPORT.HTM
U.S. Department of Transportation	http://www.fmcsa.dot.gov/safety-security/hazmat/hm-theme.htm
U.S. Department of Transportation	http://ai.fmcsa.dot.gov/CrashProfile/StateCrashProfileMain.asp?StCd=IA
Iowa Crash Statistics	http://ai.fmcsa.dot.gov/CrashProfile/st_overview.asp?StCd=IA
Federal Railroad Administration	http://www.fra.dot.gov/Pages/337.shtml
Governor's Traffic Safety Bureau	http://www.dps.state.ia.us/commis/gtsb/index.shtml
Iowa Department of Natural Resources	http://www.iowadnr.gov/law/boating/index.html
U.S. Coast Guard	http://www.uscg.mil/
National Water Safety Congress	http://watersafetycongress.org/
National Safe Boating Council	http://safeboatingcouncil.org/
Boating Risk Analysis System	http://www.boatingrisk.com/
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml

Disaster Center.com	http://www.disastercenter.com
Local Sources	Varies

2.23 Windstorm

Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
2	**1**	**2**	**1**	**1.60**

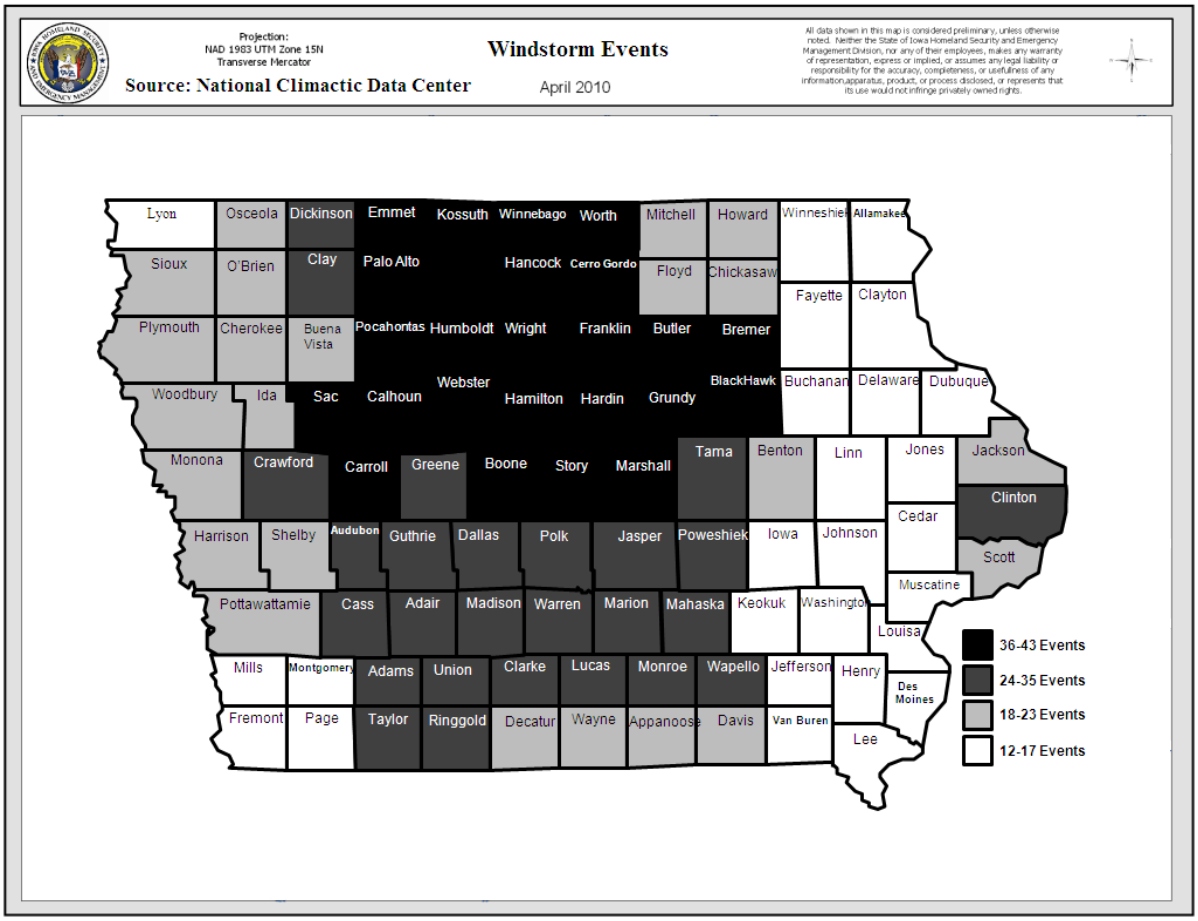
Windstorms can be described as extreme winds associated with severe winter storms, severe thunderstorms, downbursts, and very steep pressure gradients. Windstorms, other than tornados, are experienced in all regions of the United States. It is difficult to separate the various wind components that cause damage from other wind-related natural events that often occur with or generate windstorms.

Although Iowa does not experience direct impacts from hurricanes, the state is no stranger to strong, damaging winds. Unlike tornadoes, windstorms may have a destructive path that is tens of miles wide and the duration of the event could range from hours to days. These events can produce straight lines winds in excess of 64 knots causing some power outages, property damage, impaired visibility, and crop damage.

Windstorms occur in every county in Iowa. Historically, windstorm events are associated with severe thunderstorms and blizzards. It is often difficult to separate windstorms and tornado damage when winds get above 64 knots.

The National Weather Service has developed a windstorm warning system similar to other events such as, tornado, winter storm, and thunderstorm. Watches are issued when conditions are favorable for windstorms to develop and they come 12 to 24 hours in advance. Advisories are issued when existing or imminent windstorms cover part or all of the area and pose a mere inconvenience. Windstorm warnings are issued when existing or imminent high winds cover part or all of the forecast area and pose a threat to life and property.

Based on historical averages, Iowa would expect to have about 15 to 20 wind events each year where wind speeds exceed 64 knots (73 mph). The map below presents the regional occurrences of windstorms in the State of Iowa. Since 1993, Iowa has experienced 204 strong and high wind events.



The SHMT evaluated the probability that a damaging windstorm has an occasional probability in any given year.

Evaluation Criteria	Description	Score
Probability	Large-scale extreme wind phenomena are experienced over every region of the United States. Historically, windstorm events are associated with severe thunderstorms and blizzards. It is often difficult to separate windstorms and tornado damage when winds get above 64 knots. Based on historical averages, Iowa would expect to have about 15-20 windstorm events per year. Based on historical information into storms with the potential to cause large scale power outages, the SHMT determined the probability of occurrence is between 10% - 20% in any given year.	**2**
Magnitude/Severity	Those most at risk from windstorms include people living in mobile homes, campgrounds, and other dwellings without secure foundations or basements. People in automobiles are also very vulnerable to wind storms, particularly tornadoes. The elderly, very young, and the physically and mentally handicapped are most vulnerable because of the lack of mobility to seek shelter or escape the path of destruction. People who may not understand watches and warnings due to language barriers are also at risk. Unlike tornadoes, windstorms may have a destructive path that is tens of miles wide and several hundred miles long. Large hail, strong straight-line winds, heavy rains, flash flooding, and lightning are also associated with severe storms and may cause significant damage to a wider area. Disruption of critical services can also affect operations. Employees may be	**1**

Evaluation Criteria	Description	Score
	affected and unable to attend work-related issues. Impacts can range from broken tree branches, shingle damage to roofs, and some broken windows; all the way to complete destruction of well-constructed structures, infrastructure, and trees. Windstorms can affect many critical services, especially electrical power. Buried Services are not as vulnerable, but can be affected by their system components that are above ground. Economic impacts can result from direct damages to facilities or business disruption from the lack of critical services such as power. Crop damage is often associated with windstorms; laying down crops, breaking stalks, and twisting plants, reducing the yield and making it difficult to harvest.	
Warning Time	Wind speeds may approach 120 miles per hour and the storm can travel across the ground at more than 50 mph. These winds can uproot trees and structures and turn harmless objects into deadly missiles, all in a matter of seconds. The development of conditions suitable for high and strong wind events is available a day in advance. The advancement in weather forecasting has allowed watches to be delivered to those in the path of these storms up to hours in advance. The best warning lead-time for a specific severe storm is about 30 minutes.	**2**
Duration	The response tied to windstorm events is one directly related to the immediate protection of vulnerable populations from the direct threat to life and property. Response time is limited to event duration and immediate impact.	**1**
	Worksheet Total	**1.60**

Additional Sources for Windstorms	
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climateresearch.html#dandp
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html
American Red Cross	http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=62a7da30df3ea110VgnVCM10000030f3870aRCRD&vgnextfmt=default
Federal Emergency Management Agency	http://www.fema.gov/hazard/tornado/index.shtm
CBS News Disaster Links	http://www.cbsnews.com/digitaldan/disaster/disasters.shtml
Disaster Center.com	http://www.disastercenter.com
Natural Hazards Center – Univ. of Colorado	http://www.colorado.edu/hazards/
Local Sources	Varies

Further refinement of the hazard identification process grouped hazards into priority areas. The Priority Group I hazards are candidates for immediate focus in the emergency plans because of their high risk. Priority Group II hazards are those hazards that should be addressed, but are longer-term in focus. These are low-risk hazards that can affect the community, but will not be addressed immediately. Priority Group III hazards are those that have an acceptable level of risk.

