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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 (HARA) 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 a Hazard Analysis and Risk Assessment (HARA) is to identify and prioritize threats and hazards that pose risk to the health and safety of Iowa's citizens, property, and economy. This HARA both describes the methodology the State of Iowa entered into in developing the HARA 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. This 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 is a shared duty of the state and local communities. 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 assessment is validated by detailed, local-level analysis. This is not only a good way of conducting business; it is required by federal regulations.

The Iowa Department of Homeland Security & Emergency Management (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 threats and 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 unaware of because they haven't impacted 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 identify the assets that can be damaged or affected by the hazard event. For detailed assessments, the inventory would 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 the potential impact of a hazard? 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 specific 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. There may also be potential community-wide impacts from events such as windstorms or winter storms. It is important to note 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? The likely cascading effects of certain hazards is to be considered for emergency response planning, and the SHMT considered cascading effects in the discussion and analysis of hazards. Threats and hazards can create direct damages, indirect effects, and possibly trigger secondary hazards. 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 re-routed, 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. 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?

With completion of steps 1-3, the threats and hazards can be sorted by composite score. The hazard with a higher score represents the hazard with a higher risk to the community. Roughly 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 lowest priority group. Adjustments can be made to this preliminary ranking by the planning team. The HARA can be used to set priorities, but the SHMT makes 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 hazard impacts that cannot be mitigated need to be addressed in the response plan and the recovery plan. The HARA process is helps in 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 might occur.
- The extent of the potential damage.
- Portions of the State that could be impacted.

When the data for each hazard is combined officials can determine its relative vulnerability to other hazards, potential risks, and the impacts on Iowa. This will allow assignment of priorities for emergency management needs and mitigation efforts.

Current HARAs from local jurisdictions as well as input from the SHMT were used to accumulate a list of hazards that occur in the State. Along with gathering information from local plans, other resources (including data from the NCDC website) were used to gather data for analysis. A well-written local hazard mitigation plan includes a list of high-risk hazards in that jurisdiction. The plan will also include strategies to minimize the risk from those identified hazards. A survey of local hazard mitigation plans from across the State contributed to the state hazard analysis and risk assessment.

The hazard identification portion of the HARA consists of an inventory of threats and hazards that could potentially impact the State of Iowa. The planning team developed a list of potentially significant hazards. Some hazards were discussed, but ultimately left out of the hazards list for the state. Space weather (solar flares) is a relatively new topic of concern that needs more study to determine the consequences and likelihood. Space weather likely has a probability close to zero, but worst case scenario could lead to catastrophic infrastructure failure on a regional scale. Ultimately the consequences of space weather were determined to fall under infrastructure failure, and large scale power outages could also be caused by terrorism in the form of electro-magnetic pulse or cyber terrorism. A similarly difficult to quantify hazard discussed is climate change. Climate change may be causing more frequent and severe storms, but these effects are covered by other individual hazards included in the plan. Where data exists possible climate change trends are included in the specific hazard profile, and climate change trends are also identified in the Community Profile.

Additionally some hazards in the previous iteration of the Iowa mitigation plan were consolidated into general categories for the purpose of the HARA. The SHMT elected to combine Tornado and Windstorm into a single hazard. Levee and Dam failure also became a single hazard. Hailstorm was combined with Thunderstorm/Lightning to form a single hazard. As a result of this process the SHMT identified 20 hazards in three categories with a

total of 14 natural hazards, 5 technological hazards, and 1 human caused threat as listed below.

2013 Hazards List

Natural

- River Flooding
- Tornado/Windstorm
- Severe Winter Storm
- Flash Flood
- Animal/Plant/Crop Disease
- Thunderstorm/Lightning/Hail
- Drought
- Human Disease
- Extreme Heat
- Grass/Wild Land Fire
- Sinkholes
- Landslide
- Earthquake
- Expansive Soils

Technological

- Levee/Dam Failure
- HAZMAT Incident
- Radiological Incident
- Transportation Incident
- Infrastructure Failure

Human Caused

- Terrorism

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 the hazard scoring objectively a number of factors were taken into account for scoring purposes:

- Probability of occurrence in any given year;
- Magnitude and Severity of impact;
- Amount of warning time before the hazard occurs;
- Duration of the hazard's impact on the state.

The economic impact of disasters is generally restricted to major disasters involving both state and federal funding. Smaller, less significant events often do not get the economic impact of the incident captured effectively. For these smaller events, there is a greater reliance on local information and records of impacts.

Members of the SHMT were asked to review and 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 HARA seeks to strike a balance between disparate evaluation criteria using a scoring system. This means the evaluation of low probability-high impact events versus high probability-low impact events using a systematic approach. Each category of a particular hazard is rated on a scale of one (1) through four (4). It was important to score each hazard as a single event. Impacts from that particular hazard were considered in the analysis, and possible cascading was discussed. The effects of applying an additional methodology to analyze the effects of cascading hazards was determined to have little significant effect on the overall scoring of hazards and analysis of vulnerability to individual hazards, and was not included.

The scale of one (1) through four (4) was used in all of the scoring guide tables outlined on pages 6 and 7 of this section because of the large variation in historical occurrences, probabilities, percentages of vulnerabilities, spatial

extent, the number of casualties, or the value of property damaged. Often this data is either not available or would have been impossible to extract from aggregate data. Using this scale provides an intuitive option for comparison of vastly different types of threats and hazards. Other hazard analyses across the country have used "high, medium, and low" criteria to score categories. Using a quantifiable system gives 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 continue to use previously established 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. Continuity between plan drafts is also maintained by continuing to use the same criteria weighting system.

Using the four elements described above, the formula the SHMT determined to be the most effective for the Iowa HARA 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)

Probability is more than just a measure of how many times has a hazard has 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 history of weather events, as does the State Climatologist's office. Additional hazard specific sources include USDA, National Interagency Fire Center, and a variety of areas of expertise at the Iowa DNR. 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. Some threats or hazards are more difficult to estimate the probability of future occurrence. Mitigation efforts can reduce vulnerability to hazards and enhance resiliency, potentially enough to change a hazard score. Conversely, hazards that have not occurred in the past could still present themselves to the community in the future. The table on the following page shows the scoring criteria for probability.

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 (below 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 19% probability in any given year (less than 1 in 5 chance of occurring), history of events is greater than or equal to 10% but less than 20% for 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 or equal to 20% and not more than 33% 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

Warning Time

The speed of onset reflects 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 or 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	More than12 to 24 hours warning time
3	6 to 12 hours warning time
4	Minimal or no warning (Less than 6 hours warning)

Magnitude / Severity

The impact severity of a hazard event (past and perceived) is related to the vulnerability. Relevant factors include when the event occurs (year-round, seasonal), the location affected, community resilience, and the effectiveness of the emergency response and disaster recovery efforts. Quantifying impact severity is difficult to address at multiple levels simultaneously. The scale for this plan is statewide.

Magnitude / Severity: Assessment of severity in terms of injuries and fatalities, personal property, and infrastructure with regard to vulnerability to the hazard.		
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	More than 25% and up to 50% of property severely damaged, shutdown of facilities and services for a least 2 weeks, and/or injuries/illnesses that result in permanent
4	Catastrophic	More than 50% of property severely damaged, shutdown of facilities and services for more than 30 days, and/or multiple deaths

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... .

To determine what threats and hazards affect the State of Iowa, information was gathered from several sources. Local plans from Iowa jurisdictions provided a great amount of information on hazards that concern local jurisdictions. In addition, SHMT members, representing a variety of 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 subject matter experts in each of their respective departments, they give valuable information throughout the hazard identification and profiling process for the process of identifying and profiling hazards.

Some data limitations exist for the location and profile of certain hazards. These limitations will be addressed where possible in the planning process as data comes available for use by the SHMT. New data will be analyzed for inclusion in future updates. Along with incorporating any new studies or technical information for all natural hazards, including HAZUS studies, reports from other Federal or State agencies that relate to the location of natural hazards, past hazard events, and the probability of future hazards will be analyzed.

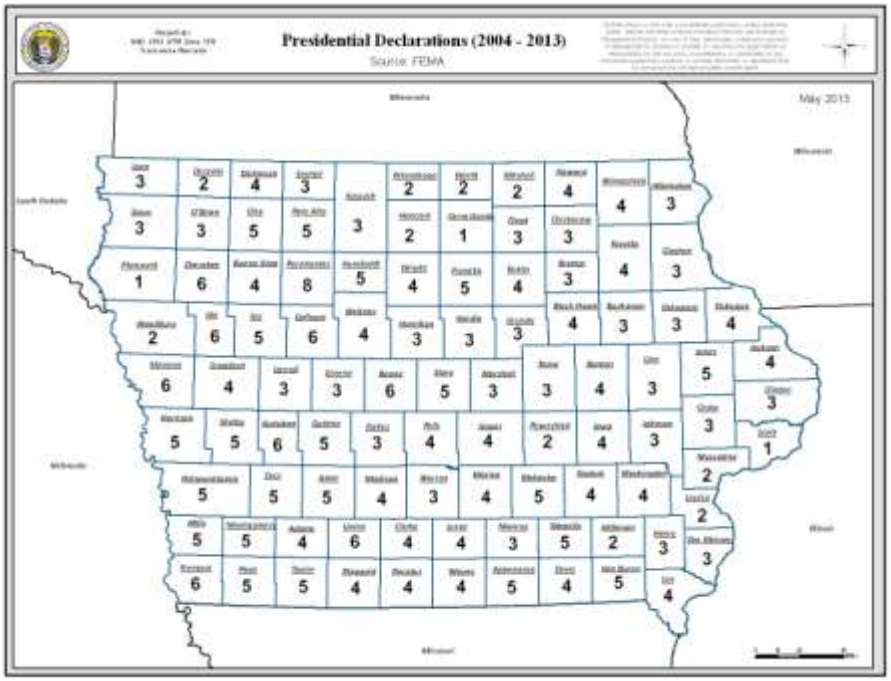
In addition, information from local risk assessments was (and will be) incorporated into the planning process as new data come available. This is a cyclical process as local plans are approved and expire. Analysis of specific local plans and the Local Mitigation Plan Data Collection Worksheets are methods used for gleaning information from local planning sources. The State requires recipients of planning grants to submit Data Collection Worksheets.

For this update, information gathered from local plans and the involvement of the SHMT in the overall planning process resulted in the identification of 20 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 HARA process the SHMT used the 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 assess each of the 20 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. Each hazard has a different period for which historical occurrences have been collected, so each hazard was analyzed in context of their respective years of occurrence data. Local, state, and federal government agencies are continually improving on their record keeping for 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.

Probability reflects the estimated frequency of the hazard occurring in any given year. The historical occurrence can sometimes be extrapolated into the future, but this methodology may result in inaccuracies. Mitigation can reduce vulnerability to hazards and enhance resiliency, potentially enough to change a hazard score. There may also 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.



The map above shows the number of Presidential Disaster Declarations by county in Iowa from 2004 - 2013.

2.1 Animal/Crop/Plant Disease

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 transmitted from animal to animal or plant to plant represents an animal/crop/plant disease. A disease outbreak will likely have a severe economic implication and/or public health impact well beyond the borders of Iowa. A crop/plant pest infestation will likely have severe economic implications, cause significant production losses, or significant environmental damage.

The introduction of some high consequence diseases could significantly limit or eliminate our ability to move, slaughter, and export animals and animal products. An outbreak will have wide spread economic and societal implications for our state, the nation, and potentially the world. Response and recovery to infectious animal disease outbreaks will be lengthy, and many producers may never be able to return to business. There would also 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 just the 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.

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

Surface wind speeds (standard measurement height of 32 feet) over Iowa have been declining which provides less crop ventilation and more heat stress

for plants and animals. In addition reduced winds create favorable conditions for survival and spread of unwanted weeds, fungi, pests and pathogens. Waterlogged soil conditions during early plan growth often result in shallower root systems that are more prone to disease, nutrient deficiencies, and drought stress later in the season. In 2010 wet soil conditions are cited as cause for the epidemic of soybean sudden death syndrome that occurred that year. Other crop diseases and pests (such as Soybean Asian rust) that have not been observed in Iowa as of yet, but if warmer winters persist could expand their ranges to include Iowa.

The SHMT analysis evaluated the probability that a high impact occurrence of animal/crop/plant disease still has a low probability to occur in any given year. For the purposes of this plan a high impact animal/plant/crop disease event would cause major disruption or shut down statewide processing sectors, halt international trade, and last multiple years. Iowa is a productive agricultural state producing both crop and livestock with large portion of the Iowa economy related to agriculture. Due to the severity of potential economic agricultural losses this hazard is of particular concern to Iowa.

2.2 Dam/Levee Failure

The SHMT elected to combine the formerly independent hazards of Dam Failure and Levee Failure into a single hazard due to their similarities to reduce redundancy. In the 2010 Plan as separate hazards dam failure had a probability rating of 1 and magnitude rating of 4. Levee failure scored a 3 on both measures. The newly combines hazard scoring is as follows.

Dam/Levee Failure - Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
2	**4**	**4**	**4**	**3.10**

Dam/Levee failure is the uncontrolled release of water resulting from a structural failure in a dam, wall, dike, berm, or area of elevated soil that causes flooding. Possible causes of the breach could include flooding, earthquakes, blockages, landslides, lack of maintenance, improper operation, poor construction, vandalism, terrorism, erosion, piping, saturation, or under seepage.