Hazard Analysis Ranking	Hazard	Scoring Total	Priority
1	River Flooding	3.55	I
2	Tornados	3.55	
3	Severe Winter Storms	3.25	
4	Levee Failure	3.25	
5	Thunderstorm & Lightning	2.90	
6	Flash Flooding	2.65	
7	Hailstorms	2.65	
8	Animal/Plant/Crop Disease	2.65	
9	Dam Failure	2.65	II
10	Radiological	2.65	
11	Terrorism	2.65	
12	Hazardous Materials	2.50	
13	Drought	2.35	
14	Human Disease	2.35	
15	Transportation Incident	2.30	
16	Infrastructure Failure	2.05	
17	Extreme Heat	1.75	III
18	Grass/Wildland Fire	1.75	
19	Windstorms	1.60	
20	Sinkholes	1.60	
21	Landslide	1.60	
22	Earthquakes	1.45	
23	Expansive Soils	1.45	

Implementation of measures to reduce the risk to these hazards is based on social acceptability, technical feasibility, administrative capacity, political willingness, legal authority, economic benefits, and environmental compatibility. While these factors are addressed more specifically in the response, mitigation, and recovery plans, it was important to consider them here when deciding which priority group the hazard belonged in, particularly when the hazard assessment concluded with identical scorings for certain hazards.

3. Assessing Vulnerability

Requirement §201.4(c)(2)(ii): [The State risk assessment shall include an] overview and analysis of the State's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities located in the identified hazard areas shall also be addressed …

3.1 Assessing Vulnerability by Jurisdiction

The Hazard Analysis and Risk Assessment (HARA) is a product developed to provide an overview and analysis of the state's vulnerability to hazards. This statewide overview is based on estimates and assessments of local hazards from hundreds of Local Hazard Mitigation Plans, as well as state level risk assessment data. State level data for this risk assessment product has been integrated to include publicly and privately owned critical assets from Iowa's Critical Asset Protection Program (CAPP)as well as loss estimation modeling of damage and loss associated with hazard events for certain natural hazards. The major assessment components of the HARA include data and information from:

- The State of Iowa Community Profile
- Local Hazard Mitigation Plans
- The Iowa Critical Asset Protection Program
- The Iowa Loss Estimation

Local plans and the State Plan continue to use the 2000 Census Data while also analyzing periodically updated estimates of data. Development patterns remain substantially the same with the Des Moines – Ames and Cedar Rapids – Iowa City corridors as the primary growth areas and rural areas continuing to decline in population.

State owned and operated critical facilities are not identified in any central database. This data limitation will be addressed through the ongoing SHMT meetings.

To assess the 23 identified hazards, a methodology was established to account for how hazards impacted the state or could potentially impact the state as a jurisdiction. The HARA is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from hazards by assessing:

- Probability - The likelihood of the hazard occurring in any given year while also incorporating any available data on historical occurrence.
- Magnitude / Severity - Measure of severity in terms of injuries and fatalities, personal property, and infrastructure and the extent with which the hazard affects the state.
- Warning Time - The potential amount of warning time that is available before the hazard occurs.
- Duration - A measure of the amount of time that the hazard will affect the state.

The hazard analysis and risk assessment process sought to strike a balance between evaluation criteria. An example would be the evaluation of low probability-high impact events versus high probability-low impact events. Each category of a particular hazard is rated on a scale of one (1) through four (4). Totaling the categorical ratings and averaging the scores provide an overall score in the range of 1.0 to 4.0.

The methodology includes a scoring guide, which was used by the State Hazard Mitigation Team (SHMT) to help obtain a proper assessment for each of the hazards in a statewide context. A scale of one (1) through four (4) was used in all of the scoring guide tables because of the large variation in historical occurrences, probabilities, percentages of vulnerabilities, percentage of spatial extent, the number of casualties, or the value of property damaged. Often this data was not available or would have been impossible to extract from aggregate data. Using this scale provided the best option for comparison of vastly different types of hazards.

Using a quantifiable system as described above gives more detail and still allows for adjustments when necessary. The idea of weighing certain categories relative to the other categories was discussed at length and it was decided that a weighing system would be used for this update from similar models utilized both in FEMA Region VII and in other Regions in the nation.

3.1.1. Integrating The Local Plan Component

The State of Iowa is proactive in local hazard mitigation planning and related activities. Coordination of local hazard mitigation planning within the framework of ongoing interagency mitigation planning efforts of the SHMT encouraged communities and counties to develop their own multi-hazard mitigation plans. Starting in 1997, numerous workshops have been held throughout the state to assist local governments as they began to develop their plans. Typical attendees at these workshops were county emergency management coordinators, Council of Government (COG) representatives, city and county officials and planners, and engineers.

Local planning forms the core of the state hazard mitigation planning process by contributing invaluable hazard and risk related data at the jurisdictional level. Data captured in database products managed by Iowa Homeland Security and Emergency Management (HSEMD). Local hazard analysis and risk assessment information from Local Hazard Mitigation Plans were compiled to assist the SHMT in understanding and assessing vulnerability by jurisdiction. This local level vulnerability data is an important part of the overall hazard identification and assessment of the SHMT and the assessment of vulnerability by jurisdiction. This process will continue for future plan updates. However, the state is reviewing the current system to capitalize on improving the process of integrating the local hazard mitigation hazard analysis and risk assessment process into the State Mitigation Plan.

3.1.2. Integrating the Critical Asset Protection Program (CAPP)

The overall purpose of the CAPP is to identify, assess, prioritize, and recommend protective security actions concerning publicly and privately owned critical assets. Such protection is intended for use in a multi-hazard context for of prevention, deterrence, and immediate response for the protection of citizens and property. While the CAPP addresses all hazards as listed in this section (whether natural, human caused accidental, human caused purposeful, or other), it focuses more on the issue of criticality of the facility and not strictly on the types of hazards.

The CAPP is also designed to help the State of Iowa work with appropriate federal, state, and local agencies for critical asset protection purposes. The State of Iowa has implemented measures to reduce vulnerability by identifying key critical assets that, due

to their inherent importance, must be made secure. The primary objectives to be achieved by implementing the CAPP are:

- Develop or enhance information exchange methods while complying with regulatory, statutory, privacy-related, and other issues that may govern the sharing of information
- Provide platforms to enable the private sector to interact and share information on critical infrastructure and key resources with governmental organizations
- Share information and/or intelligence between Federal, State, local, tribal levels and private sector by using clearly defined mechanisms and processes
- Strengthen collaboration within and between Iowa's critical infrastructure sectors and collaboratively identify ways to strengthen sectors from disruption or loss
- Assess, mitigate, and reduce vulnerabilities in Iowa's critical assets
- Develop and keep current management and administrative tools necessary to ensure that the TIIPP can function
- Develop partnerships between the TIIPP and other homeland security and emergency management agencies
- Conduct assessments of the factors of risk and utilize these to assess critical infrastructure
- Ensure that risk methodologies are accurate and account for the full spectrum of threats facing Iowa

To identify vulnerabilities across the State, Iowa Homeland Security and Emergency Management is in the process of implementing two programs. First is the development of the Threat Information and Infrastructure Protection Program (TIIPP). TIIPP includes critical asset protection (CAP), infrastructure protection and information sharing. Asset protection involves identifying both public/private State critical assets, conducting assessments, and providing protective measure information.

Infrastructure protection is associated with asset protection where necessary. Infrastructure protection focuses on developing relationships with Iowa's 17 critical infrastructure sectors and identifying sector vulnerabilities. In order to establish a more sustainable effort, integrate with National Infrastructure Protection Plan (NIPP) guidance, and better coordinate with relevant state agencies, HSEMD staff identified key agencies and associated points of contact by sector. A review of the critical assets in Iowa showed over 90% is owned by the private sector.

Site visits were conducted to assess specific state and private assets through completion of a questionnaire containing approximately 150 items to determine each asset's vulnerability. The assessment produced numerous findings and additional recommendations related to asset vulnerabilities. As we continue to evolve through the process of evaluating critical assets, new processes are being developed and we are evaluating additional assessment tools to determine the best all-hazard approach method.