Dams are constructed for a variety of uses, including flood control, erosion control, water supply impoundment, hydroelectric power generation, and recreation. In Iowa, dams are classified according to the downstream damages that would occur if that dam were to fail. The more risk, the higher the standards that have to be met when that dam is constructed or modified. There are 3 dam classifications: High Hazard, Moderate Hazard and Low Hazard. **These classifications do not describe the current condition of the dam.** High Hazard class dams have to meet the state's highest level of criteria and are inspected on a 2 year cycle. 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):

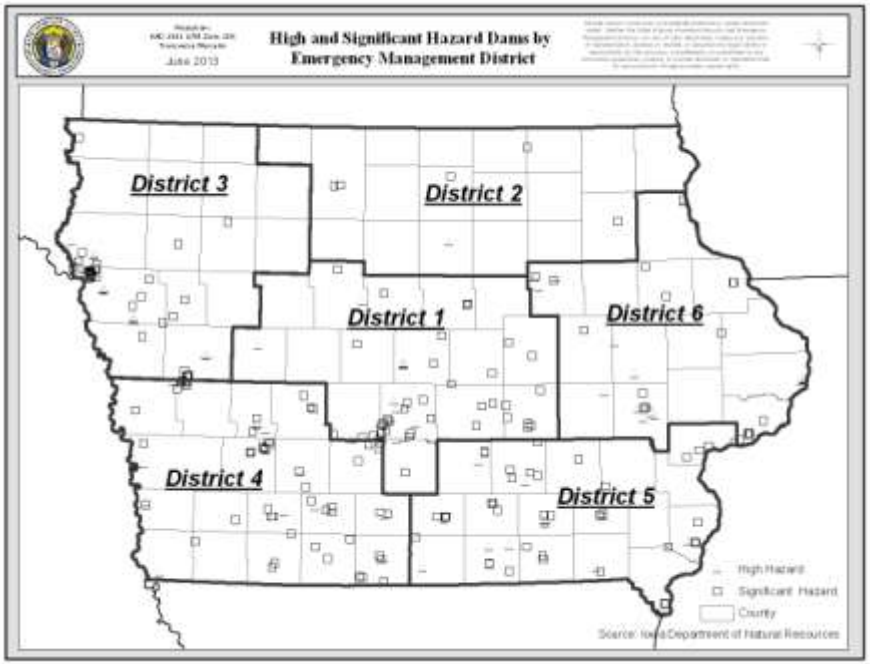
- **High Hazard** – Dams are classified as High Hazard when it is located in an area where dam failure may create a serious threat of loss of human life.

- **Moderate (Significant) Hazard** – A Moderate Hazard Dam is where failure may damage isolated homes or cabins, industrial or commercial buildings, moderately traveled roads, interrupt major utility services, but are without substantial risk of loss of human life. Dams are also classified as Moderate Hazard where the dam and its impoundment are 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.

- **Low Hazard** – Low Hazard dams are classified as such where damages from a failure would be limited to loss of the dam, livestock, farm outbuildings, agricultural lands and lesser used roads and where loss of human life is considered unlikely.

As previously stated 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 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 approximately 3,800 dams on the State of Iowa Dam Inventory. There are 269 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; they are then measured at the top of the dam. Federally owned dams are not subject to state inspection. The 269 major 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. The map above illustrates the planning districts and dams within them.

There are 9 high hazard and 2 significant hazard Federal dams identified on the State Major Dam Inventory. The Planning District, Potential Hazard, Number of Potential Hazard, County, and Number of the Federal Dams in the County are shown in the chart below:

Planning District	Hazard Potential (#)	Counties (# of Dams)
1	High (4)	Polk (4),
5	High (2)	Appanoose (1), Marion (1)
5	Significant (2)	Des Moines (1), Clayton (1)
6	High (3)	Dubuque (1), Johnson (1), Scott (1)

The following chart shows Planning Districts 1 and 6 have the highest number of high hazard dams (27). 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 Districts	*# of High Hazard Dams*	*Counties (# of Dams)*
1	27	Carroll(1), Dallas(6), Polk(13), Poweshiek(2), Story(3), Warren(1), Webster(1)
2	1	Franklin
3	20	Buena Vista(1), Crawford(2), Plymouth(4), Sioux(1), Woodbury(12)
4	16	Adair(1), Adams(1), Audubon(2), Clarke(2), Decatur(1), Fremont(1), Harrison(1), Madison(1), Mills(1), Pottawattamie(2), Union(2)
5	12	Appanoose(1), Des Moines(3), Lucas(1), Marion(1), Van Buren(1), Wapello(5)
6	27	Black Hawk(5), Clayton(3), Clinton(4), Dubuque(2), Iowa(1), Jackson (1), Johnson(5), Linn(2), Scott(4)

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

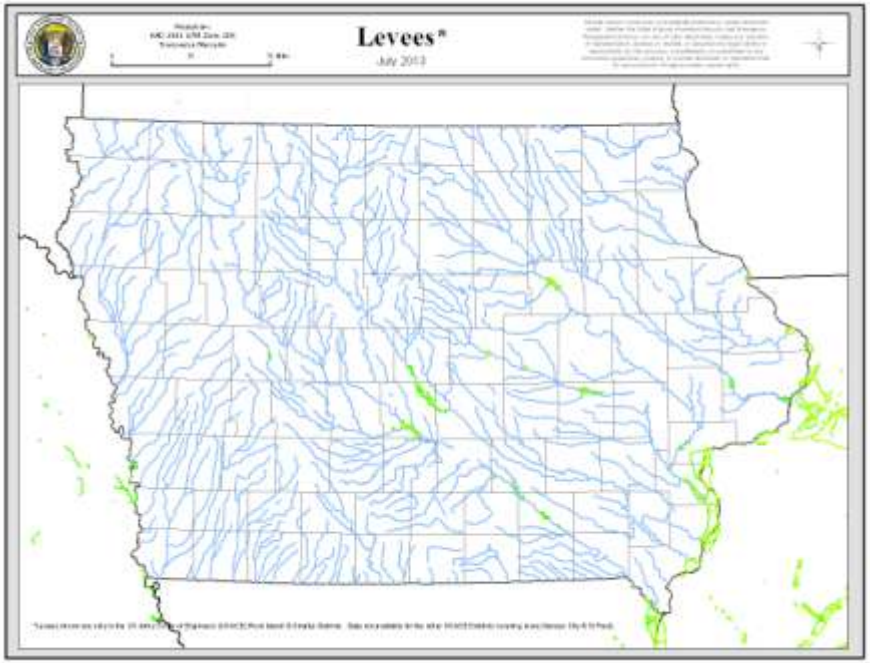
Planning District	# Significant Hazard Dams	Counties (# of Dams)
1	52	Boone (1), Dallas (9), Greene (1), Hamilton (1), Hardin (2), Jasper (5), Marshall (3), Polk (16), Poweshiek (6), Story (3) Tama (2), Warren (2), Webster (1)
2	5	Cerro Gordo (1), Fayette (1), Howard (1), Kossuth (2)
3	38	Buena Vista (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	47	Appanoose (3), Davis (3), Des Moines (6), Henry (1), Jefferson (2), Keokuk (1), Lee (2), Lucas (3), Mahaska (6), Marion (4), Monroe (2), Muscatine (6), Van Buren (1), Wapello (2), Washington (1), Wayne (4)
6	24	Benton (1), Black Hawk (2), Clayton (2), Delaware (2), Dubuque (4), Jackson (1), Johnson (5), Linn (2), Scott (5)

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. 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 Delhi 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. There was concern during the very wet period of 1993 that water would overtop the dam at 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. While technically not a dam failure the flooding caused on the Missouri River in 2011 by the controlled release of water from Gavins Point Dam in South Dakota illustrated how Iowa could be affected by a dam failure that occurred outside the state borders.

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.

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. This increases hydrostatic forces, and the water also 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. 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 approaching 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 following map shows geographic locations of levees collected in the State of Iowa.



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 rate of failure of a levee or floodwall is difficult to predict with sudden failure a possibility. In 2011 a levee along the Missouri River failed, threatening the City of Hamburg, Interstate 29, rural residences, county roads, and crops. 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 National Levee Database (NLD) lists 90 levees in Iowa. The following table shows the Planning District, County, and number of NLD levees. Some levees exist in multiple counties.

District	County	NLD Levees
1	Dallas	2
	Marshall	3
	Polk	6
	Tama	1
	Warren	1
2	Fayette	1
	Winneshiek	2
3	Crawford	2
	Ida	2
	Monona	15
	Sioux	2
	Woodbury	7
4	Fremont	6
	Harrison	3
	Mills	3
	Montgomery	1
	Pottawattamie	6
5	Des Moines	6
	Lee	2
	Louisa	3
	Muscatine	2
	Wapello	3
6	Black Hawk	6
	Clayton	4
	Clinton	2
	Dubuque	2
	Iowa	2
	Jackson	2
	Jones	1
	Scott	1

The SHMT put the probability that a Dam/Levee failure event associated with heavy flooding occurring in Iowa is between 10% and 20% in a given year.

2.3 Drought

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 abnormally low precipitation 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 occurrences 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.

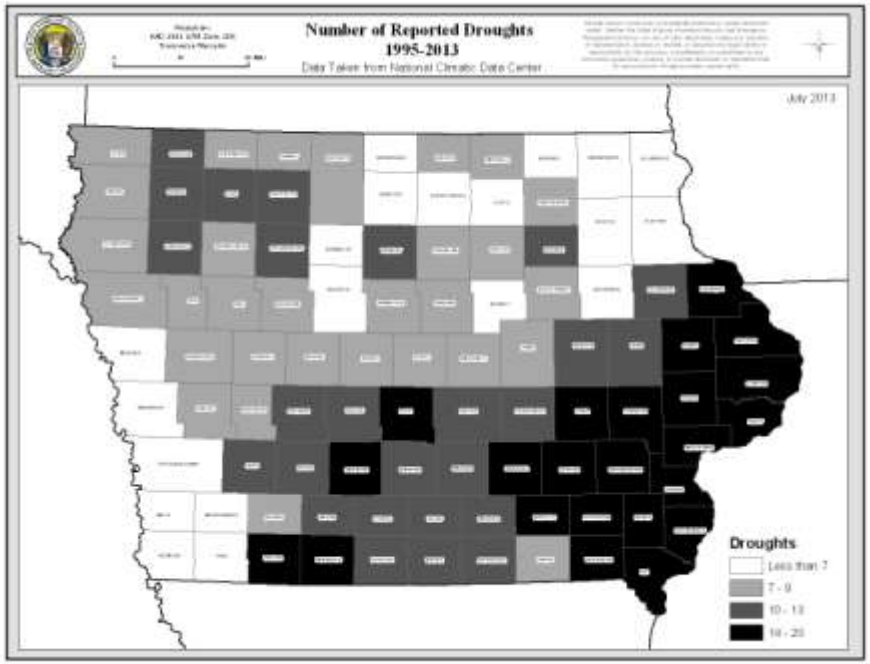
Droughts can be spotty or widespread and last from a few weeks to a period of years. A prolonged drought can have a serious impact on a community's water supply and economy. Increased demand for water and electricity may result in shortages of resources. Moreover, food shortages may occur if agricultural 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 (NCDC), Iowa had 23 periods of drought from 1995-2011. During that period there was $2.010 billion in crop damages resulting from drought periods and over $645 million in property damage. In 2012 alone crop damages from drought were $4.992 billion.

While some may have been more severe than others, agricultural areas are impacted much more than the metropolitan areas where impacts were mostly indirect. The following chart shows drought periods and the amount of the state affected.

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 – 12/31/99	11 percent of the state
2/1/00 – 4/30/00	11 percent of the state
8/14/00 – 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
9/1/11 – 9/30/11	7 percent of the state
10/1/11 – 10/31/11	7 percent of the state
7/1/12 – 7/31/12	62 percent of the state
8/1/12 – 10/31/12	78 percent of the state
11/1/12 – 11/30/12	44 percent of the state
12/1/12 – 1/31/13	20 percent of the state

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 severe 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 map above shows the number of drought events recorded by county.

Drought severity is measured by multiple monitoring indices. The table below shows how they relate to each other.

Drought Severity	Return Period (years)	Description of Possible Impacts	Drought Monitoring Indices		
			Standardized Precipitation Index (SPI)	NDMC* Drought Category	Palmer Drought Index
Minor Drought	3 to 4	Going into drought; short-term dryness slowing growth of crops or pastures; fire risk above average. Coming out of drought; some lingering water deficits; pastures or crops not fully recovered.	-0.5 to -0.7	D0	-1.0 to -1.9
Moderate Drought	5 to 9	Some damage to crops or pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested.	-0.8 to -1.2	D1	-2.0 to -2.9
Severe Drought	10 to 17	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-1.3 to -1.5	D2	-3.0 to -3.9
Extreme Drought	18 to 43	Major crop and pasture losses; extreme fire danger; widespread water shortages or restrictions.	-1.6 to -1.9	D3	-4.0 to -4.9
Exceptional Drought	44+	Exceptional and widespread crop and pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells creating water emergencies.	less than -2	D4	-5.0 or less

*NDMC - National Drought Mitigation Center

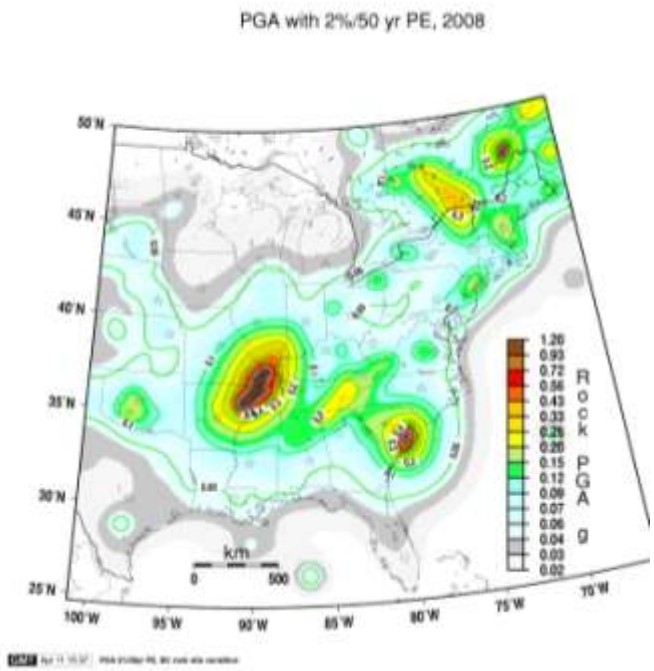
The SHMT analysis evaluated the statewide probability of future droughts in Iowa in the order of magnitude of between -3.0 to -3.9 Palmer drought severity index (severe drought event) at between 10% and 19% probability in any given year.

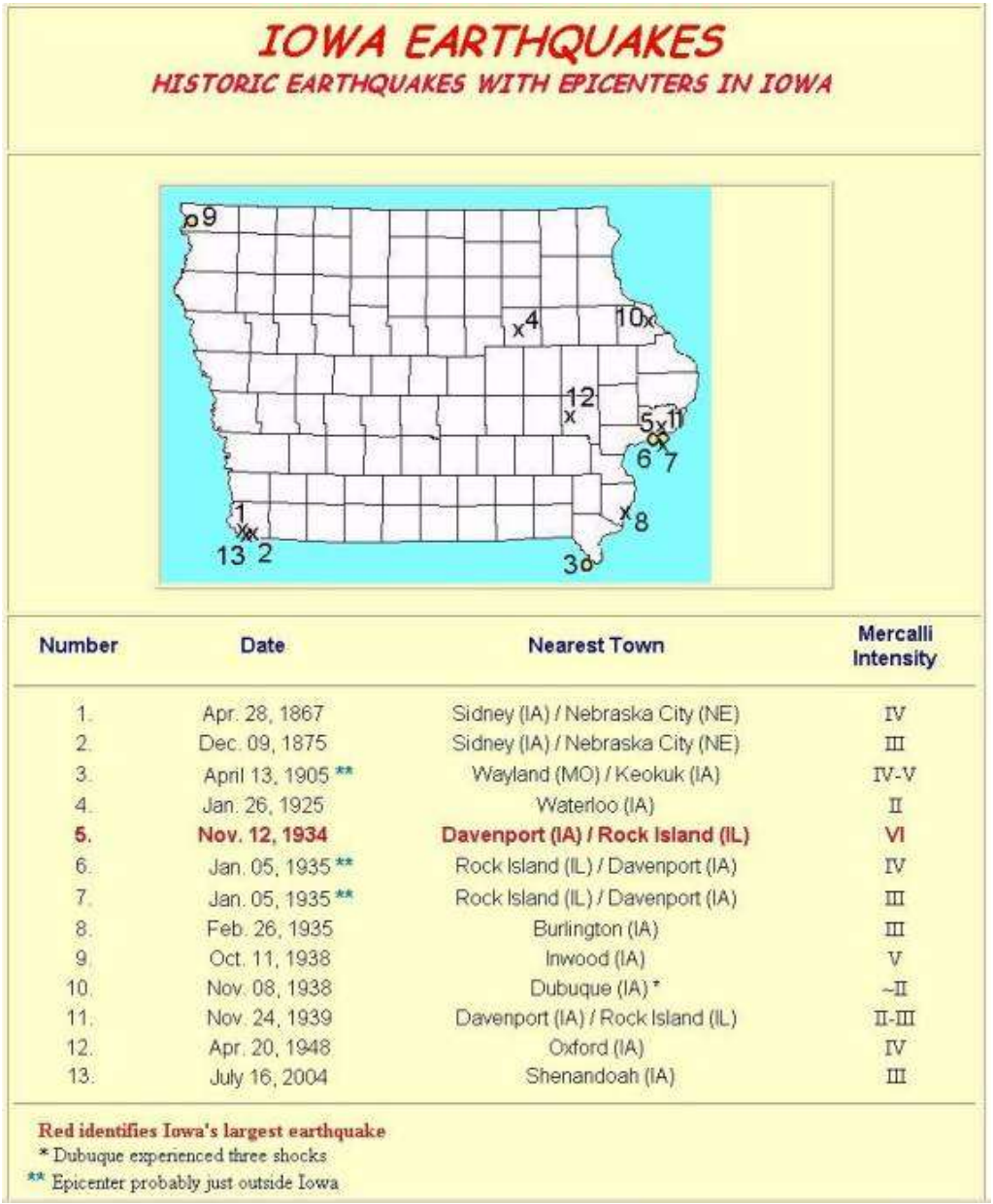
2.4 Earthquake

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.

The following 2008 USGS map shows Iowa located in low risk zones on the Peak Ground Acceleration Map for the New Madrid Fault.





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

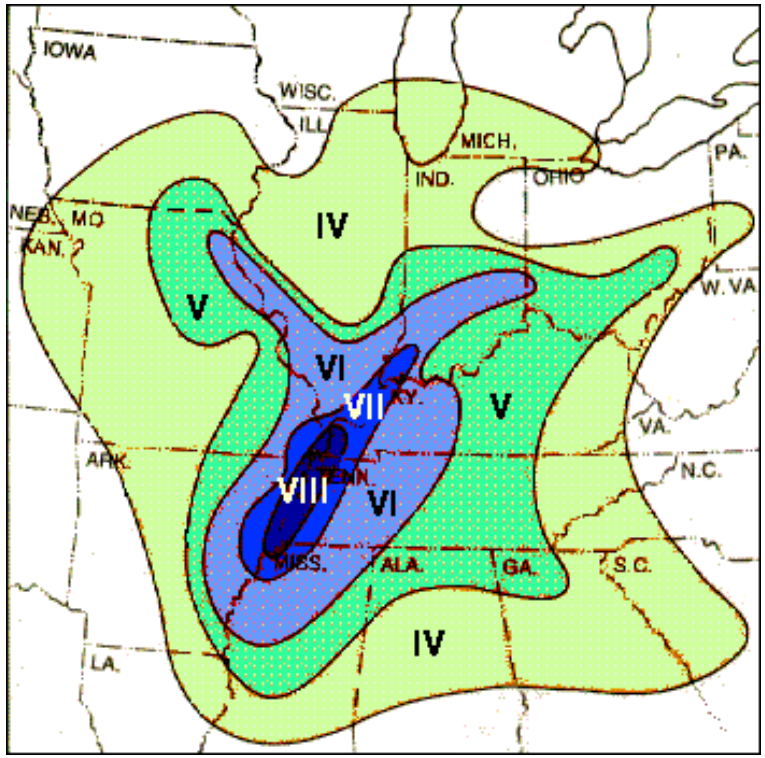
This does not mean that the state or certain areas of the state are not vulnerable to earthquake effects. Most structures in Iowa are not built to earthquake standards, but the most serious property damage would still likely be minor foundational damage. The most vulnerable structures are those built on poorly consolidated substrate, particularly floodplain materials.

Iowa as a whole has experienced the effects of few earthquakes in the past 175 years that are illustrated previously. The epicenters of thirteen (13) earthquakes have been located in the state with the majority along the Mississippi River. The first known 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. FEMA published a report in 2008 using the HAZUS-MH software that determined 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.

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 earthquake on the New Madrid Fault would create a Modified Mercalli intensity magnitude four (4) effect in most of Iowa resulting in minimal damages. Roman numerals on the following map below 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.

2.5 Expansive Soils

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 (Krohn and Slosson, 1980). 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. Expansive soils can also contribute to or cause damage to roadways, bridges, pipelines, and other infrastructure.

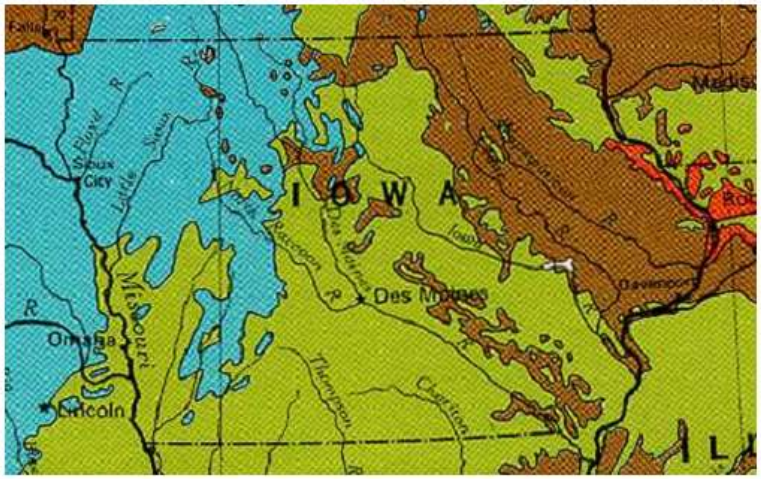
The availability of data on expansive soils varies greatly. In or near metropolitan areas and at dam sites, abundant information on the amount of clay generally is available. However, for large areas of the U.S., little information is reported other than field observations of the physical characteristics 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 19% 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, 1989.

2.6 Extreme Heat

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

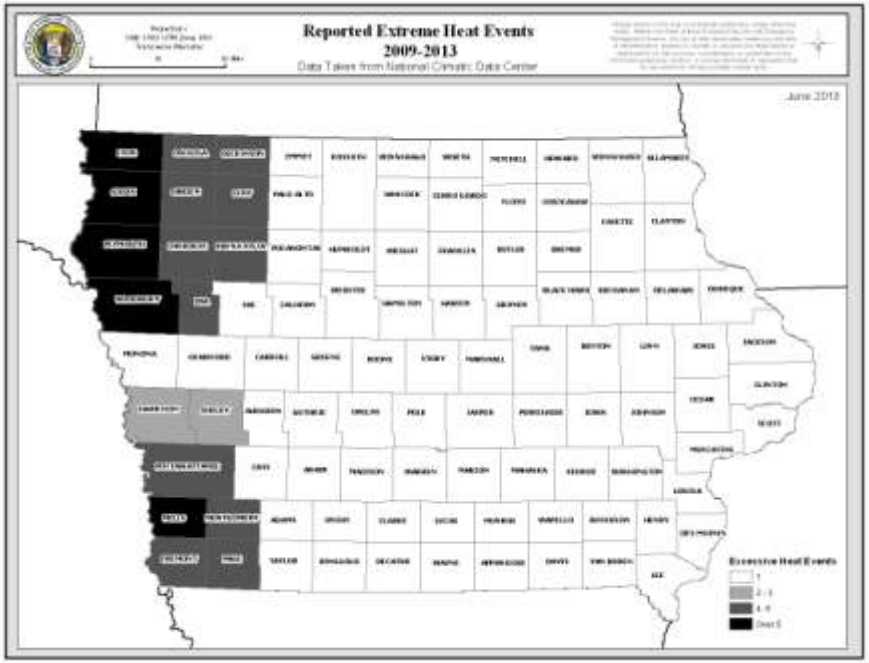
Conditions for extreme heat are defined by summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. This includes temperatures (including heat index) in excess of 100 degrees Fahrenheit for at least three (3) successive days of 90+ degrees Fahrenheit. The heat index is a number in degrees Fahrenheit that tells how hot it really feels when relative humidity is factored into actual air temperature. Exposure to full sunshine can increase the heat index by at least 15 degrees. The National Weather Service can issue a Heat Advisory or Excessive Heat Warning.

- Heat Advisory
  A heat index of 100°F or higher is expected for a period of 3 hours or more. A heat advisory shall be continued through the overnight hours, following a day with excessive heat, if the heat index is not expect to fall below "around 75°F". A heat advisory can be issued for a heat index less than 100°F when the cumulative effect of successive days of near advisory heat leads to potentially life threatening conditions.

- Excessive Heat Warning
  A heat index of 105°F or higher is expected for a period of 3 hours or more. An excessive heat warning shall be continued through the overnight hours, following a day with excessive heat, if the heat index is not expected to fall below "around 75°F". An excessive heat warning can be issued for a heat index less than 105°F when the cumulative effect of successive days of near warning heat leads to life threatening conditions.

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.

The following map shows excessive heat events from the last few years.



During the last planning period between 1995 and 2010 Iowa experienced 30 extreme heat events. The new map depicts the number of excessive heat occurrences from 2009-2012. The NCDC storm events no longer report extreme heat, and the closes substitute was excessive heat. Excessive heat event documentation covers a much shorter time series, but is the best data available.

Extreme heat can pose a threat to livestock and crops. High temperatures have been shown to reduce summer milk production, impair immunological and digestive function of animals, and increase mortality of livestock. In July, 2011 according to The Iowa Cattlemen's Association approximately 4,000 cattle died due to extreme heat. In 1995, livestock-related economic losses due to heat stress were estimated to be $31 million in Iowa. Extreme heat can also cause pavement to buckle and rupture. A 2011 article states that in a typical year, Iowa DOT maintenance equipment operators spend 2,000 to

4,000 hours making temporary repairs of pavement blowups and another 6,000 hours replacing these pavement sections, costing an average of $400,000 annually.

The SHMT evaluated the probability of extreme heat in Iowa. The discussion focused around historical information, climate change, and personal experiences dealing with extremely high temperatures. Discussion also included 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. The SHMT agreed that Iowa has between a 10% and 19% probability of an extreme heat occurrence in any given year.

2.7 Flash Flood

Flash Flood - Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
4	**2**	**2**	**1**	**2.80**

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. The SHMT elected to increase the Warning Time score from 1 to 2 due to the short time it takes for water to rise. Even with information on soil saturation and predicted rainfalls flash floods can still catch people by surprise. 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 July of 2011 when Dubuque got more than 12 inches of rain within a 24 hour period. This event resulted in a Presidential Disaster Declaration due to widespread personal and physical property losses. Many other flash flood events have occurred across Iowa though mostly localized events. The National Climatic Data Center lists 97 flash flooding events from 2000-2013. In that span of time there have been four deaths and eleven injuries reported as related to flash flooding in Iowa. From 1996 to 2012 the NCDC reports 634 flash flood events in Iowa which results in an average of more than 39 events per year over that time period.

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 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 become more frequent. 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 seem to be moving upwards) and rainfall extremes (that also seem to be 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.

2.8 Grass or Wildland Fire

Grass/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 a rural or a wooded area. Grass and wild-land fires are more likely to occur when conditions are favorable, such as during periods of drought when natural vegetation is drier and more combustible.

According to the National Interagency Fire Center there have been 1,817 wildfires spanning 33,122 acres and 1,884 prescribed fires spanning 14,079 acres from 2002 until 2012 in Iowa. The Wildland Fires in Iowa chart on the following page breaks out fire statistics by year. No event 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 (10-19%) 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).

Wildland Fires in Iowa

	Wildfire		Prescribed	
Year	Number	Acres	Number	Acres
2002	5	1,045	17	2,617
2003	34	3,417	6	457
2004	26	585	86	7,727
2005	94	10,566	142	12,058
2006	15	827	131	10,433
2007	54	684	217	12,231
2008	177	2,217	5	323
2009	718	8,565	621	33,339
2010	123	2,722	98	7,800
2011	561	2,145	463	34,372
2012	10	349	98	14,079
Total	1,817	33,122	1,884	135,436
Annualized	165	3,011	171	12,312

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2.9 Hazardous Materials Incident

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

This hazard encompasses fixed hazardous materials, pipeline transportation, and transportation hazardous materials. This can include the accidental release of flammable or combustible, explosive, toxic, noxious, corrosive, oxidizable, irritant, or radioactive substances or mixtures that can pose a risk to life, health, or property possibly requiring evacuation. The SHMT adjusted the scoring for Hazardous Materials (HAZMAT) Incident increasing the probability rating and reducing the magnitude/severity rating by 1 point each. This increases the weighted score from 2.5 in 2010 to 2.65 in 2013. This adjustment reflects comments that many small HAZMAT incidents occur, but they are dealt with locally. In addition HAZMAT response is generally standardized and effective. Chemicals are manufactured and used in ever-increasing types and quantities and as many as 500,000 products pose physical or health hazards and can be defined as "hazardous chemicals."