Critical Asset Protection Sectors	Primary Organization of Responsibility
Agriculture-Food	Iowa Department of Agriculture and Land Stewards
Banking-Finance	Iowa Department of Commerce
Chemical	Iowa Department of Natural Resources
Commercial Facilities	Iowa Department of Commerce

Critical Asset Protection Sectors	Primary Organization of Responsibility
Dams	Iowa Department of Natural Resources
Defense-Infrastructure	Iowa Department of Public Defense
Emergency Services	Homeland Security and Emergency Management Division
Energy	Iowa Utilities Board
Government	Homeland Security and Emergency Management Division
Information Technology-Telecommunication	Infraguard
Events Venues and Icons	Iowa Department of Cultural Affairs
Education	Iowa Department of Education
Postal-Shipping	United States Postal Service
Public Health-Healthcare	Iowa Department of Public Health
Community Organizations	Iowa Disaster Human Resources Council
Transportation	Iowa Department of Transportation
Water	Iowa Department of Natural Resources

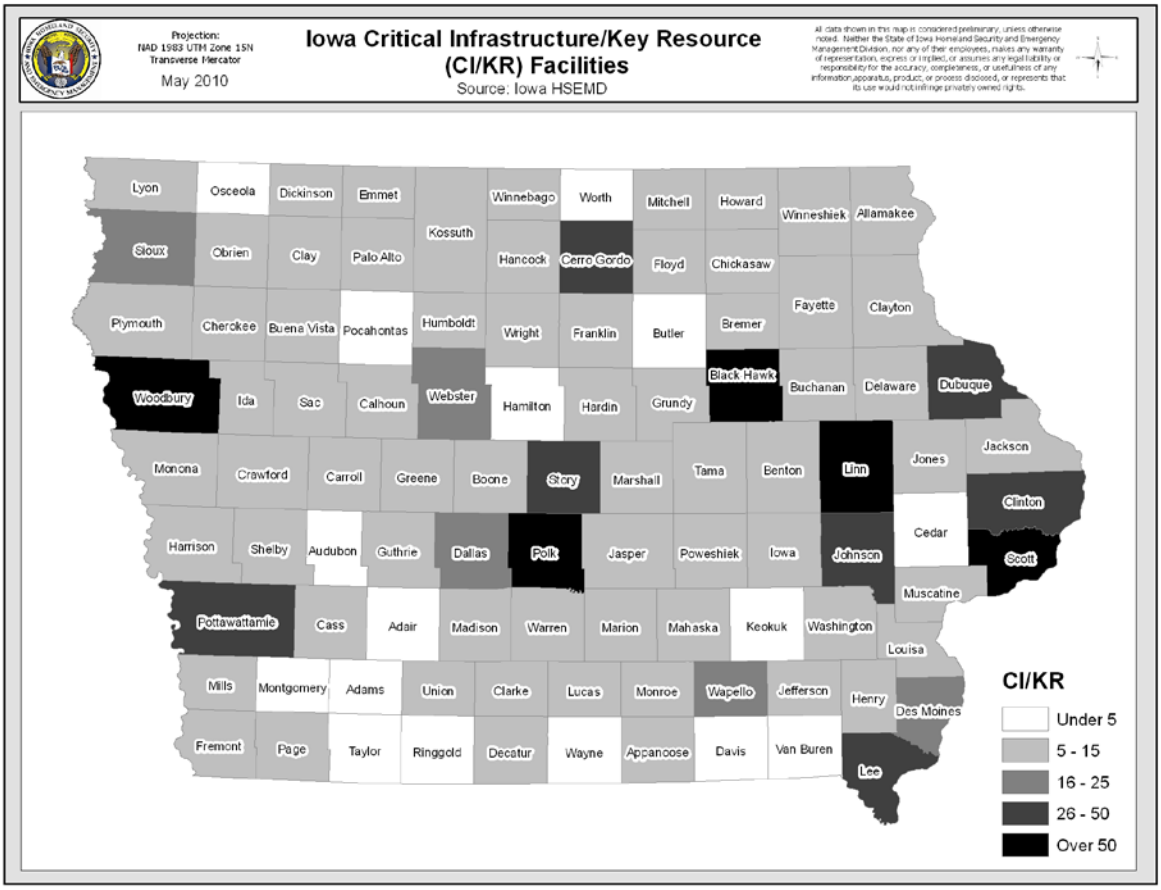
It was obvious that a public/private partnership needed to be established. As a result, Iowa Homeland Security and Emergency Management partnered with the Iowa Business Council and the Business Executives of National Security (BENS) to establish the Safeguard Iowa Partnership.

Information sharing is the other section within the TIPP, which provides 'scrubbed' law enforcement information, conditional threat information and severe weather bulletins with the 17 sectors and other non-law enforcement partners such as Iowa Safeguard Partnership, Emergency Management Coordinators, and the Iowa Air National Guard. Implementation of the continuity of operations and continuity of government program is the other system in place, which mitigates vulnerability by identifying essential services needed for state agencies to continue operating during and after a disaster.

The data that has been gathered for CAPP is stored in the Critical Assets Database. This information is protected as confidential under Section 22.7 of the Iowa Code. Under its provisions, this information shall be kept confidential, but with the following qualifications:

- The Administrator of HSEMD shall make the list of assets available for examination by any person upon making a written request to the Administrator on an approved form.
- The list may be viewed at the office of the division during normal working hours; the list may not be copied in any manner.
- Any communications or asset information gathered from non-government sources; for which the administrator has signed a nondisclosure agreement is exempt from public disclosures.
- At the Administrator's discretion, all or part of the CAPP database may be provided to federal, state, or local agencies for emergency planning or response functions.
- Any agency receiving such information is not allowed to release it without prior approval of the Administrator.

A map with county-by-county figures of the critical assets, which includes state owned facilities, is located below.



3.2 Assessing Vulnerability of State Facilities

Vulnerability of state facilities is assessed through Iowa's Critical Asset Protection Program (CAPP) as described in the prior section. State facilities are addressed in the same fashion as local facilities within the assessment process.

4. Estimating Potential Losses

Requirement §201.4(c)(2)(iii): [The State risk assessment shall include an] overview and analysis of potential losses to the identified vulnerable structures based on estimates provided in local risk assessments as well as State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.
Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development…

4.1 Estimating Potential Loss by Jurisdiction

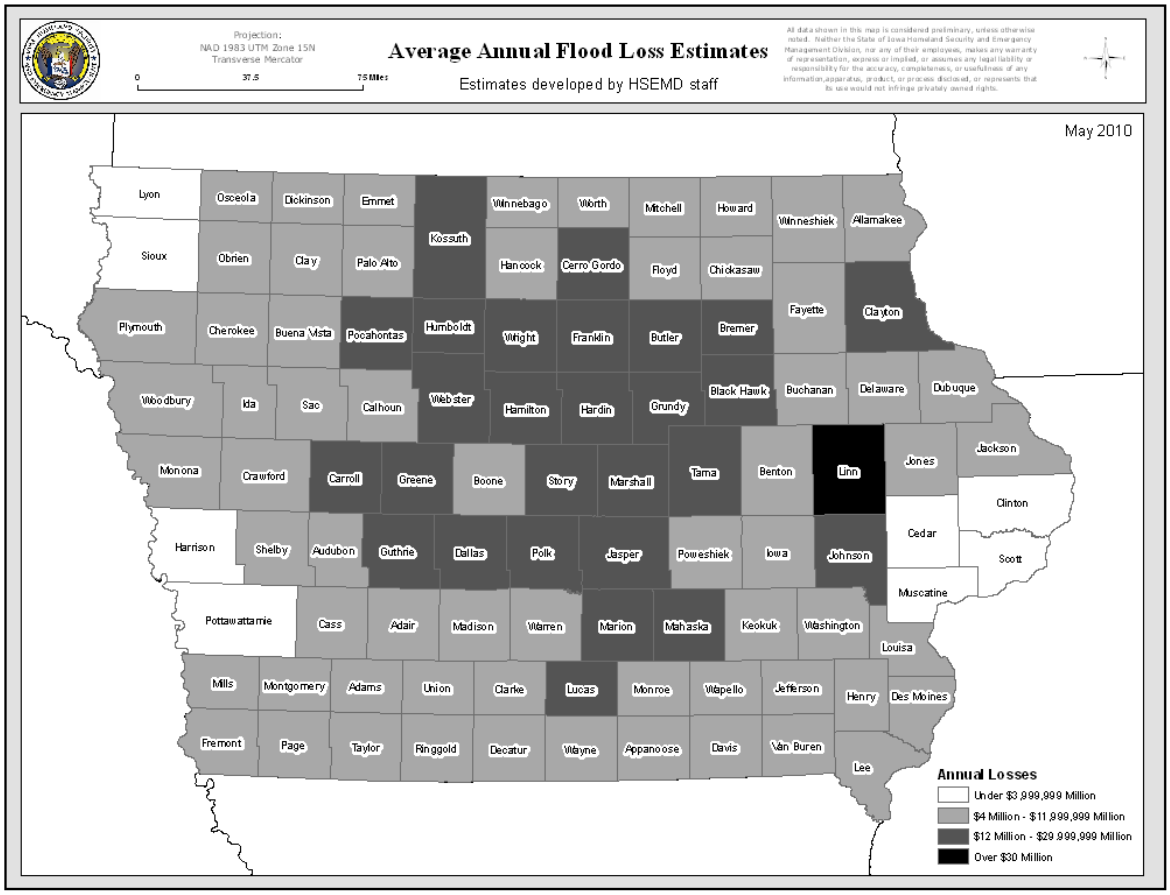
HSEMD developed an analysis and methodology that became the loss estimation model for Iowa's mitigation planning efforts. Due to the complexity of the formula, sufficient data is only available for the 11 most common hazards discussed below with statewide data available for 1 hazard. New data was also incorporated from 2004 through March of 2010. The results of the loss estimation model were formulated at the statewide, regional, and countywide level. The resulting loss estimates were developed and broken into categories and types of damage,

whenever the available data allowed. They were applied as models for estimating losses from 11 natural hazards and 1 human-caused hazard including flooding, drought, crop loss, tornado, hail, thunderstorm, extreme cold, snow & ice, windstorm, lightning, and extreme heat.

Information regarding local loss estimation has not changed due to data limitations. During the period covered in this update, the transition was made to the use of the local data mitigation plan data collection worksheet. However, due to a limited amount of results from the updated plans, a comprehensive loss estimate statewide was not available for use other than validating the updated statewide loss estimate to verify its accuracy. In the future the SHMT will address the inconsistency in local plan loss estimation and methods of improvement for loss data integration in their regularly schedule hazard mitigation team meetings and agency coordination.

In addition, some hazards were not addressed as part of the 2010 updated loss estimation due largely in part to data limitations and available criteria to evaluate loss to county jurisdictions. These hazards will be evaluated for inclusion in future updates as data becomes available for use in the loss estimate.