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. Fixed hazardous material incidents usually 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.

		Substance			Mode					
Year	Total Incidents	Agri-Chemical	Petroleum Products	Other Chemicals	Transport	Fixed Facility	Pipeline	Railroad	Fire	Other*
2000	893	142	454	297	279	535	8	15	7	50
2001	947	170	539	238	274	552	18	25	12	66
2002	995	169	601	225	265	644	18	16	12	42
2003	744	133	405	206	223	406	19	20	10	66
2004	752	121	416	215	215	447	17	18	5	52
2005	785	116	452	217	237	408	16	29	12	83
2006	705	106	417	182	191	395	12	26	9	74
2007	806	114	442	250	224	442	18	22	11	89
2008	888	110	532	246	228	504	26	36	8	87
2009	782	111	430	241	216	454	12	25	5	79
2010	743	101	443	199	193	451	24	26	11	50
2011	775	127	418	210	163	522	8	23	8	35
2012	769	134	421	214	187	504	10	13	14	41
2013**	248	30	156	62	59	163	4	7	2	14
Total	10832	1684	6126	3002	2954	6427	210	301	126	828
% of Total	1	16	57	28	27	59	2	3	1	8
Average	814	127	459	226	223	482	16	23	10	63

* Other includes: Dumping, Theft, Vandalism, and Unknown Causes ** Through April 30, 2013

Source: Iowa Department of Natural Resources

Despite increasing safeguards, more and more potentially hazardous materials are being used in commercial, agricultural, and domestic activities. This situation is further complicated 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 10-19% 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.

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. A 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.

Pipeline System	Mileage
Hazardous Liquid	4,868
Gas Transmission	8,376
Gas Gathering	0
Gas Distribution*	17,693
Total	**30,937**
*931,017 total services	

Source for charts: Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety, Iowa Significant Incidents and Mileage Overview (May 2, 2013)

A Serious Pipeline Event is defined by the Pipeline & Hazardous Materials Safety Administration (PHMSA) as those incidents that involve a fatality or injury requiring in-patient hospitalization. A Significant Pipeline Event is defined by the PHMSA as those incidents reported by pipeline operators when any of the following specifically defined consequences occur:

1. fatality or injury requiring in-patient hospitalization
2. $50,000 or more in total costs, measured in 1984 dollars
3. highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more
4. liquid releases resulting in an unintentional fire or explosion

Iowa Pipeline Significant Incidents						
Year	Number	Fatalities	Injuries	Property Damage	Gross Barrels Lost	Net Barrels Lost
2002	6	0		$ 1,195,442	300	71
2003	1	0	1	$ -	0	0
2004	4	0	1	$ 687,219	52	52
2005	8	0	1	$ 1,281,461	191	110
2006	3	0		$ 434,713	0	0
2007	1	0		$ 226,060	100	100
2008	4	0		$ 1,425,071	9,104	9,103
2009	3	0		$ 522,600	36	0
2010	9	0	3	$ 2,684,065	1,130	1,078
2011	4	0	1	$ 7,980,635	822	818
2012	11	0	2	$ 1,960,696	1,726	1,664
2013 YTD	2	0	0	$ 401,837	286	286
Total	56	0	9	$ 18,799,799	13,747	13,282
Annualized	**4.7**	**0**	**1.3**	**$ 1,566,650**	**1,146**	**1,107**

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.

Iowa Pipeline Serious Incidents						
Year	Number	Fatalities	Injuries	Property Damage	Gross Barrels Lost	Net Barrels Lost
2002	0	0	0	$ -	0	0
2003	1	0	1	$ -	0	0
2004	1	0	1	$ 1,187	0	0
2005	1	0	1	$ 341,716	0	0
2006	0	0	0	$ -	0	0
2007	0	0	0	$ -	0	0
2008	0	0	0	$ -	0	0
2009	0	0	0	$ -	0	0
2010	1	0	3	$ 86,175	0	0
2011	1	0	1	$ 5,252	0	0
2012	1	0	2	$ 472,273	0	0
2013 YTD	0	0	0	$ -	0	0
Total	6	0	9	$ 906,603	0	0
Annualized	**0.5**	**0**	**0.75**	**$ 75,550**	**0**	**0**

According to the Iowa Utilities Board (IUB) and the United State Department of Transportation Pipeline and Hazardous Materials Safety Administration, 56 pipeline accidents, incidents, or service outages were reported between 2002 and 2013, resulting in a total of 9 injuries and no fatalities.

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 as occasional in any given year.

2.10 Human Disease

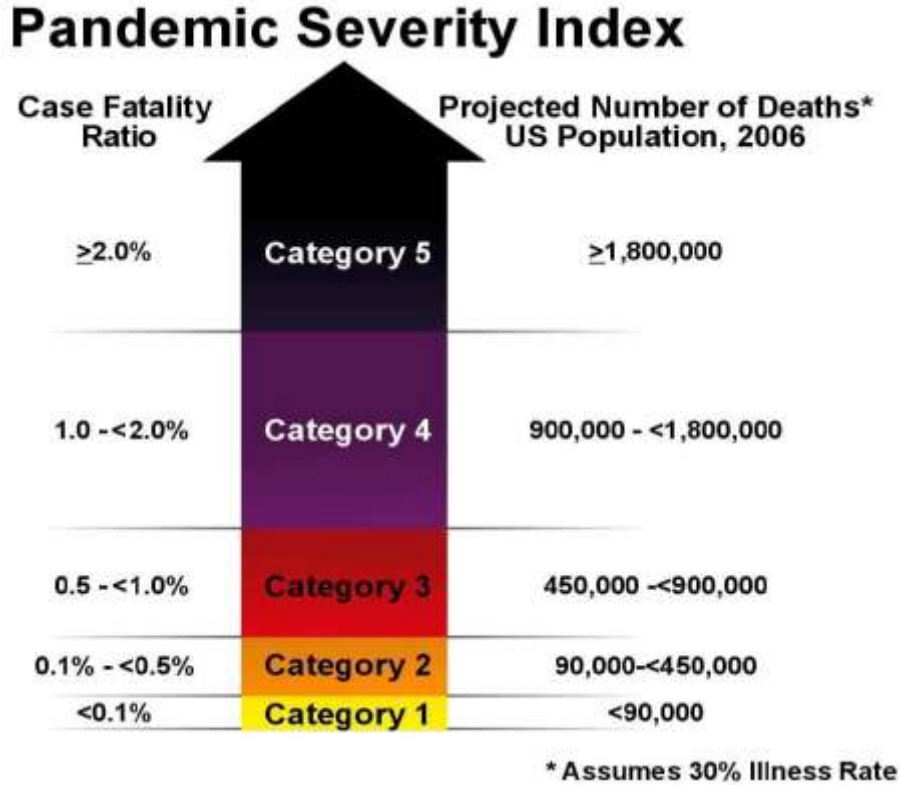
Human Disease - Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
1	**4**	**2**	**4**	**2.35**

An incident related to human disease is defined as a medical, health, or sanitation threat to the general public including contamination, epidemics, plagues, or infestations. 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. There are 67 infectious diseases designated for 2013 as notifiable at the national level. A notifiable infectious disease is one which must be reported to authorities because 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. Iowans remain vulnerable to diseases known and unknown even though vaccines exist for many modern diseases.

A pandemic human disease is a disease that is prevalent over a whole country, region, continent, or world. Many diseases throughout the history of the world have been pandemic. The 1918 influenza pandemic killed an estimated 50 million people. More than 25% of United States population was afflicted and in one calendar year average life expectancy dropped by 12 years! Influenza pandemics in 1957 and 1968 killed 70,000 and 34,000 people respectively worldwide. The H1N1 pandemic flu may have killed as many as 18,000 people in 2009-2010. A pandemic will have wide spread economic and societal implications for our state. Response and recovery to a pandemic will likely be lengthy if Iowa is severely infected. The Death Rate of a pandemic depends on the number of people infected, the virulence of the virus, characteristics and vulnerability of the population, and availability and effectiveness of preventative measures. Future pandemics will be assigned to one of five discrete categories of increasing severity that correspond with appropriate steps to take.



The Pandemic Severity Index chart from the Center for Disease Control shows fatality rates and projected deaths for each category. An example of the corresponding steps to take would be if the case-fatality rate during a pandemic is less than 1 percent (with estimated deaths nationwide under 90,000), the pandemic would be considered a category 1 and the only recommended community measure would be voluntary isolation of ill persons. However, communities could choose to take additional measures. In contrast, a category 5 pandemic (i.e., case fatality rate of 2 percent or higher and estimated deaths nationwide of nearly 2 million) would warrant recommendation of all of the community mitigation strategies.

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

2.11 Infrastructure Failure

Infrastructure Failure - Hazard Score Calculation				
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score
1	2	4	4	2.05

This hazard encompasses a variety of occurrences including 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. One potential cause of infrastructure failure is space weather/solar flare.

Communication failure is the widespread breakdown or disruption of normal communication capabilities. 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, solar flares, and severe 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 major widespread communication failures have occurred in Iowa. Local incidents; due to weather conditions, equipment failure, excavation incidents, or traffic accidents have been reported, but 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 only 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 electric, petroleum, or natural gas service, which by an actual or impending acute shortage of usable energy, could create a potential health problem for the population and possibly even 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. State and federal government strategies exist to respond to energy shortages, but are generally called upon only when free market forces are unable to provide for health, welfare, and safety of citizens. The State of Iowa has multiple strategies to limit the likelihood of an energy shortage and keep energy supply and demand in check. These strategies include:

- voluntary and mandatory demand reduction mechanisms
- 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 (partial or total) of any 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 also cause the roof of a building to collapse (under the weight of snow). In 1983 a KWWL television tower collapsed due to ice buildup. Heavy rains and flooding can undercut and washout a road or bridge. This occurred twice in 2008 when railway bridges failed in Waterloo and Cedar Rapids due to flooding. 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 structural failures across the state in the past as mentioned above. They have included homes, commercial structures, and communications towers. There is no central collection point for this information, but news articles document infrastructure failure.

Civil structures may fail for a variety of reasons. The unprecedented growth in technology has resulted in a host of problems related to complex structures, special materials, and severe operational and environmental loads. These include fire, excessive vibrations, explosion, high-energy piping failures, missiles, and earthquakes. With some possible exceptions (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 and problems with new materials discussed above, structural failures will continue to occur. Efforts to inspect and maintain these structures will lessen the probability of failure, but not guarantee that it will not occur. Internal weaknesses can be hidden from inspectors and may 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 a populated area 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. Less severe structural fires are almost a common occurrence in some communities. Nearly all are extinguished by on-site personnel or local fire departments. There have been 284 deaths in Iowa from fires from 2006 to March of 2013 according to the State Fire Marshall Division.

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 infrastructure failure will occur in Iowa as less than 10% in any given year.

2.12 Landslide

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, landslides have been occurring in slide-prone areas of Iowa since long before the state was created. Landslides can occur due to rainstorms, fires, or human activities that modify slope and drainage.

There have been no reported landslide events in Iowa resulting in injury or death. The geographic extent of the documented 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. 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 19% probability in any given year. The best available data was consultation with IDNR Geology and Groundwater Section. The SHMT discussed known occurrences around the state but no agency documents historical data on landslides in Iowa.

2.13 Radiological

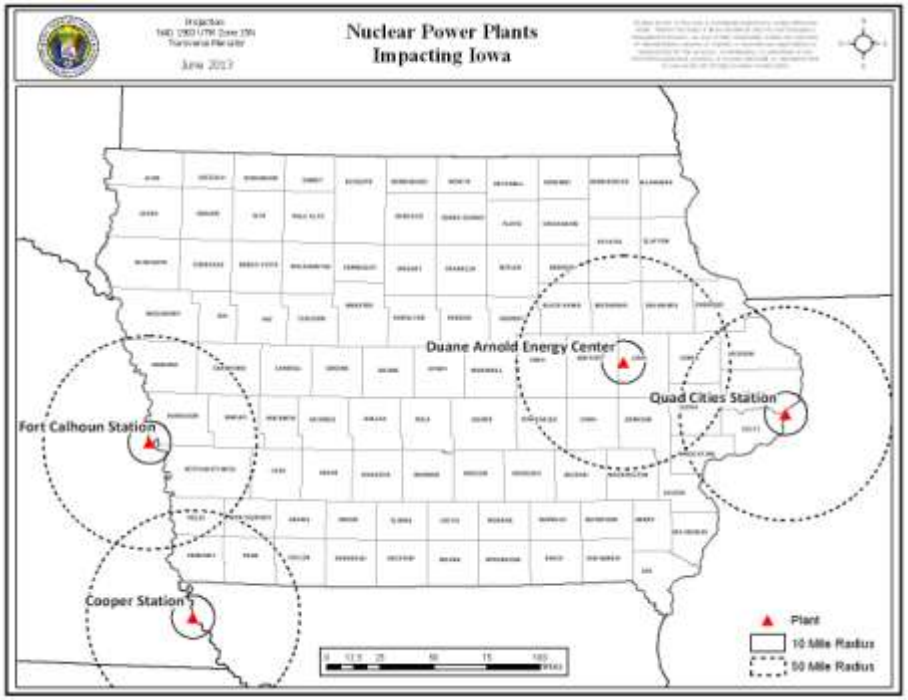
Radiological - Hazard Score Calculation				
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score
1	4	4	4	2.65

A radiological incident is an occurrence resulting in a release of radiological material at a fixed facility or in transit. An incident resulting in a release of radiological material at a fixed facility includes, but is not limited to, power plants, hospitals, and laboratories. 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. With this level of design they should withstand most natural hazards, but events that occurred in 2011 at the Fukushima nuclear plant in Japan illustrate the possibilities of what can happen in a kind of worst case scenario. The Japanese plant may have been able to withstand either the earthquake or the tsunami, but both hazards together caused release of radioactive materials.