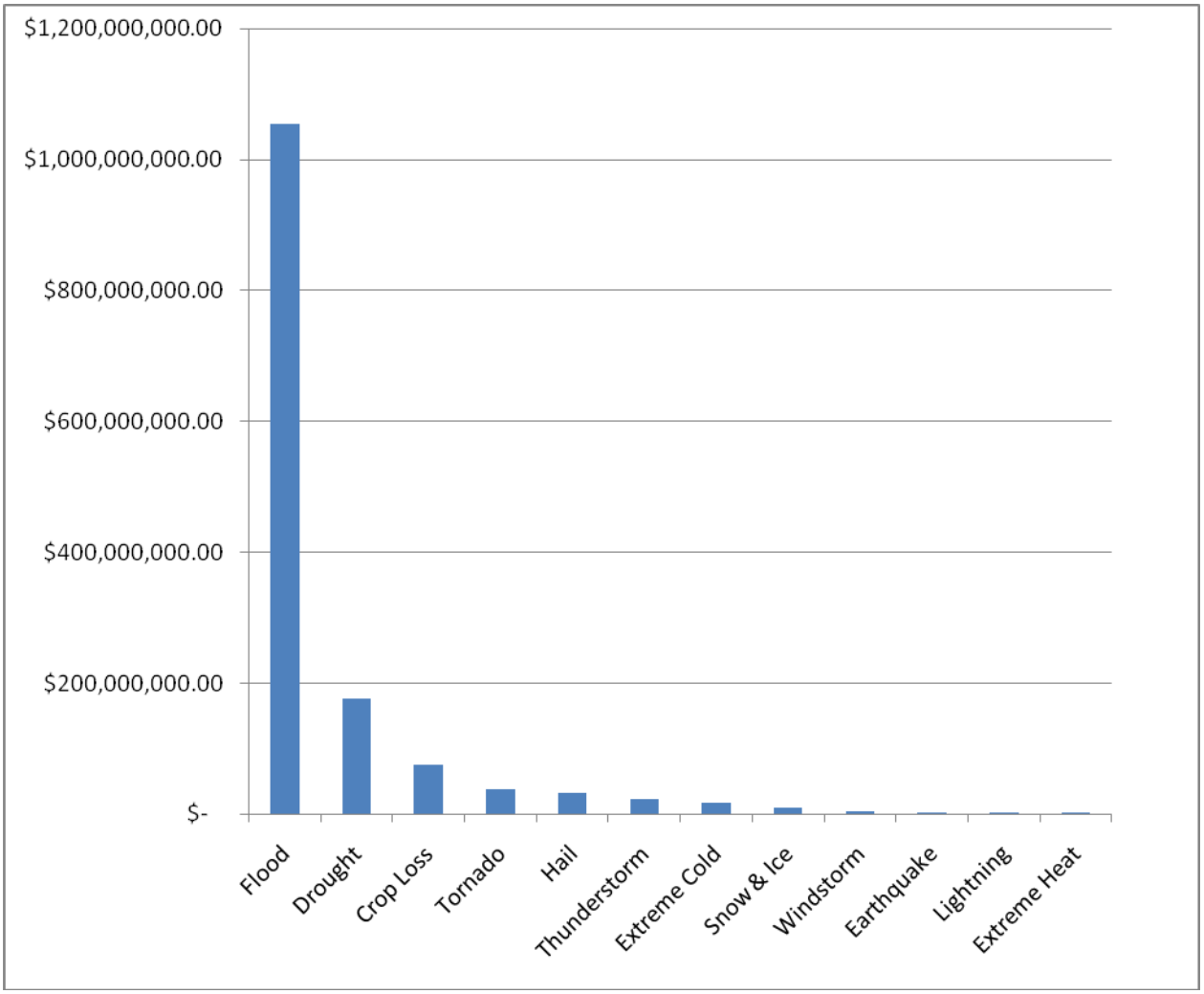
For all 11 natural hazards and 1 man-made hazard (crop loss), statewide annual damage parameters were established utilizing the National Climatic Data Center (NCDC) database, HAZUS published studies, and indemnity information from the USDA Risk Management Agency. The flooding loss estimation methodology also used historical reporting data from the U.S. Army Corps of Engineers Annual Flood Damage Report to Congress. Factors were developed specific to the attributes of each county and these factors were applied to produce annual loss estimation for each of Iowa's 99 counties.



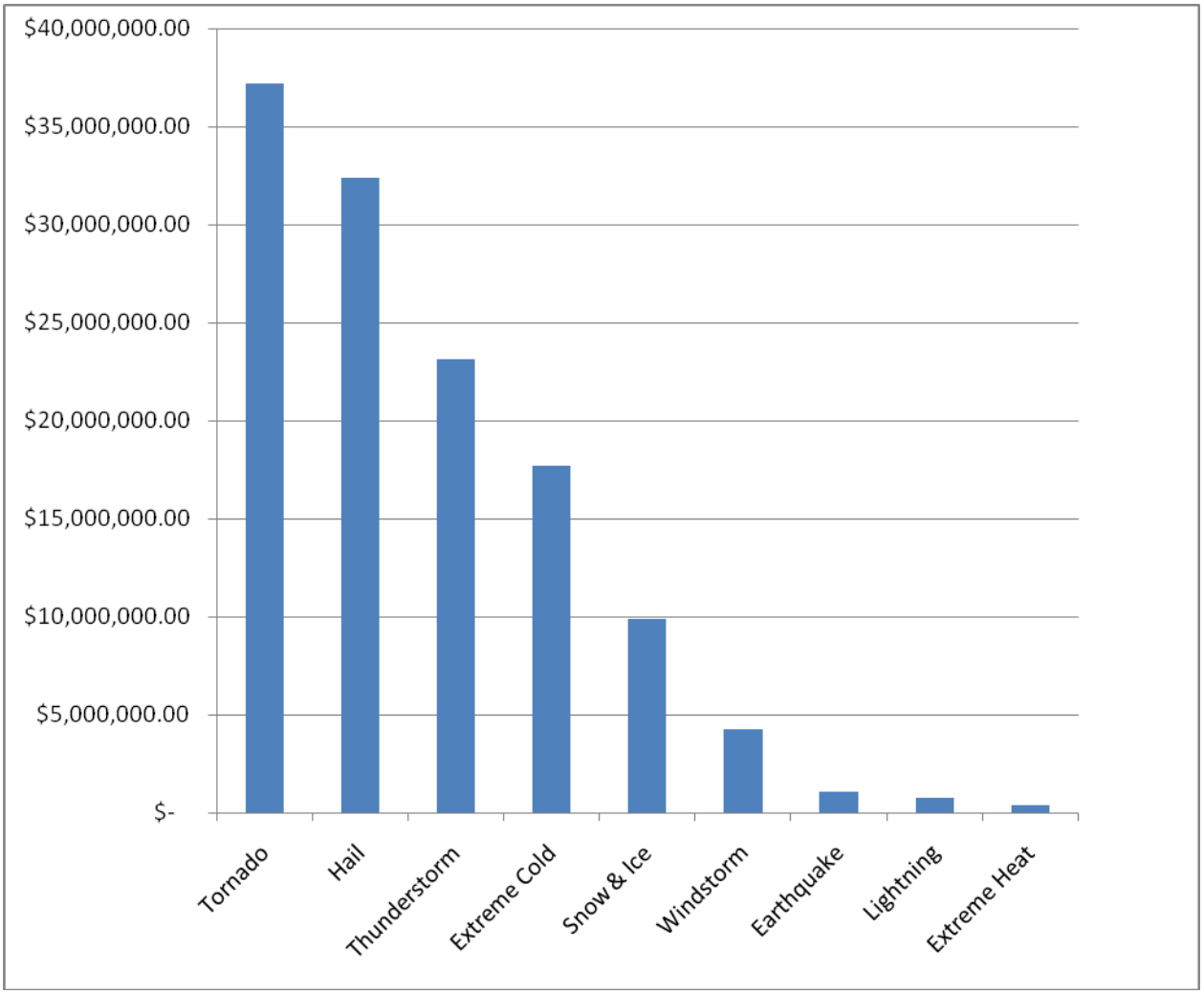
The number and types of factors varied from one hazard loss estimation to another, but in each one, each factor was multiplied times the statewide annual damage history for that hazard to equal the annual countywide loss estimate.

The loss estimate for each county was calculated and then summed up for all 99 counties in Iowa. This calculated a statewide loss estimate that in turn was validated against the damage history factor. Each county loss estimation was then validated comparatively utilizing historical data from the NCDC database and, if available, historical damage data from the Federal Emergency Management Agency (FEMA) Public Assistance Program. Additional information related to the methodology used in estimating losses is in Annex 1.3-A.

Estimated statewide losses are largely the result of flooding, as shown in the table below. The estimated $1,054,733,588 in flooding losses represents 73.54 percent of total losses associated with natural hazards. Annual estimated losses from the remaining hazards ranged from $177 million to $390,000, and represented the remaining 26.46 percent of total losses. Total estimated losses from hazards were $1,434,234,008. Based on this analysis, flood mitigation activities should be a high priority for the state.

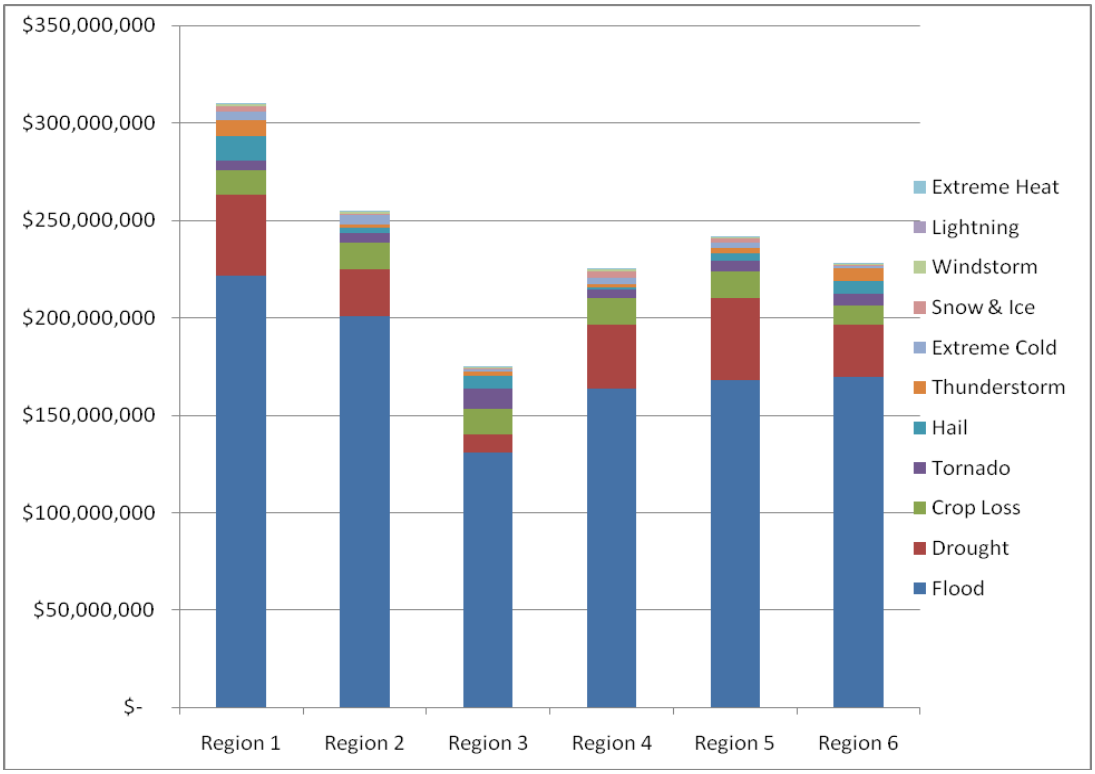


To better illustrate all the hazards, the following table includes only the losses associated with tornados through extreme heat.

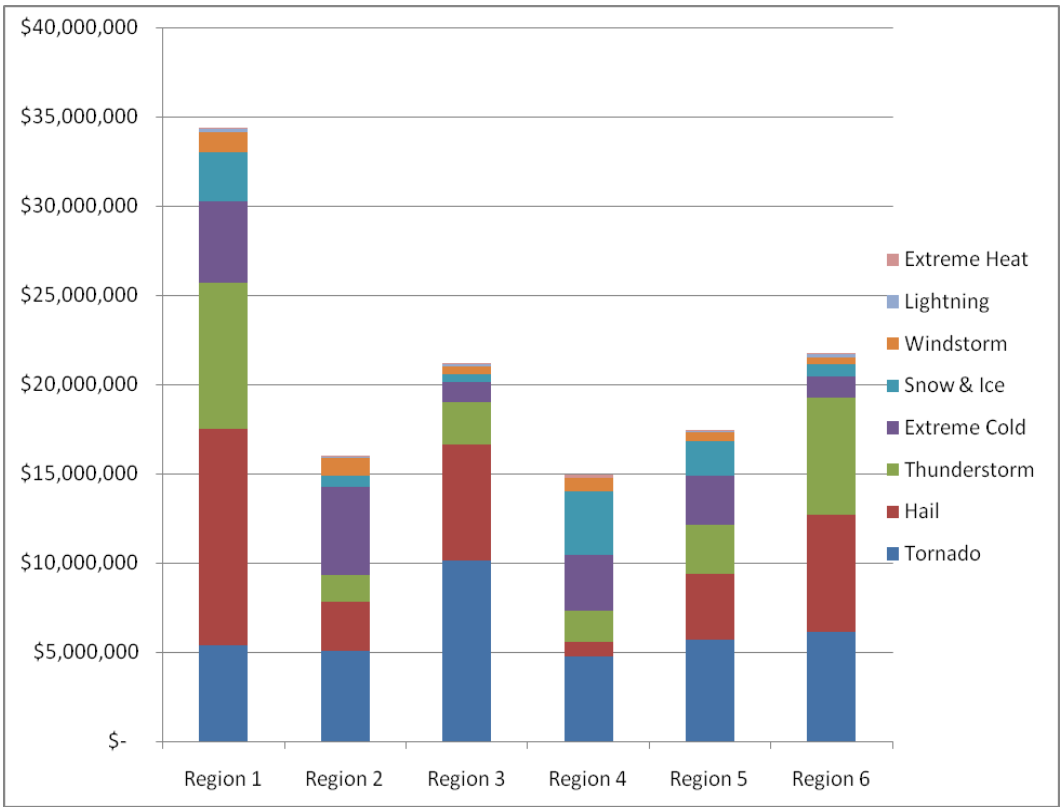


Evaluating estimated losses from hazards at a regional level indicates concentrations of losses across the state. For this evaluation, the state was broken down into the existing six planning districts, as shown in the chart on the following page. Central, eastern, and northern Iowa show slightly higher levels of estimated losses to hazards than other regions. Estimated annual losses were $309 million for central Iowa and $254 million for northeast Iowa and 241 million for southeast Iowa. The estimated losses for these three regions represent approximately 56 percent of the total losses statewide. East central Iowa had $227 million in estimated losses, followed by southwest Iowa with $224 million and concluding with northwest Iowa with $174 million.

When looking at hazard based distribution of estimated annual losses in each region, flooding accounted for much of the damage, followed by drought, crop loss, and tornados. Following results from the last update, flooding accounted for 70 to 80 percent of annual estimated costs in each region. The average losses by hazard across regions were nine (9) percent for windstorms, eight (8) percent for tornados, five (5) percent for hail storms, and three (3) percent for winter storms.

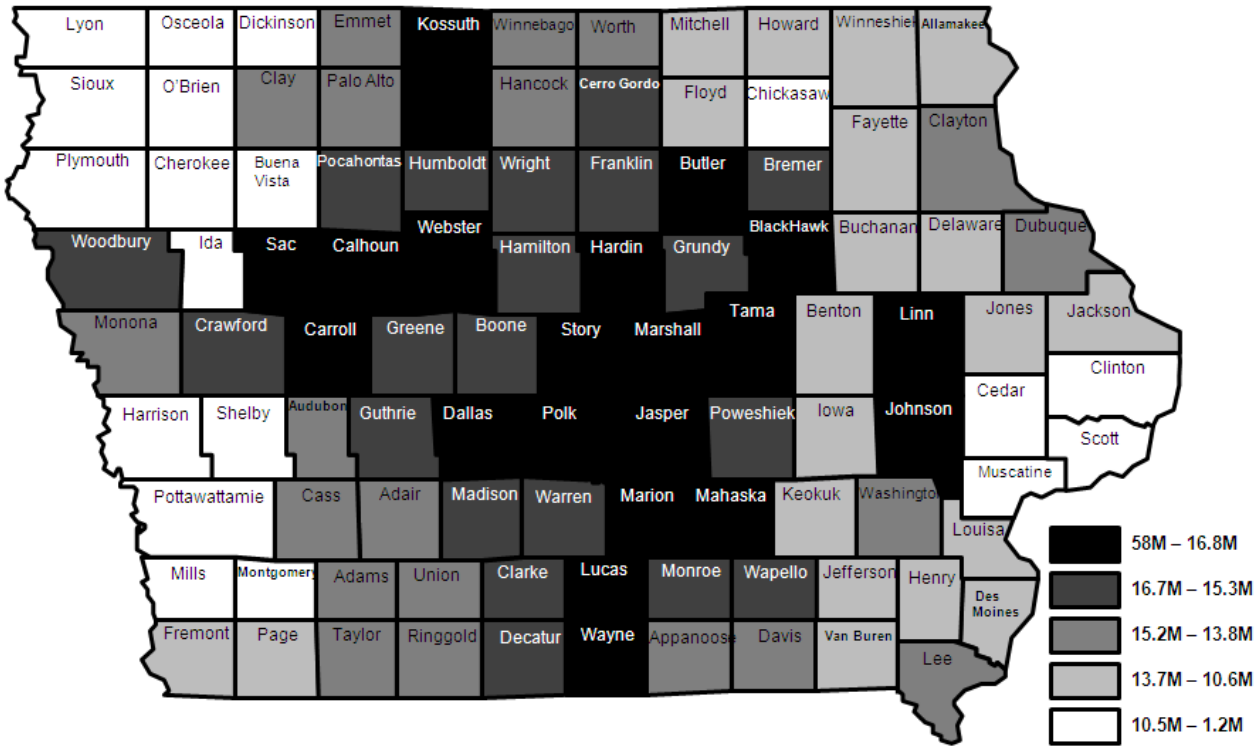


To better illustrate all the hazards, the following table includes only the regional data associated with tornados through extreme heat.