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

Emergency classifications defined by the United States Nuclear Regulatory Commission are divided into four 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



An **Unusual Event** constitutes events that are in process or have occurred which indicate potential degradation in the level of safety of the plant. No release of radioactive material requiring offsite response or monitoring is expected unless further degradation occurs.

If an **Alert** is declared, events are in process or have occurred that involve an actual or potential substantial degradation in the level of safety of the plant. Any releases of radioactive material from the plant are expected to be limited to a small fraction of the Environmental Protection Agency (EPA) protective action guides (PAGs).

A **Site Area Emergency** involves events in process or which have occurred that result in actual or likely major failures of plant functions needed for protection of the public. Any releases of radioactive material are not expected to exceed the EPA PAGs except near the site boundary.

A **General Emergency** involves actual or imminent substantial core damage or melting of reactor fuel with the potential for loss of containment integrity. Radioactive releases during a general emergency can reasonably be expected to exceed the EPA PAGs for more than the immediate site area.

The following are statistics for the four relevant nuclear facilities for the State of Iowa since 1990:

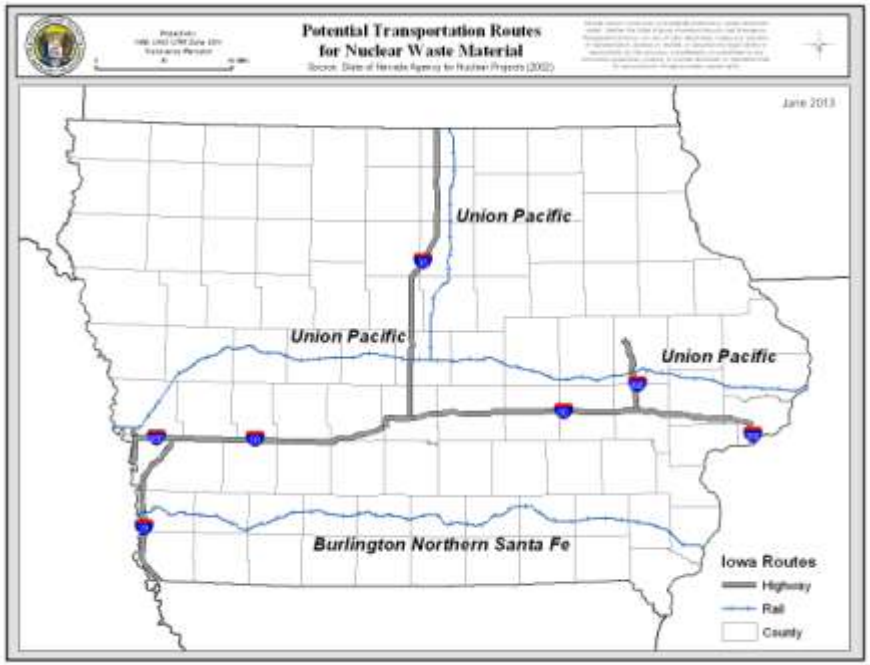
- The Quad Cities Nuclear Power Plant has had 18 Unusual Events, 7 Alerts, and no Site Area Emergencies or General Emergencies.
- The Duane Arnold Energy Center has had 7 Unusual Events, 1 Alerts, and no Site Area Emergencies or General Emergencies.
- The Cooper Nuclear Power Plant has had 20 Unusual Events, 1 Alert, and no Site Area Emergencies or General Emergencies.
- The Ft. Calhoun Nuclear Power Plant has had 20 Unusual Events, 3 Alerts, and no Site Area Emergencies or General Emergencies.

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 transit. 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 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 that which exists from 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.



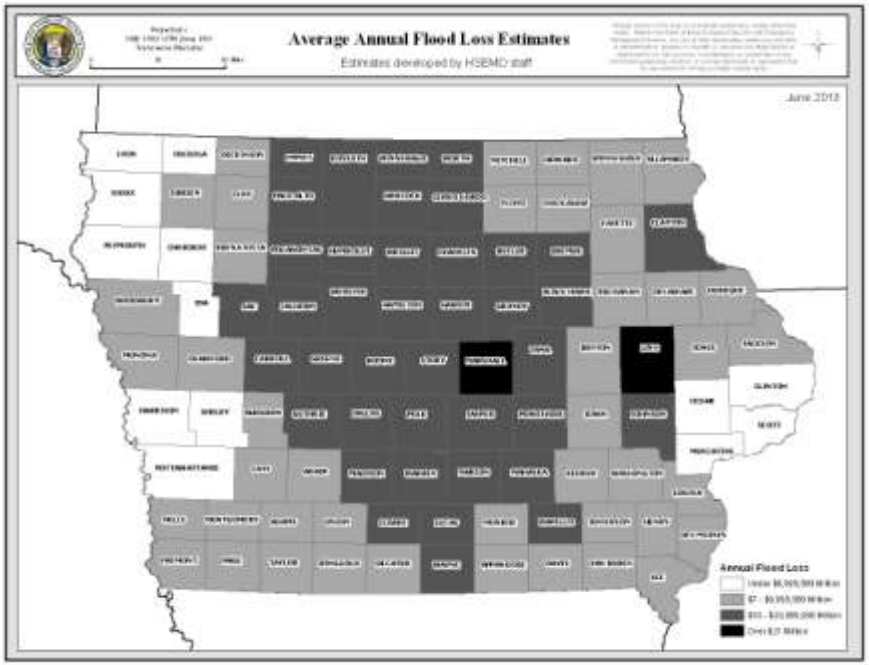
Since 1990, hundreds of shipments have been made through Iowa. There have been no occurrences of a radiological incident in Iowa. Transportation accidents are the most common type of incident involving radioactive materials because of the sheer number of radioactive shipments.
Potential rail and highway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

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

2.14 River Flooding

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

Floodwaters can be extremely dangerous; the force of six inches of swiftly moving water can knock people off their feet and two 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 November 2012.

County	Number of Properties	Total Paid
Audubon	1	$5,263.82
Benton	1	$56,662.18
Blackhawk	87	$4,650,109.07
Boone	2	$323,398.77
Bremer	70	$3,237,774.31
Buchanan	27	$781,236.25
Butler	18	$642,587.95
Carroll	1	$285,698.66
Cerro Gordo	9	$340,067.64
Cherokee	1	$11,735.76
Clayton	6	$235,994.46
Clinton	9	$274,934.11
Crawford	9	$647,104.97
Dallas	5	$100,818.34
Decatur	1	$14,557.99
Delaware	30	$3,042,326.02
Des Moines	16	$538,679.63
Dubuque	9	$551,787.72
Fayette	9	$102,670.41
Floyd	14	$595,811.12
Fremont	2	$120,671.22
Hamilton	1	$24,558.23
Hancock	1	$6,597.66
Harrison	6	$93,018.61
Humboldt	4	$49,876.21
Jackson	2	$53,082.48
Jasper	4	$311,967.76
Johnson	7	$3,708,163.05
Jones	13	$2,225,153.51
Lee	5	$238,758.14
Linn	20	$1,477,198.61
Louisa	4	$153,747.35
Lyon	3	$56,852.02
Mahaska	1	$39,137.07
Marion	1	$35,246.29
Mills	4	$197,124.67
Mitchell	3	$46,444.45
Montgomery	4	$31,212.38
Muscatine	29	$1,312,439.69
Plymouth	1	$24,054.89
Polk	26	$2,395,965.75
Pottawattamie	17	$909,464.39
Scott	173	$10,941,723.37
Shelby	1	$74,367.68
Story	28	$4,091,860.12
Tama	1	$4,198.89
Union	2	$17,190.18
Van Buren	1	$56,913.74
Wapello	11	$596,238.09
Warren	1	$76,667.80
Washington	1	$17,805.82
Webster	12	$1,326,633.76
Woodbury	2	$19,405.32

The Floods of 2008 and the recovery from the losses associated with it as well as the devastating flooding that occurred in 1993 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 2008 floods resulted in 86 of the State's 99 counties included in Governor's disaster declarations, and 84 being declared presidentially. The event resulted in 18 fatalities and 106 injuries, the evacuation of approximately 38,000 Iowans and impacting 21,000 housing units.

Iowa had 2 presidentially declared disasters in 2010, both of which included flooding and severe storms. Over half of Iowa's 99 counties were included in one (or both) of theses declarations. In 2011 Iowa had 3 separate presidentially declared disasters due to flooding (as well as severe storms and straight-line winds). Counties covered in the 2011 disasters ranged from the western borders due to flooding on the Missouri River to eastern counties along the Mississippi River. Crop losses in Iowa alone from Missouri River flooding were an estimated $162 million.

Iowa has been involved in 36 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 years.

While hundreds of homes and businesses have been removed from the floodplain over the last decade, many opportunities for mitigation remain. While all the mitigation work Iowa has done may not be enough to significantly alter vulnerability statewide, at a local level risk has been substantially reduced.

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

2.15 Severe Winter Storm

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 can affect day-to-day activities 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 in Iowa.

The various types of severe winter weather can cause considerable damage. Winter storms can immobilize transportation systems, down trees and power lines, collapse buildings, and cause the loss of livestock and wildlife. Blizzard conditions are winter storms lasting at least three 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 inches in a 12 hour period or freezing rain greater than 1/4 inch accumulation can cause hazardous conditions in the community by slowing or stopping the flow of vital supplies as well as disrupting emergency and medical services.

Loose snow begins to drift when wind reaches a 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 power outages over large areas of Iowa; they have also shut down or made roadways impassable, and as a result, have prevented first responders from providing emergency services to people in need of assistance.

Just since the last planning cycle (since April 2010), Iowa has had a plethora of winter storm related events cataloged in the National Climactic Data Center. Events include 49 winter weather, 93 winter storm, 96 blizzard, 22 ice storm, 76 heavy snow, 25 cold/extreme cold/wind chill, and 76 frost/freeze events. Some of these may overlap, but it is clear that in Iowa a

variety of winter weather related hazards are commonplace. In Iowa there are cases where deaths have been attributed to cold or blizzards.

Eight winter storm related Presidential Declarations for Major Disaster have been declared in Iowa since 1991. The first declaration related to winter storms 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. In 2007 the third declaration (3/14/2007) affected 48 counties and the fourth declaration (3/30/2007) 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 plus days. In central Iowa, one county had twenty 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 also collapsed. Due to the severity of the winter blizzard, the Governor signed a Governor's Emergency Declaration for all 99 counties in Iowa. Another disaster was declared in January of 2008, affecting 30 counties in southern Iowa. The remaining two Presidential Declarations occurred in late February 2010, impacting 27 counties, and in early March of 2010, impacting 27 counties in western Iowa. Most recently Iowa had a Presidential Declaration for a winter storm that occurred in April of 2013 in five northwestern counties.

According to the National Oceanic and Atmospheric Administration 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. Most Iowa counties can expect two or three winter storms a season with an extreme storm, on average, every three to five years.

A six inch snowfall or more from one storm occurs only in 49% of Iowa winters, while a large winter storm event of ten inches or more will occur about once every three years.

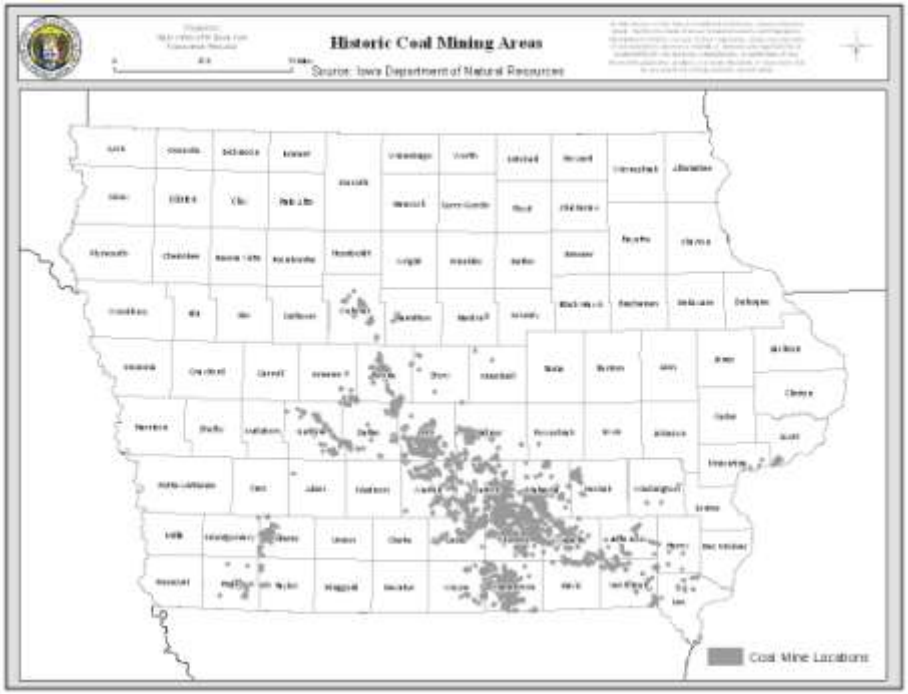
Cold temperatures can cause hypothermia especially when combined with wind chills that further reduce the perceived air temperature to exposed skin. Hypothermia can affect anyone, but the elderly and the very young are particularly vulnerable. Water pipes, livestock, fish, wildlife, and pets are also affected by the dangers of extremely cold weather.

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.

2.16 Sinkholes

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

A sinkhole is the loss of surface elevation due to the removal of subsurface support. Sinkholes range from broad, regional lowering of the land surface to abrupt localized collapse. The primary causes of most subsidence are human activities such as underground mining of coal, groundwater/petroleum withdraw, or drainage of organic soils. Sinkholes can aggravate flooding potential, collapse of an abandoned mine may destroy buildings, roads and utilities.



The map above shows historic coal mining areas in Iowa. It is possible for sinkholes to form in historic mining locations.

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 above.

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.

2.17 Terrorism

Terrorism - Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
2	**4**	**4**	**4**	**3.1**

This hazard encompasses a wide variety of human caused threats including 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. The SHMT increased the probability score from a 1 to a 2 primarily in response the prevalence of cyber terrorism.