High estimated annual losses for east-central and central Iowa are likely associated with the high populations and associated development in those regions. In addition, each region holds one or more of the state's larger rivers which can be tied back to the high estimated losses from flooding. Conversely, south-central Iowa is the part of the state with the lowest population density and represents the region with the lowest estimated annual losses from hazards. The counties making up the east-central and central regions of Iowa generally have the highest per capita losses.

The following map illustrates the statewide consolidated loss estimate incorporating all included hazards in this update:



By continuing to evaluate estimated annual losses by natural hazard to smaller geographic areas such as counties, a greater understanding of how losses are distributed within the region and what relative weight they have on the overall total can be discerned. For instance, in central Iowa, Polk County alone represents nearly 60 percent of all estimated losses. The following two (2) tables show the county-level breakdown for the eleven (11) hazards analyzed.

County Annual Loss Estimation by Natural Hazard

County	Flood	Drought	Crop Loss	Extreme Heat	Extreme Cold	Hail
Linn	53,631,647.06	2,082,963.92	635,309.82	3,000.00	52,187.50	370,000.00
Marshall	29,307,529.41	2,681,156.15	667,967.88	3,000.00	283,375.00	68,937.50
Johnson	23,527,941.18	2,082,963.92	829,509.84	3,000.00	52,187.50	2,602,187.50
Polk	17,363,882.35	2,986,433.93	462,889.68	3,000.00	283,375.00	886,437.50
Hardin	13,562,647.06	2,033,031.15	948,366.87	3,000.00	283,375.00	4,870,125.00
Mahaska	13,882,588.24	2,986,433.93	869,363.78	3,000.00	283,375.00	59,250.00
Webster	12,483,705.88	2,033,031.15	1,000,974.76	3,000.00	283,375.00	2,208,437.50
Story	13,145,882.35	2,681,156.15	1,097,320.75	3,000.00	283,375.00	212,625.00
Dallas	13,397,705.88	2,986,433.93	598,699.89	3,000.00	283,375.00	77,250.00
Carroll	12,659,176.47	2,681,156.15	933,568.79	3,000.00	283,375.00	61,937.50
Butler	13,519,352.94	2,033,031.15	717,490.27	3,000.00	283,375.00	121,000.00
Jasper	13,287,117.65	2,986,433.93	742,557.47	3,000.00	283,375.00	161,312.50
Calhoun	11,754,470.59	2,033,031.15	805,707.66	3,000.00	283,375.00	2,027,062.50
Sac	10,949,705.88	2,681,156.15	1,230,588.15	3,000.00	283,375.00	2,238,312.50
Black Hawk	13,064,294.12	2,033,031.15	687,928.56	3,000.00	283,375.00	197,937.50
Marion	13,073,882.35	2,986,433.93	646,635.33	3,000.00	283,375.00	40,187.50
Tama	12,570,176.47	2,681,156.15	881,267.74	3,000.00	283,375.00	44,562.50
Kossuth	12,386,647.06	2,033,031.15	1,414,811.13	3,000.00	283,375.00	71,562.50
Wayne	11,799,588.24	2,986,433.93	1,112,400.48	3,000.00	283,375.00	50,937.50
Lucas	12,096,941.18	2,986,433.93	615,107.97	3,000.00	283,375.00	43,687.50
Hamilton	12,402,529.41	2,033,031.15	1,030,918.98	3,000.00	283,375.00	149,375.00
Franklin	13,167,235.29	2,033,031.15	880,677.17	3,000.00	283,375.00	31,187.50
Guthrie	12,104,058.82	2,986,433.93	504,105.92	3,000.00	283,375.00	89,437.50
Greene	12,789,588.24	2,681,156.15	599,758.78	3,000.00	283,375.00	43,562.50
Wapello	11,649,235.29	2,986,433.93	703,001.97	3,000.00	283,375.00	46,375.00
Grundy	12,171,529.41	2,033,031.15	596,724.16	3,000.00	283,375.00	1,045,375.00
Poweshiek	11,836,058.82	2,986,433.93	615,706.54	3,000.00	283,375.00	37,625.00
Warren	11,686,176.47	2,986,433.93	786,967.64	3,000.00	283,375.00	96,500.00
Clarke	11,817,647.06	2,986,433.93	768,611.01	3,000.00	283,375.00	25,687.50
Boone	11,447,235.29	2,681,156.15	740,426.77	3,000.00	283,375.00	109,875.00
Madison	11,290,470.59	2,986,433.93	678,996.99	3,000.00	283,375.00	62,812.50
Humboldt	12,769,882.35	2,033,031.15	519,096.53	3,000.00	283,375.00	36,625.00
Wright	12,140,764.71	2,033,031.15	785,059.47	3,000.00	283,375.00	66,750.00
Cerro Gordo	12,261,411.76	1,600,130.72	1,306,416.18	3,000.00	283,375.00	62,562.50
Pocahontas	12,206,352.94	2,033,031.15	648,907.46	3,000.00	283,375.00	59,375.00
Monroe	10,728,117.65	2,986,433.93	738,225.40	3,000.00	283,375.00	33,937.50
Bremer	12,302,529.41	2,033,031.15	478,915.18	3,000.00	283,375.00	43,062.50
Decatur	10,204,705.88	2,986,433.93	651,741.71	3,000.00	283,375.00	34,437.50

County	Flood	Drought	Crop Loss	Extreme Heat	Extreme Cold	Hail
Crawford	9,981,235.29	2,681,156.15	1,421,086.97	3,000.00	283,375.00	145,062.50
Woodbury	8,506,470.59	0.00	1,442,227.29	0.00	625.00	270,937.50
Clayton	12,607,411.76	432,900.43	371,879.32	3,000.00	264,062.50	738,250.00
Monona	9,717,058.82	0.00	1,073,586.48	0.00	625.00	18,500.00
Winnebago	11,544,000.00	2,033,031.15	575,637.56	3,000.00	283,375.00	169,562.50
Emmet	11,587,529.41	2,033,031.15	613,089.86	3,000.00	283,375.00	49,875.00
Worth	11,398,000.00	2,033,031.15	623,062.73	3,000.00	283,375.00	63,250.00
Adair	10,231,352.94	2,986,433.93	568,313.47	3,000.00	283,375.00	103,875.00
Washington	9,232,647.06	2,082,963.92	1,045,200.42	3,000.00	52,187.50	147,937.50
Audubon	10,001,352.94	2,986,433.93	632,374.19	3,000.00	283,375.00	36,000.00
Cass	9,829,882.35	2,986,433.93	609,133.97	3,000.00	283,375.00	125,187.50
Hancock	11,429,000.00	1,600,130.72	694,082.58	3,000.00	283,375.00	48,500.00
Lee	9,654,764.71	2,082,963.92	754,185.10	3,000.00	52,187.50	1,543,937.50
Ringgold	9,374,588.24	2,986,433.93	779,047.66	3,000.00	283,375.00	33,562.50
Appanoose	10,196,647.06	2,986,433.93	589,254.89	3,000.00	283,375.00	36,250.00
Palo Alto	10,607,352.94	2,033,031.15	697,948.32	3,000.00	283,375.00	333,125.00
Davis	9,583,411.76	2,986,433.93	563,846.83	3,000.00	283,375.00	183,625.00
Dubuque	10,566,235.29	2,082,963.92	421,406.95	3,000.00	52,187.50	374,062.50
Union	9,119,058.82	2,986,433.93	562,958.91	3,000.00	283,375.00	80,875.00
Taylor	9,063,235.29	2,986,433.93	896,143.48	3,000.00	283,375.00	64,812.50
Clay	10,963,823.53	0.00	720,456.30	0.00	625.00	1,995,312.50
Adams	9,107,235.29	2,986,433.93	450,135.38	3,000.00	283,375.00	56,937.50
Iowa	10,024,117.65	2,082,963.92	836,467.77	3,000.00	52,187.50	98,500.00
Benton	9,195,882.35	2,082,963.92	797,699.56	3,000.00	52,187.50	230,500.00
Louisa	9,480,882.35	2,082,963.92	818,911.88	3,000.00	52,187.50	414,437.50
Keokuk	9,234,117.65	2,082,963.92	1,355,467.07	3,000.00	52,187.50	63,937.50
Fayette	10,362,117.65	432,900.43	850,758.36	3,000.00	264,062.50	604,937.50
Delaware	9,177,823.53	2,082,963.92	737,036.78	3,000.00	52,187.50	280,375.00
Jones	9,218,823.53	2,082,963.92	686,830.52	3,000.00	52,187.50	35,500.00
Jefferson	9,216,470.59	2,082,963.92	967,840.67	3,000.00	52,187.50	43,750.00
Jackson	8,708,823.53	2,082,963.92	488,987.49	3,000.00	52,187.50	1,284,187.50
Des Moines	9,061,941.18	2,082,963.92	428,732.19	3,000.00	52,187.50	903,375.00
Henry	9,291,176.47	2,082,963.92	725,266.69	3,000.00	52,187.50	25,312.50
Van Buren	9,224,117.65	2,082,963.92	714,514.49	3,000.00	52,187.50	10,000.00
Buchanan	9,288,294.12	1,424,963.92	598,107.42	3,000.00	52,187.50	208,500.00
Winneshiek	9,535,764.71	432,900.43	585,249.65	3,000.00	264,062.50	839,875.00
Mitchell	9,787,764.71	432,900.43	962,460.04	3,000.00	264,062.50	139,625.00
Fremont	9,862,941.18	0.00	1,404,909.43	21,437.50	625.00	37,500.00
Howard	9,521,000.00	432,900.43	737,720.44	3,000.00	264,062.50	52,687.50
Allamakee	9,916,411.76	432,900.43	147,881.76	3,000.00	264,062.50	35,937.50