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. While this data is dated it remains included due to the scarcity of available information. A Quad-City Times article states that according to the Iowa Department of Human Rights between 2002 and 2012 authorities have filed terrorism or threat of terrorism 121 times.

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. An enemy attack is a remote 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 military attack on the United States, it is unlikely that Iowa would be a primary target during a conventional attack.

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 groups of people assembling together to

substantially interfere with public peace and constitute a threat. Use of unlawful force or violence against another person, causing property damage or attempting to interfere with, disrupting, or destroying the government, political subdivision, or group of people are potential methods employed. 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 property. 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, Iowa experienced a large number of responses for suspicious powders. Following the development of a threat assessment/response protocol the number of responses was reduced.

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 classified as agro-terrorism. Activities could include: intentional introduction of disease, animal rights activists who release 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. Depending upon the type of action taken, the implications will vary greatly.

Incidents of agro-terrorism have occurred in the state of Iowa. Over the past 10 years Iowa has experienced incidents in which animal rights activists have vandalized or released animals in our agricultural facilities. Most prominently in 2004 animals were released at the University of Iowa. Recent clashes between activists and so-called factory farms have also been in the news recently. There has also 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. There have been recent instances where public officials nationally have received suspicious letters, and this certainly can happen in Iowa. In 2005 a subject mailed “rat poison” to a number of state and local officials. There have been recent instances where public officials nationally have received suspicious letters, and this certainly could happen in Iowa. 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 event were subjects broke into a city’s water supply and it was suspected that chemicals may have been deposited in the water supply. There have been many releases of anhydrous ammonia by persons engaged in clandestine drug manufacturing.

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. 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 injured in the bombings in Iowa and Illinois. In 2005 and 2006, pipe bombs were used in attempted murder cases in two Iowa cities. In 1991 there was a murder suicide at the University of Iowa. Recent national events have increased awareness pertaining to school safety, workplace safety, and vulnerability at public gatherings. 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. 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. Documentation of the number of instances is difficult in the case of cyber terrorism, but there certainly are many instances where account information has been jeopardized. Many of these notifications are concerning private companies where there could be financial concerns with data breach. Iowa is home to

large targets due to the financial and insurance industries located within its borders.

The SHMT analysis evaluated the probability of cyber terrorism occurring in Iowa. While targeted local attacks could be becoming more common a serious impact intrusion in Iowa was determined to be unlikely to occur 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.

2.18 Thunderstorms/Lightning/Hail

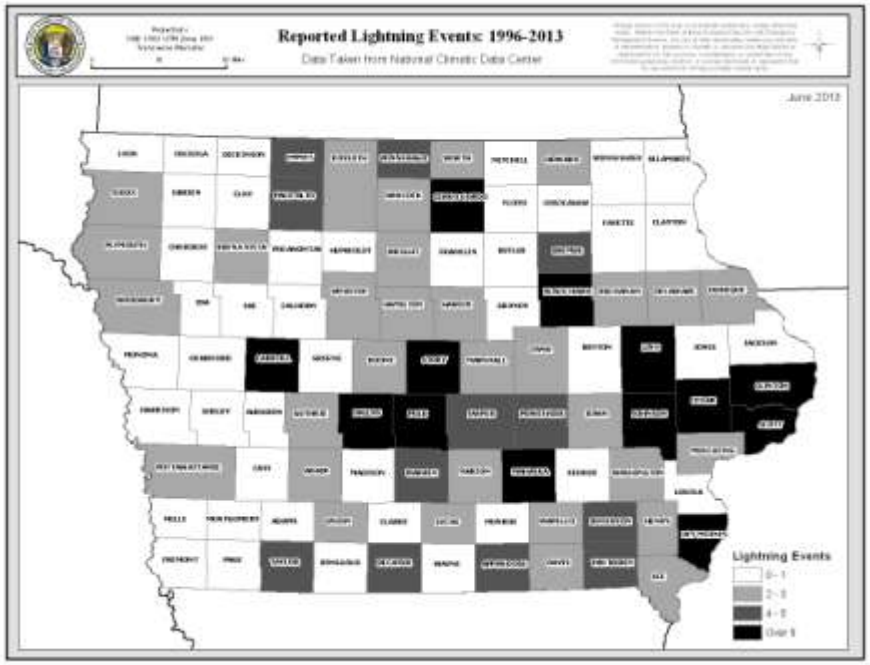
Thunderstorm/Lightning/Hail - Hazard Score Calculation				
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score
4	1	2	2	2.60

Thunderstorms are common in Iowa and can occur singly, in clusters, or in lines. Thunderstorms can result in heavy rains, high winds (reaching or exceeding 58 mph), tornados, or hail. Thunderstorms are created from a combination of moisture, rapidly raising warm air, and the lifting mechanism such as that caused when warm and cold air masses collide. The SHMT chose to combine previously separated hazards of Thunderstorm/Lightning and Hail. The combined hazard was then scored with lower of the two values for magnitude as well as warning time. The magnitude reduction was due to the fact that a majority of thunderstorms don't cause state level response, and tracking and prediction of thunderstorms is quite sophisticated.

From 2010 to April 2013, the NCDC lists 370 hail events, 37 lightning events, and 68 heavy rain events that have impacted Iowa. The NCDC lists events by county, and one storm can be listed as multiple events. Thunderstorms also may occur singly, in clusters, or in lines, so it is possible that several thunderstorms may affect the same area in the course of a few hours. The NCDC data is not perfect, but represents best available data. Associated hazards related to thunderstorms are discussed further as individual hazards (tornado/windstorm and various kinds of flooding). Most thunderstorms produce thunder, lightning, and rain. Severe storms can also produce tornadoes, straight-line winds with microburst above 58 mph, 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 that exceed 60 mph are often mistaken for tornadoes.

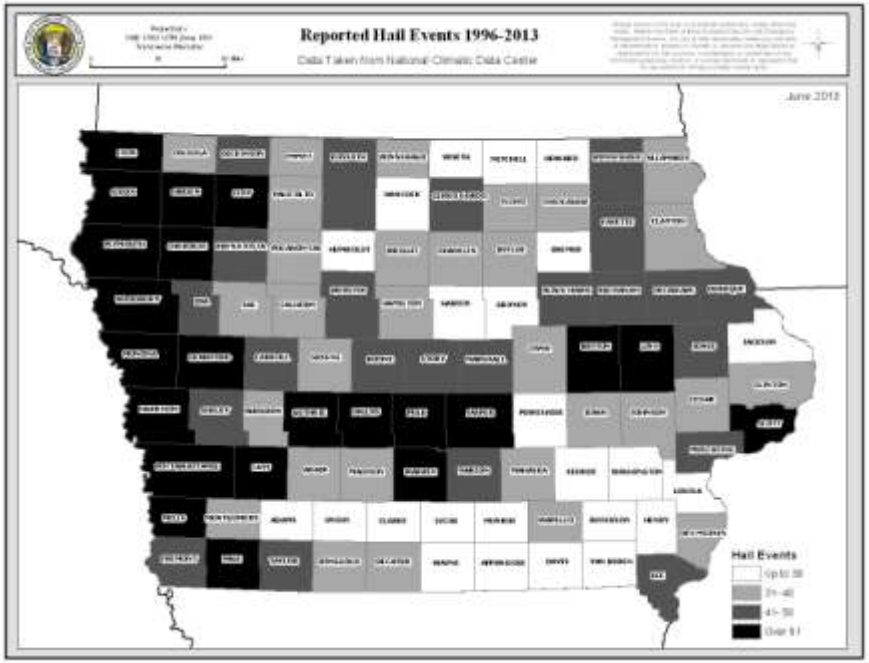
As mentioned thunderstorms are hazards unto themselves, but can cause other hazards such as flash flooding, river flooding, and tornadoes/windsotrms. There have been five Presidential Declarations for Major Disaster since the last plan update in 2010 related to severe storms in Iowa.

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” or flash of light that 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 1996.



Data collected from the NCDC shows Iowa experiences many 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. The humid continental climate of Iowa frequently provides the ingredients for a severe thunderstorm. These ingredients include 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.

Hailstorms are a product of a severe thunderstorm in which pellets or lumps of ice (of most concern when 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 map above depicts a geographic breakdown of the number of hailstorms in Iowa 1996. According to the National Climactic Data Center (NCDC), Iowa experienced 370 hail events from 2010-2013 (April 1 data cutoff). Five injuries and zero deaths resulted from these hailstorms in Iowa. NCDC website data shows more than $4.75 million in property damage and over $4.5 million in crop damage over that time period. NCDC 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 to three 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 Thunderstorm/Lightning/Hail event is highly likely to occur in any given year.

2.19 Tornado/Windstorm

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 around a mile wide where it touches the ground. An average tornado is a few hundred yards wide. A tornado can move over land for distances ranging from short hops to many miles, causing damage and destruction wherever it descends. The funnel is made visible by the dust sucked up and condensation of water droplets in the center of the funnel. Windstorms are 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 miles wide and duration of the event could range from hours to days. These events can produce straight line winds in excess of 64 knots (73 mph) causing power outages, property damage, impaired visibility, and crop damage. It is often difficult to separate windstorms and tornado damage when winds get above 64 knots. For this reason the SHMT chose to combine the formerly separate hazards of tornado and windstorm.

The Enhanced Fujita Scale (EF) is used to assign a tornado a 'rating' based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of Damage Indicators and Degrees of Damage which help estimate better the range of wind speeds the tornado likely produced. From that, a rating (from EF0 to EF5) is assigned. The National Weather Service is the only federal agency with authority to provide 'official' tornado EF Scale ratings. The following chart shows the relationship between structure damage and wind speeds as it pertains to EF tornado ratings.

EF Rating	Wind Speeds	Expected Damage		
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.		
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.		
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.		
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.		
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.		
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.		

Though the description of "tornado alley" varies slightly, Iowa is generally considered to be included in, or on the edge of, the geographic area. Between 2000 and 2013, Iowa has averaged more than 17 tornadoes per year. In Iowa, most tornadoes occur in the spring and summer months, but can also occur in the fall and winter seasons. Tornadoes tend to be the most common in the late afternoon or evening, but they can occur at any time of day. The NCDC identifies 224 tornado events in Iowa from 2000-2013. Since the first time in 1968, Iowa has received eleven Presidential Disaster Declarations that include tornadoes in the description.

The most recent strong-violent tornado in Iowa was an EF-4 tornado that struck Pocahontas County on April 9, 2011 with estimated wind speeds of 170 mph and a base around 600 yards wide that caused $2.5 million in damages according to the NCDC.

On May 25, 2008 an EF-5 tornado struck the cities of Parkersburg, Dunkerton, and New Hartford, killing nine people. The tornado destroyed 296 buildings and caused damages of approximately $75 million. This was followed by an EF-2 tornado that struck the town of Attica on May 30, damaging dozens of homes and injuring ten people. The final tornado to affect Iowa in this string of summer storms occurred on June 11 when an EF-3 tornado struck a Boy Scout camp in the western Iowa town of Little Sioux, killing four scouts and injuring 48 people.

Windstorms occur in every county in Iowa. Historically, windstorm events are associated with severe thunderstorms and blizzards. 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 an 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.

In 2011 Iowa had two Presidentially Declared Disasters that included straight line winds in the disaster description. The NCDC shows Iowa has experienced 4 instances where recorded wind speeds equaled or exceeded 100 knots since 2009. Since 2000 Iowa has experienced 78 instances of wind speeds at or exceeding 70 knots.

The Beaufort Wind Scale below identifies winds over 73 mph as hurricane force winds with accompanying damages.

Beaufort Wind Scale

Windspeed in MPH	Description - Visible Condition
0	Calm smoke rises vertically
1 - 4	Light air direction of wind shown by smoke but not by wind vanes
4 - 7	Light breeze wind felt on face; leaves rustle; ordinary wind vane moved by wind
8 - 12	Gentle breeze leaves and small twigs in constant motion; wind extends light flag
13 - 18	Moderate breeze raises dust and loose paper; small branches are moved
19 - 24	Fresh breeze small trees in leaf begin to sway; crested wavelets form on inland water
25 - 31	Strong breeze large branches in motion; telephone wires whistle; umbrellas used with difficulty
32 - 38	Moderate gale whole trees in motion; inconvenience in walking against wind
39 - 46	Fresh gale breaks twigs off trees; generally impedes progress
47 - 54	Strong gale slight structural damage occurs; chimney pots and slates removed
55 - 63	Whole gale trees uprooted; considerable structural damage occurs
64 - 72	Storm very rarely experienced; accompanied by widespread damage
73+	Hurricane devastation occurs

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

2.20 Transportation Incident

Transportation Incident - Hazard Score Calculation				
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**
2	2	4	1	2.20

This hazard encompasses air transportation, highway transportation, railway transportation, and waterway incidents. A transportation incident is described as an accident involving any mode of transportation that directly threatens life, property damage, injury, or adversely impacts a community's capabilities to provide emergency services. The SHMT determined that for most transportation incidents the duration is short and chose to reduce the duration rating.

An air transportation incident may involve a military, commercial, or private aircraft. 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 including mechanical failure, pilot error, weather conditions, or an on-board fire could 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 locations. An aircraft incident can also occur while the aircraft is on the ground.

Iowa has 109 publicly owned airports that serve general aviation activity, with eight of those airports offering commercial air service. An additional 8 privately owned airports are also open for public use. There are 125 private use heliports and landing zones in Iowa used for helicopter EMS operations. Iowa could experience a significant air transportation incident anywhere, but it would be most likely to occur near an airport.

From 1962 to 2010, there were approximately 2,035 (around 40 per year) air transportation incidents/accidents in Iowa according to the National Transportation Safety Board. Since the year 2000 only 214 air transportation incidents (around 16 per year), so the number of incidents is dropping due to advances in air transportation safety. Despite the increase in the number of people using air travel, incidents that require response personnel and involve casualties are not likely to increase due to advances 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. Probably the most significant air transportation incident occurred in 1989 when one hundred eleven (111) fatalities were recorded in the crash of United Flight 232 in Sioux City, Iowa.

According to Iowa DOT there are 2.5 million commercial service passenger boardings and nearly 250 million pounds of air cargo moved through Iowa airports annually. A 2009 Economic Impact Report estimates over $18 billion and 47,000 jobs are linked to aviation.

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 and 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 traffic accidents occur daily in Iowa and result in property damage and injury, major accidents involving multiple vehicles and serious injury are not uncommon. The map at right depicts 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 improved, highway incidents continue to occur. 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 Iowa Motor Vehicle Crashes 1990-2011 chart below displays Iowa DOT statistics for crashes, fatal crashes, and motor vehicle fatality numbers by year.

Iowa Motor Vehicle Crashes 1990-2010

Year	Total Crashes	Fatal Crashes	Fatalities
1990	71,792	403	464
1991	71,271	423	488
1992	69,261	387	436
1993	73,608	399	457
1994	74,048	416	479
1995	76,203	446	527
1996	78,357	411	465
1997	71,512	412	468
1998	64,041	381	448
1999	64,485	428	490
2000	63,364	394	445
2001	62,000	384	446
2002	56,659	372	405
2003	59,437	384	443
2004	59,128	354	388
2005	58,434	398	450
2006	54,815	386	439
2007	60,420	393	446
2008	61,195	368	412
2009	56,237	338	371
2010	54,346	348	390
2011	48,713	333	364

Source: Iowa DOT

A railway transportation incident is a train accident that directly threatens life, 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 including human error, mechanical failure, faulty signals, or problems with the track. Results of an incident can range from minor "track hops" to catastrophic hazardous material incidents with human/animal casualties.

With the 3,945 miles of track in Iowa in 2010, vehicles must cross the railroad tracks at numerous at-grade crossings. In 2012 there were 6,943 railroad crossings in Iowa with 4,348 public crossings, and 2,558 private crossings. In 2011 there were 37 highway/rail crashes. Derailments are also possible, while a major derailment would occur less frequently. In 2011 there were 45 derailments in Iowa with no injuries or fatalities reported. In Section 1.0 Community Profile or the Iowa Map Book a map can be found that depicts the active rail lines to illustrate the areas in the State most at risk for rail accidents. Iowa has 6 passenger rail stations located in Creston, Osceola, Ottumwa, Mount Pleasant, Burlington, and Fort Madison. In addition, rail accident data has been collection from the Iowa Department of Transportation by county and is presented in the map on the following page.

A waterway incident is an accident involving any water vessel that threatens life, property, or adversely affects a community's capability to provide emergency services. Waterway incidents 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 are largely 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 large-scale 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 of a major transportation incident and determined it to be occasional. Compiling a probability rating for widely disparate types of incidents from a passenger airline crash to a car accident it difficult, but is the best option with the scoring format utilized.

Iowa Hazard Priority

Further refinement of the HARA process by the SHMT grouped hazards into priority areas as illustrated on the right. 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. Priority Group III hazards are those that have an acceptable level of risk.

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 (STAPLEE). 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.

Hazard Analysis Ranking	Hazard	Scoring Total	Priority
1	River Flooding	3.55	I
2	Tornado/Windstorm	3.55	
3	Severe Winter Storm	3.25	
4	Levee/Dam Failure	3.1	
5	Terrorism	3.1	
6	Flash Flood	2.8	
7	Animal/Plant/Crop Disease	2.65	II
8	HAZMAT Incident	2.65	
9	Radiological Incident	2.65	
10	Thunderstorm/Lightning/Hail	2.6	
11	Drought	2.35	
12	Human Disease	2.35	
13	Transportation Incident	2.2	
14	Infrastructure Failure	2.05	
15	Extreme Heat	1.75	III
16	Grass/Wild Land Fire	1.75	
17	Sinkholes	1.6	
18	Landslide	1.6	
19	Earthquake	1.45	
20	Expansive Soils	1.45	

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 HARA is 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 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 used the 2010 Census Data while also analyzing periodically updated estimates of data. Development patterns from 2010-2012 according to the Iowa Library Services State Data Center remain mostly the same with most of the growth occurring in the more urban counties. Of Iowa's 99 counties there were 31 that gained population in those two years. Rural areas continue to decline in population primarily due to domestic migration. Iowa City and Des Moines/West Des Moines metro corridors are the fastest growing metropolitan areas. As populations increase in urban areas potential vulnerability will increase. In Section 1.4 Annex A many mitigation projects are documented, and while all the mitigation work Iowa has done may not be enough to significantly alter vulnerability statewide, at a local level risk has been substantially reduced. State owned and operated critical facilities are not identified in any central database. This data limitation is addressed through the ongoing SHMT coordination as each organization brings knowledge and expertise of their specific critical facilities.

3.1.1 Integrating Local Plan Risk Assessments

Coordination of local hazard mitigation planning within the framework of ongoing interagency mitigation planning efforts of the SHMT encourages locals to develop 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. Local hazard analysis and risk assessment information from Local Hazard Mitigation Plans were surveyed to see how state level hazard priority compared with local priorities. The top hazards from currently approved or active local mitigation plans were in order:

1- Tornado/Windstorm
2- Severe Winter Storm
3- Thunderstorm/lightning/hail
4- Infrastructure Failure
5- River Flooding

Analysis of the local hazard rankings provides a kind of check on state rank to make sure it makes sense. It also illustrates differences between priority levels. For example many local jurisdictions are not concerned with river flooding because they are not located near a river or stream. Iowa from a state level is very concerned about river flooding due to past experience with major floods. Additionally hazards such as lightning strikes or hail storms generally strike a small geographical area, so it makes sense that local jurisdictions would worry about them more than the State. A state-level response to a lightning strike would be rare as the local jurisdiction generally would handle the situation without help from that state. 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, and Iowa continues to look for opportunities to improve integrating local data 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. 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 Threat Information and Infrastructure Protection Program (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

Critical Asset Protection Sectors	Primary Organization of Responsibility
Agriculture-Food	Iowa Dept of Agriculture and Land Stewardship
Banking-Finance	Iowa Division of Banking
Chemical	Iowa Dept of Natural Resources
Commercial Facilities	Safeguard Iowa Partnership
Dams	Iowa Dept of Natural Resources
Defense-Infrastructure	Iowa Dept of Public Defense
Emergency Services	Iowa Dept of Homeland Security and Emergency Management
Energy	Iowa Utilities Board
Government	Iowa Dept of Homeland Security and Emergency Management
Info Tech - Telecommunication	Dept of Administrative Services – Information Technology Enterprise
Events Venues and Icons	Iowa Dept of Cultural Affairs
Education	Iowa Dept of Education
Postal-Shipping	United States Postal Service
Public Health-Healthcare	Iowa Dept of Public Health
Community Organizations	Iowa Disaster Human Resources Council
Transportation	Iowa Dept of Transportation
Water	Iowa Dept of Natural Resources

To identify vulnerabilities across the State, Iowa HSEMD is in the process of implementing two programs. First is the development of the TIIPP. The TIIPP includes critical asset protection, 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% are 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.

It was obvious that a public/private partnership needed to be established. As a result, Iowa HSEMD 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 TIIPP, 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 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 Director of HSEMD shall make the list of assets available for examination by any person upon making a written request to the Director on an approved form.
- The list may be viewed at the office of the department 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 Director has signed a nondisclosure agreement is exempt from public disclosures.
- At the Director'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 Director.

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…

5 Estimating Potential Loss by Jurisdiction

HSEMD developed an analysis and methodology that became the loss estimation model for Iowa's mitigation planning efforts. This loss estimation model is primarily historically based. It was determined to retain this methodology for consistency. The State of Iowa does engage in a kind of loss estimation during completion of the Estimated Impacts piece of the THIRA. Possible integration of THIRA materials will be explored for the next update.

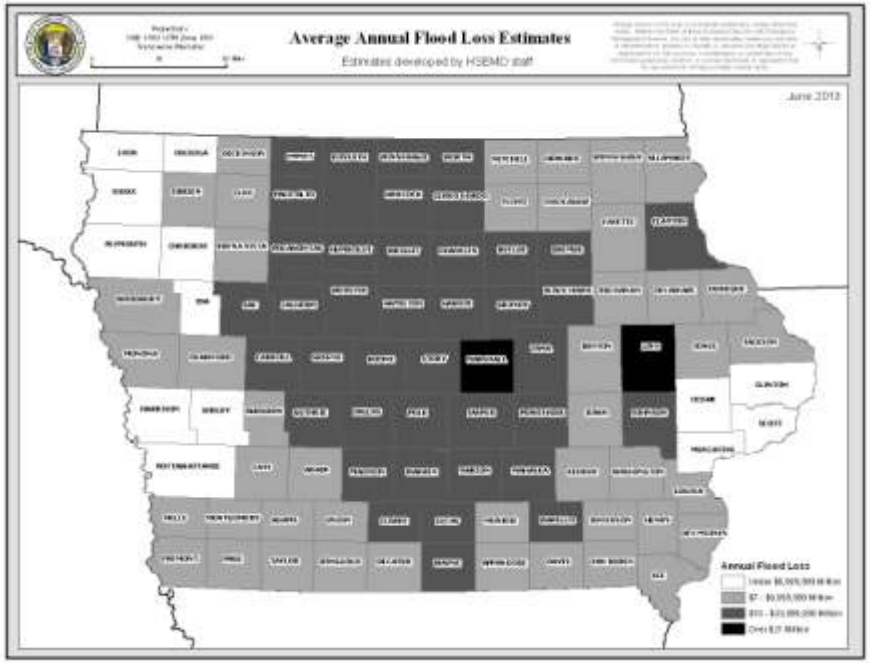
Due to data limitations sufficient data is only available for 8 hazards discussed below. Changes to the NCDC data available made continuity of historical data difficult for some hazards and impossible for others. New data was incorporated from the last three years and added to historical information from the last planning cycle for flood, tornado, and drought. Newly defined NCDC event types created further continuity problems. Winter storm event type was substituted for extreme cold, snow, and ice. Excessive heat replaced extreme heat. Hail and Lightning were compiled and combined for loss estimation of the Thunderstorm/Lightning/Hail hazard as the NCDC event thunderstorm is no longer available. Windstorm is no longer an event type in the NCDC, so it was eliminated. To retain a longer historical collection of tornado events loss estimation for Tornado/Windstorm used the tornado data. New NCDC events utilized for loss estimation include flash flooding and wildfire. The results of the loss estimation model were formulated at the state, planning region, and countywide levels. The resulting loss estimates were developed and broken into categories and types of damage, where available data allowed. They were applied as models for estimating losses from 8 hazard including flooding, tornado, winter storm, flash flood, drought, hail, lightning, excessive heat, and wildfire.

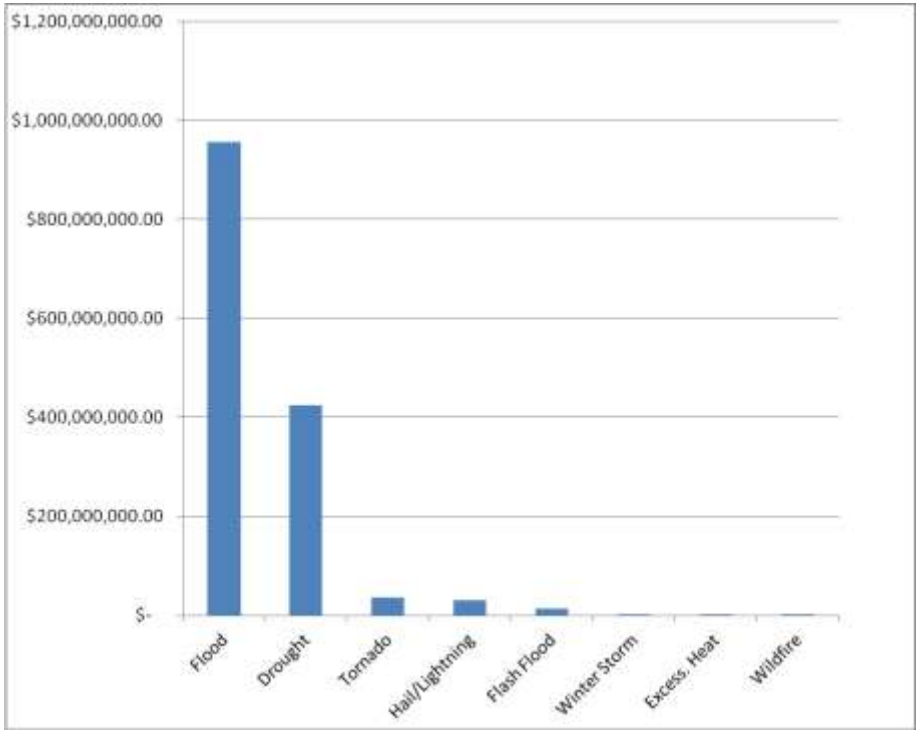
Information regarding local loss estimation has changed due to data limitations. During the period covered in this update, the attempted transition to the use of the local data mitigation plan data collection worksheet as a primary data source remains incomplete. The near complete shift to multi-jurisdictional local mitigation plans in Iowa caused the collected data to vary widely. Due to this inconsistency of results from local mitigation plans, loss estimate statewide was not practical for use as the primary data source. Data collection worksheets were helpful in validating the updated loss estimate where good locally collected data exists. The data collection sheet remains a useful tool, but it could be improved. In the future HSEMD, with input from the SHMT, will address the inconsistency in local plan loss estimation data.

In addition, some hazards were not addressed as part of the 2013 updated loss estimation due largely in part to data limitations and available criteria to evaluate loss to county jurisdictions. Hazards will continue to be evaluated for inclusion in future updates as data becomes available for use in the loss estimate.

For all 8 hazards identified, statewide annual damage parameters were established utilizing the National Climatic Data Center (NCDC) database, HAZUS published studies, the Tornado History Project, 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.