County	Flood	Drought	Crop Loss	Extreme Heat	Extreme Cold	Hail
Page	9,971,705.88	0.00	673,702.53	21,437.50	625.00	6,875.00
Floyd	8,750,588.24	0.00	783,743.55	3,000.00	264,062.50	228,562.50
Montgomery	9,823,529.41	0.00	541,836.92	21,437.50	625.00	21,562.50
Chickasaw	8,598,705.88	432,900.43	673,400.99	3,000.00	264,062.50	68,937.50
O'Brien	8,238,529.41	0.00	366,078.78	0.00	625.00	891,562.50
Plymouth	7,904,411.76	0.00	1,220,774.01	0.00	625.00	44,375.00
Mills	8,331,764.71	0.00	814,938.74	21,437.50	625.00	16,250.00
Buena Vista	8,256,764.71	0.00	852,990.09	0.00	625.00	29,250.00
Dickinson	8,303,529.41	0.00	504,352.31	0.00	625.00	65,937.50
Osceola	8,208,823.53	0.00	439,253.14	0.00	625.00	110,312.50
Ida	7,903,294.12	0.00	931,117.89	0.00	625.00	7,187.50
Cherokee	7,914,705.88	0.00	539,767.70	0.00	625.00	72,500.00
Shelby	7,536,764.71	0.00	745,706.31	21,437.50	625.00	6,875.00
Pottawattamie	2,543,000.00	0.00	1,342,099.66	21,437.50	625.00	4,375.00
Clinton	281,411.76	2,082,963.92	1,084,956.53	3,000.00	52,187.50	82,125.00
Harrison	3,417,647.06	0.00	878,452.51	21,437.50	625.00	6,250.00
Muscatine	383,235.29	2,082,963.92	796,679.87	3,000.00	52,187.50	36,937.50
Scott	363,117.65	2,082,963.92	441,728.35	3,000.00	52,187.50	26,000.00
Cedar	183,235.29	2,082,963.92	880,956.23	3,000.00	52,187.50	29,562.50
Sioux	491,176.47	0.00	711,246.72	0.00	625.00	207,812.50
Lyon	476,470.59	0.00	562,452.70	0.00	625.00	25,000.00
Annualized Loss	1,054,733,588.24	177,000,000.00	75,668,861.11	390,062.50	17,672,437.50	32,404,937.50
Rank	1	2	3	11	7	5

County Annual Loss Estimation by Natural Hazard (Cont.)

County	Snow & Ice	Tornado	Lightning	Thunderstorm	Windstorm	Total
Linn	80,981.95	541,166.67	4,941.18	642,647.06	26,726.32	58,071,571.48
Marshall	258,825.58	522,033.33	50,176.47	98,882.35	70,225.46	34,012,109.15
Johnson	81,172.37	500,366.67	63,529.41	2,665,176.47	21,930.24	32,429,965.10
Polk	274,351.01	818,766.67	45,235.29	4,145,370.59	68,966.27	27,338,708.29
Hardin	43,087.84	570,833.33	7,529.41	229,764.71	77,141.86	22,628,902.23
Mahaska	269,380.01	451,566.67	19,823.53	92,882.35	53,314.34	18,970,977.85
Webster	43,494.03	68,566.67	9,000.00	437,117.65	77,801.36	18,648,504.00
Story	260,292.61	562,800.00	11,529.41	199,941.18	72,258.21	18,530,180.66
Dallas	280,130.36	71,783.33	9,705.88	507,352.94	65,122.15	18,280,559.37
Carroll	58,554.35	34,933.33	21,764.71	1,430,941.18	71,591.97	18,239,999.45
Butler	40,909.59	1,339,850.00	0.00	43,117.65	78,912.84	18,180,039.44
Jasper	258,533.91	104,266.67	12,882.35	166,058.82	64,445.88	18,069,984.17

County	Snow & Ice	Tornado	Lightning	Thunderstorm	Windstorm	Total
Calhoun	40,058.46	512,200.00	2,411.76	361,823.53	73,494.91	17,896,635.56
Sac	58,840.03	84,000.00	294.12	84,176.47	68,812.56	17,682,260.87
Black Hawk	41,452.00	940,466.67	63,941.18	235,529.41	75,213.31	17,626,168.89
Marion	279,138.50	38,400.00	588.24	126,529.41	60,321.01	17,538,491.27
Tama	258,918.81	553,916.67	5,882.35	161,176.47	65,326.64	17,508,758.80
Kossuth	27,168.27	1,040,716.67	3,764.71	145,352.94	82,045.08	17,491,474.51
Wayne	255,343.60	652,616.67	2,941.18	58,117.65	50,012.11	17,254,766.34
Lucas	270,814.08	423,916.67	176.47	30,411.76	57,409.25	16,811,273.81
Hamilton	49,103.80	681,383.33	4,117.65	67,705.88	85,482.77	16,790,022.97
Franklin	50,643.63	52,400.00	2,941.18	52,529.41	81,089.31	16,638,109.65
Guthrie	279,126.42	50,466.67	0.00	252,882.35	68,341.68	16,621,228.30
Greene	65,613.45	16,383.33	0.00	36,352.94	67,238.44	16,586,028.83
Wapello	254,055.44	486,433.33	3,235.29	55,235.29	46,482.78	16,516,863.34
Grundy	42,428.95	108,650.00	5,882.35	102,705.88	73,030.68	16,465,732.60
Poweshiek	256,940.99	221,383.33	1,764.71	89,235.29	60,031.56	16,391,555.18
Warren	272,853.16	43,283.33	5,411.76	95,000.00	56,919.05	16,315,920.35
Clarke	270,166.66	33,133.33	0.00	29,235.29	56,330.82	16,273,620.60
Boone	264,308.88	510,866.67	2,352.94	100,647.06	70,980.68	16,214,224.44
Madison	274,510.68	8,850.00	1,176.47	413,176.47	60,912.58	16,063,715.21
Humboldt	46,368.50	90,050.00	0.00	31,588.24	77,531.97	15,890,548.74
Wright	43,863.89	425,316.67	4,235.29	21,529.41	80,327.47	15,887,253.06
Cerro Gordo	41,360.56	69,666.67	32,176.47	118,000.00	88,809.90	15,866,909.75
Pocahontas	43,754.59	170,000.00	1,470.59	46,529.41	69,805.50	15,565,601.64
Monroe	270,988.02	436,833.33	0.00	25,588.24	50,863.36	15,557,362.43
Bremer	40,831.67	108,816.67	764.71	153,529.41	74,818.13	15,522,673.83
Decatur	255,300.61	925,933.33	5,588.24	46,058.82	49,775.47	15,446,350.49
Crawford	57,695.60	126,583.33	4,411.76	543,823.53	64,238.44	15,311,668.58
Woodbury	23,124.36	4,249,700.00	7,705.88	793,470.59	13,455.36	15,307,716.56
Clayton	16,013.91	435,633.33	6,176.47	304,647.06	21,480.47	15,201,455.26
Monona	15,805.00	4,178,750.00	32,352.94	82,000.00	5,487.82	15,124,166.07
Winnebago	37,907.18	153,383.33	12,352.94	71,882.35	81,115.29	14,965,247.31
Emmet	28,420.62	51,633.33	5,294.12	64,058.82	72,865.87	14,792,173.18
Worth	37,008.83	217,533.33	1,470.59	31,647.06	80,305.19	14,771,683.89
Adair	273,991.51	78,233.33	2,058.82	67,823.53	67,646.49	14,666,104.03
Washington	27,912.43	665,966.67	294.12	1,328,529.41	11,785.15	14,598,424.17
Audubon	276,470.57	1,450.00	0.00	204,882.35	62,240.62	14,487,579.60
Cass	276,219.93	81,133.33	0.00	217,235.29	68,752.11	14,480,353.42
Hancock	40,263.56	206,550.00	5,000.00	54,000.00	78,194.93	14,442,096.78
Lee	17,423.68	48,416.67	6,764.71	214,000.00	12,233.33	14,389,877.11
Ringgold	255,349.95	495,633.33	1,764.71	95,000.00	58,109.58	14,365,864.90

County	Snow & Ice	Tornado	Lightning	Thunderstorm	Windstorm	Total
Appanoose	54,048.77	104,800.00	4,823.53	51,647.06	41,767.43	14,352,047.67
Palo Alto	43,499.71	108,900.00	18,823.53	69,000.00	76,437.63	14,274,493.28
Davis	37,971.82	487,566.67	3,529.41	98,705.88	41,767.43	14,273,233.73
Dubuque	19,048.62	482,183.33	352.94	179,470.59	11,785.15	14,192,696.80
Union	262,066.17	508,833.33	3,235.29	79,294.12	64,818.21	13,953,948.79
Taylor	268,992.67	155,216.67	13,941.18	83,117.65	61,444.08	13,879,712.44
Clay	20,274.36	32,383.33	1,823.53	109,705.88	18,563.00	13,862,967.44
Adams	256,267.28	490,416.67	0.00	62,352.94	68,271.14	13,764,425.13
Iowa	44,458.62	491,600.00	3,294.12	58,235.29	13,667.50	13,708,492.37
Benton	150,260.76	66,300.00	58.82	1,024,470.59	12,832.21	13,616,155.72
Louisa	73,412.43	465,950.00	0.00	130,764.71	11,785.15	13,534,295.43
Keokuk	30,254.24	494,200.00	1,470.59	45,647.06	12,196.91	13,375,442.45
Fayette	20,282.65	557,900.00	764.71	92,823.53	19,925.67	13,209,472.99
Delaware	22,552.64	542,400.00	3,529.41	219,058.82	11,785.15	13,132,712.75
Jones	32,428.89	591,216.67	882.35	240,058.82	26,832.21	12,970,724.41
Jefferson	30,365.55	470,250.00	1,470.59	35,235.29	13,667.50	12,917,201.61
Jackson	21,321.74	64,466.67	1,176.47	107,352.94	29,255.73	12,843,723.50
Des Moines	30,295.86	69,216.67	10,529.41	175,823.53	12,491.03	12,830,556.29
Henry	11,306.80	26,916.67	4,411.76	93,470.59	11,785.15	12,327,798.06
Van Buren	4,798.68	73,966.67	1,176.47	26,117.65	12,792.15	12,205,635.17
Buchanan	44,488.89	106,916.67	7,411.76	214,058.82	13,596.91	11,961,526.01
Winneshiek	16,820.25	103,233.33	9,705.88	132,764.71	18,454.89	11,941,831.35
Mitchell	20,108.38	14,583.33	0.00	135,588.24	18,745.99	11,778,838.61
Fremont	93,026.67	104,716.67	6,352.94	3,705.88	11,377.51	11,546,592.78
Howard	23,030.57	61,066.67	470.59	85,470.59	24,618.73	11,206,028.02
Allamakee	17,077.75	55,216.67	176.47	72,470.59	18,062.93	10,963,198.37
Page	1,407.50	196,883.33	2,058.82	28,352.94	11,848.10	10,914,896.61
Floyd	23,238.90	439,000.00	0.00	95,117.65	20,491.09	10,607,804.42
Montgomery	93,074.17	24,300.00	588.24	3,294.12	9,495.16	10,539,743.01
Chickasaw	24,176.40	83,350.00	2,941.18	124,647.06	18,050.11	10,294,172.05
O'Brien	21,171.23	60,333.33	0.00	79,117.65	12,455.36	9,669,873.26
Plymouth	24,061.86	239,650.00	588.24	130,529.41	12,984.77	9,578,000.05
Mills	93,437.29	10,766.67	14,705.88	1,647.06	9,495.16	9,315,068.01
Buena Vista	23,209.36	56,383.33	34,117.65	19,176.47	11,651.44	9,284,168.04
Dickinson	12,914.98	184,633.33	2,941.18	78,411.76	18,563.00	9,171,908.49
Osceola	11,416.02	151,800.00	34,411.76	100,647.06	16,553.20	9,073,842.21
Ida	20,624.36	95,916.67	588.24	40,529.41	12,386.73	9,012,269.91
Cherokee	22,684.36	85,500.00	1,470.59	30,882.35	15,602.42	8,683,738.30
Shelby	106,792.92	93,883.33	3,235.29	68,294.12	5,487.82	8,589,101.99
Pottawattamie	107,233.54	1,422,333.33	0.00	17,823.53	9,762.54	5,468,690.10

County	Snow & Ice	Tornado	Lightning	Thunderstorm	Windstorm	Total
Clinton	33,512.37	640,216.67	1,764.71	415,941.18	96,479.26	4,774,558.90
Harrison	106,824.17	81,550.00	0.00	65,941.18	9,902.60	4,588,630.01
Muscatine	34,584.30	303,133.33	58.82	168,882.35	23,059.66	3,884,722.56
Scott	22,710.82	602,600.00	26,294.12	139,529.41	23,059.66	3,783,191.42
Cedar	61,062.69	146,166.67	9,705.88	114,470.59	26,491.03	3,589,802.30
Sioux	23,487.48	159,916.67	2,352.94	121,470.59	5,196.94	1,723,285.31
Lyon	11,064.77	158,200.00	0.00	25,411.76	3,726.35	1,262,951.17
Annualized Loss	9,916,799.62	37,230,550.00	730,117.65	23,169,429.41	4,249,224.34	1,433,166,007.86
Rank	8	4	10	6	9	

4.2 Estimating Potential Losses of State Facilities

The Iowa Homeland Security and Emergency Management Division maintain a listing of the state's Critical Infrastructure and Key Resources (CI/KR). This listing represents systems or assets in Iowa that if attacked would result in catastrophic loss of life and/or catastrophic economic loss. The listing ranges across 17 sectors, from agricultural to energy to health care and transportation. In following national trends, the majority of the assets is privately owned and comprises approximately 2/3 of the listing. Close to 550 assets are publicly owned, either at the local, state or federal levels. The vast majority (500) of these publicly owned assets are either state-owned or locally owned with state offices within the facility, e.g. County Courthouses.

In addressing losses to state facilities, analysis was performed using a Geographic Information System (GIS) using the CI/KR asset listing and available hazard data. The two hazard datasets were FEMA Q3 Floodplain data and locations of all tornados reported in Iowa from 1950-1995, provided by the Iowa Environmental Mesonet.

Since the FEMA Q3 floodplain data does not exist for all counties in Iowa, county-by-county samples covering 40% of Iowa's population were used to develop statewide numbers. Of the approximately 500 state-owned or used facilities in the CI/KR database, 20 were located in the 100 year flood zone. This amounts to 4% of the most critical state assets. In terms of historical tornado data, 95 facilities are located within one mile of the occurrence of an F-2 or greater tornado (1950-1995). This is close to one out of every five (21%) of Iowa's most critical state-owned or used facilities.

To further assess estimated losses of state facilities, available building information was collected from the Iowa Department of Administrative Services, the primary state agency responsible for building services. The information containing in the database is not intended to represent critical assets. Also, the database is not inclusive of State government but does represent a good cross section of the best data available. This building inventory represents a little less than 900 buildings, 70+ sites, 11.7 million square feet and a replacement value of $2.5 billion, give or take a few million.

Information provided in the building database covers 21 percent of the state's assets and reports on the following data fields:

- State Agency
- Location
- Construction Material
- Electric / Gas Provider
- Water Provider
- Year Built
- Number of Floors
- Primary Tenant
- Building Intended Use
- Building Current Use

The scope covered by the database in terms of state agencies represents about 50 percent of those owning property and with associate responsibilities. These state agencies include:

- Capitol Complex (excluding Judicial, including Ankeny Labs)
- Terrace Hill
- Iowa Department of Corrections
- Iowa Department of Human Services
- Department of Public Safety
- Iowa Public Television
- Iowa Veteran's Home
- Iowa Department of Cultural Affairs
- Iowa Law Enforcement Academy
- Iowa Department of Commerce, Alcoholic Beverages Division

To expand this analysis and estimates of loss to state facilities, comparable data fields to those described prior will be collected from the following State agencies:

- Iowa Board of Regents
- Iowa Department of Public Defense
- Iowa Department of Natural Resources
- Iowa Department of Transportation
- Iowa Department for the Blind
- Iowa State Lottery
- Iowa Public Employees Relations Board
- Iowa Finance Authority
- Judicial Branch

The following table shows the number of state buildings by county and their associated size and replacement cost.

County Location of State Building	Number of Buildings	Gross Area	Replacement Cost
Allamakee	6	23,960	$2,381,453
Black Hawk	2	5,500	893,116
Boone	89	828,599	119,680,887
Buchanan	38	659,083	160,373,439
Buena Vista	1	3,112	275,669

County Location of State Building	Number of Buildings	Gross Area	Replacement Cost
Calhoun	29	166,788	20,237,105
Cass	2	1,650	138,342
Cedar	2	4,024	417,774
Cerro Gordo	2	3,216	542,781
Cherokee	45	580,215	$97,349,030
Clarke	1	10,923	$967,587
Clay	2	7,368	$660,006
Crawford	2	8,704	$1,398,598
Dallas	3	11,019	$1,150,711
Decatur	1	64	$2,566
Dickinson	2	1,260	$146,693
Fayette	17	41,430	$4,403,067
Hamilton	1	64	$2,566
Hardin	39	323,272	$43,752,183
Henry	45	574,688	$94,537,274
Humboldt	2	2,114	$222,759
Jackson	2	1,608	$143,455
Jasper	41	359,992	$66,483,259
Jefferson	1	1,200	$106,299
Johnson	21	470,106	$103,351,440
Jones	82	680,688	$325,716,092
Lee	85	686,929	$109,473,452
Linn	2	7,960	$1,249,408
Louisa	1	800	$70,866
Lyon	1	168	$17,148
Marshall	50	673,662	$102,687,020
Mills	90	1,042,284	$139,867,005
Mitchell	3	4,846	$529,501
Monroe	1	64	$2,566
Osceola	1	168	$17,148
Page	46	830,424	$163,827,032
Polk	72	3,188,774	$855,547,856
Pottawattamie	8	30,327	$3,935,232
Scott	5	17,018	$2,357,040
Tama	20	133,028	$15,655,033
Taylor	1	64	$2,566
Van Buren	1	168	$17,148
Wapello	5	6,033	$762,207
Webster	21	339,707	$73,748,296
Winneshiek	1	168	$17,148
Woodbury	3	4,311	$457,888
Wright	1	1,440	$127,559
Total	**896**	**11,738,990**	**$2,515,703,272**