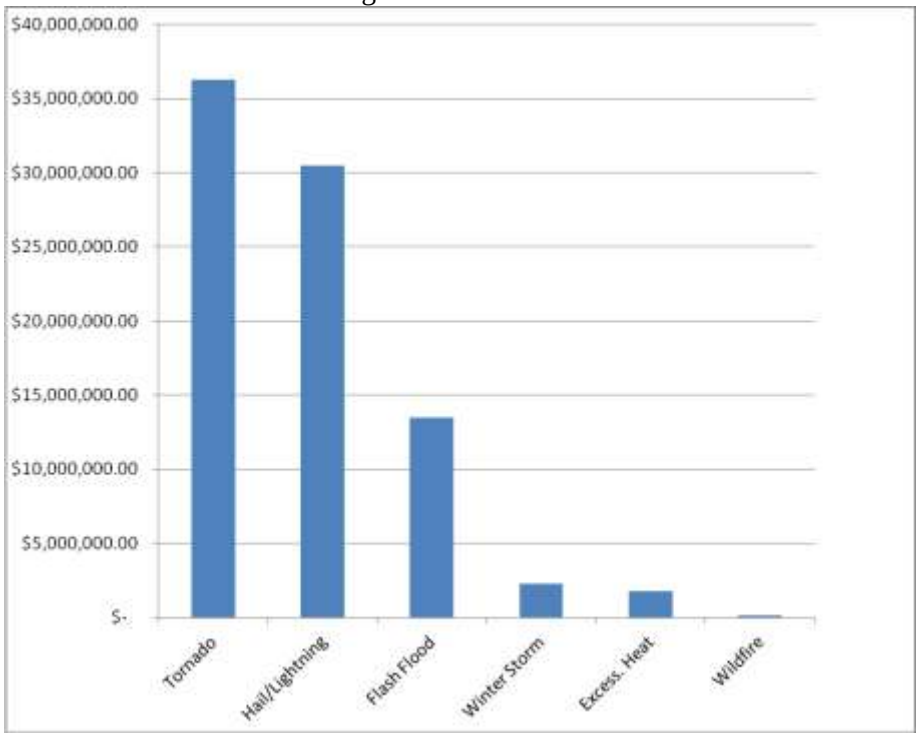
The loss estimate for each county was calculated and then summed up for each planning district, and then all 99 counties in Iowa. These loss estimates were in turn validated against relevant local data. Each county loss estimation was then validated comparatively utilizing historical data from the NCDC database and, if available, historical damage data from the Federal Emergency Management Agency (FEMA) Public Assistance Program.



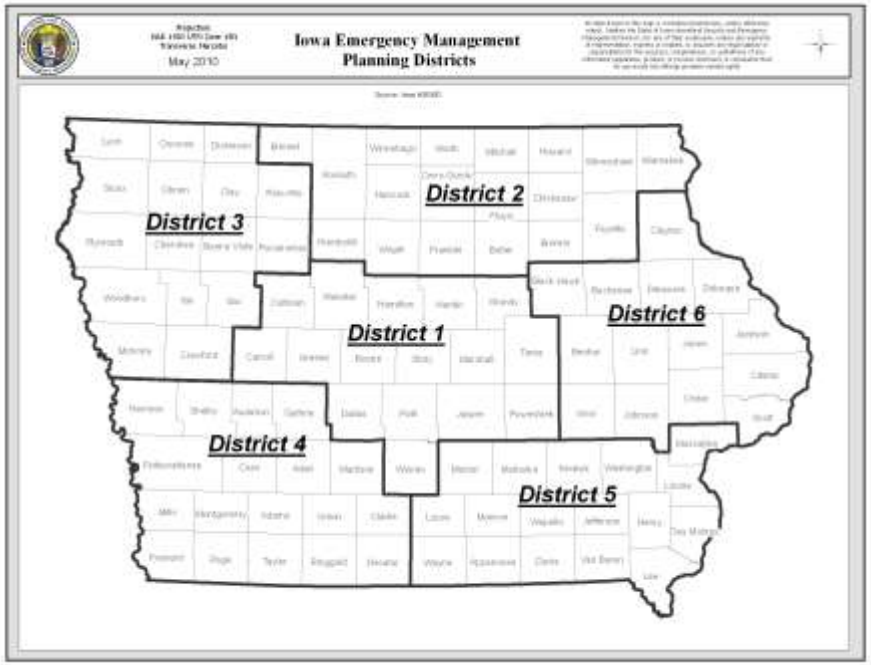


Additional information related to the methodology used in estimating losses is in Annex 1.3-A. Estimated statewide losses are largely the result of flooding, as shown in the table on the right. The estimated $955,857,750 in flooding losses represents 65.24 percent of total losses associated with natural hazards. The map above shows Average Annual Flood Loss Estimates by county. Annual estimated losses from the remaining hazards range from over $424 million to $144,375 and represented the remaining 34.76 percent of total losses. Total estimated losses from hazards were $1,465,058,265. Based on this analysis, flood mitigation activities should be a high priority for the state.

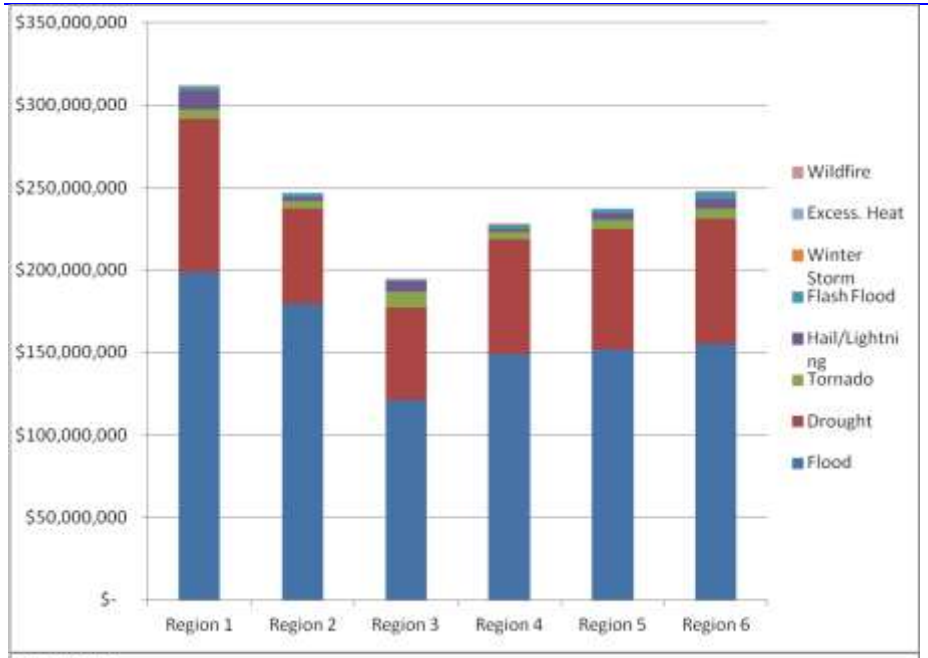
To better illustrate all the hazards, the table below includes only the losses associated with tornados through wildfire.

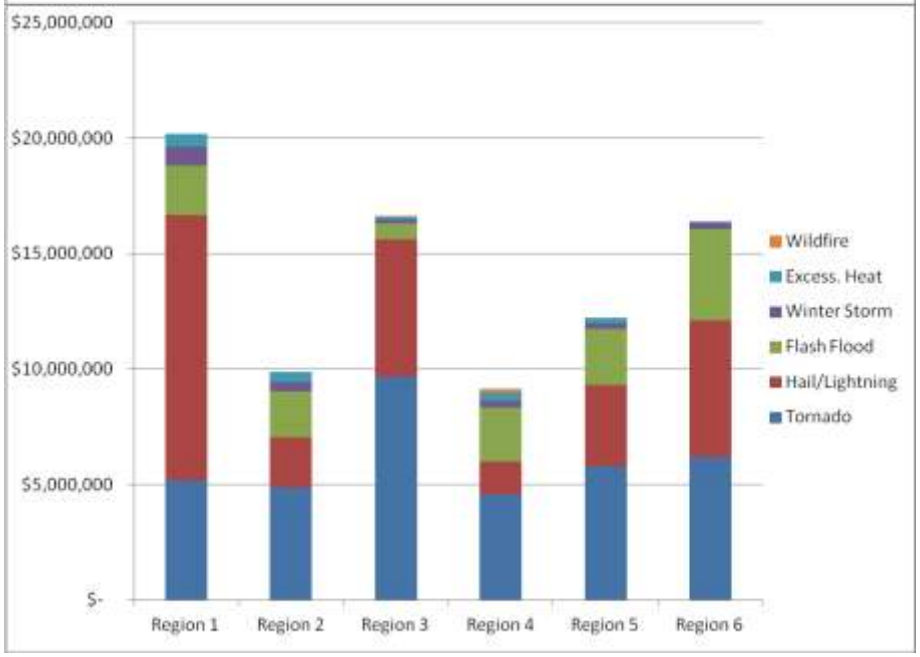


Evaluating estimated losses from hazards at a regional level indicates concentrations of losses across the state. For this evaluation, the state was broken down into the existing six planning districts, as shown in the chart on the following page. Central, northern, and eastern Iowa show slightly higher levels of estimated losses to hazards than other regions. Estimated annual losses were $311 million for Region 1 in central Iowa, $246 million for Region 2 in northern Iowa, and $247 million for Region 6 in eastern Iowa. Region 5 in southeastern Iowa had $237 million in estimated losses, followed by Region 4 located toward the southwest at $227 million, and finally Region 3 in northwest Iowa with $193 million. When looking at hazard based distribution of estimated annual losses in each region, flooding accounted for much of the damage, followed by drought, thunderstorm/lightning/hail, and tornados.



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.





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. The following tables show the statewide total and county-level breakdown for the eight hazards analyzed with dollar values in millions.

Iowa	Flood	Tornado	Winter Storm	Flash Flood
Hazard Total	$955.858	$36.249	$ 2.250	$ 13.480
Hail*	**Drought**	**Ex. Heat**	**Wildfire**	**Total**
$ 30.455	$424.833	$ 1.789	$ 0.144	$1,465.058

***Hail figure also includes lightning damage and is representative of Thunderstorm/Lightning/Hail hazard identified in the Risk Assessment**

County Annual Loss Estimation by Natural Hazard ($M)

County	Flood	Tornado	Winter Storm	Flash Flood
Adair	$ 9.697	$ 0.075	$ 0.034	$ 0.083
Adams	$ 8.746	$ 0.468	$ 0.033	$ 0.069
Allamakee	$ 8.429	$ 0.053	$ 0.000	$ 0.435
Appanoose	$ 9.672	$ 0.100	$ 0.030	$ 0.275
Audubon	$ 9.501	$ 0.001	$ 0.033	$ 0.098
Benton	$ 7.830	$ 0.063	$ -	$ 0.043
Black Hawk	$ 12.185	$ 0.896	$ 0.209	$ 0.203
Boone	$ 10.730	$ 0.487	$ 0.035	$ 0.075
Bremer	$ 11.458	$ 0.104	$ 0.034	$ 0.127
Buchanan	$ 7.945	$ 0.102	$ 0.058	$ 0.177
Buena Vista	$ 7.018	$ 0.070	$ -	$ 0.020
Butler	$ 12.512	$ 1.276	$ 0.035	$ 0.038
Calhoun	$ 10.009	$ 0.488	$ 0.032	$ 0.086
Carroll	$ 11.760	$ 0.035	$ 0.038	$ 0.026
Cass	$ 9.355	$ 0.080	$ 0.034	$ 0.142
Cedar	$ 0.156	$ 0.139	$ -	$ 0.013
Cerro Gordo	$ 11.423	$ 0.066	$ 0.029	$ 0.168
Cherokee	$ 6.733	$ 0.083	$ 0.029	$ 0.018
Chickasaw	$ 7.309	$ 0.079	$ 0.037	$ 0.059
Clarke	$ 11.045	$ 0.032	$ 0.013	$ 0.042
Clay	$ 9.319	$ 0.031	$ 0.004	$ -
Clayton	$ 10.721	$ 0.415	$ -	$ 0.214
Clinton	$ 0.328	$ 0.610	$ -	$ 0.055
Crawford	$ 9.484	$ 0.121	$ 0.031	$ 0.015
Dallas	$ 12.538	$ 0.068	$ 0.037	$ 0.121
Davis	$ 9.146	$ 0.464	$ 0.026	$ 0.146
Decatur	$ 9.698	$ 0.882	$ 0.011	$ 0.065
Delaware	$ 9.106	$ 0.517	$ 0.002	$ 1.976
Des Moines	$ 7.771	$ 0.071	$ -	$ 0.323
Dickinson	$ 7.058	$ 0.176	$ 0.023	$ -
Dubuque	$ 8.994	$ 0.459	$ -	$ 0.701
Emmet	$ 10.971	$ 0.049	$ 0.029	$ 0.098

County	Flood	Tornado	Winter Storm	Flash Flood
Fayette	$ 8.812	$ 0.535	$ 0.009	$ 0.104
Floyd	$ 7.438	$ 0.418	$ 0.007	$ 0.052
Franklin	$ 12.193	$ 0.050	$ 0.032	$ 0.036
Fremont	$ 9.068	$ 0.100	$ -	$ 0.008
Greene	$ 11.871	$ 0.016	$ 0.035	$ 0.046
Grundy	$ 11.346	$ 0.103	$ 0.035	$ 0.073
Guthrie	$ 11.288	$ 0.048	$ 0.035	$ 0.112
Hamilton	$ 11.610	$ 0.649	$ 0.033	$ 0.049
Hancock	$ 10.715	$ 0.197	$ 0.032	$ 0.012
Hardin	$ 12.528	$ 0.544	$ 0.035	$ 0.050
Harrison	$ 3.264	$ 0.078	$ -	$ 1.154
Henry	$ 7.923	$ 0.034	$ -	$ 0.021
Howard	$ 8.103	$ 0.058	$ 0.006	$ 0.086
Humboldt	$ 11.956	$ 0.086	$ 0.031	$ 0.041
Ida	$ 6.718	$ 0.094	$ -	$ -
Iowa	$ 8.596	$ 0.472	$ -	$ 0.105
Jackson	$ 7.465	$ 0.065	$ -	$ 0.141
Jasper	$ 12.345	$ 0.099	$ 0.055	$ 0.007
Jefferson	$ 7.847	$ 0.448	$ -	$ 0.012
Johnson	$ 20.021	$ 0.477	$ -	$ 0.115
Jones	$ 9.124	$ 0.563	$ -	$ 0.090
Keokuk	$ 7.949	$ 0.471	$ -	$ 0.010
Kossuth	$ 12.574	$ 0.991	$ 0.032	$ 0.102
Lee	$ 8.335	$ 0.046	$ -	$ 0.159
Linn	$ 45.587	$ 0.515	$ -	$ 0.043
Louisa	$ 8.120	$ 0.444	$ -	$ 0.073
Lucas	$ 11.296	$ 0.404	$ 0.011	$ 0.169
Lyon	$ 0.405	$ 0.159	$ -	$ 0.314
Madison	$ 10.597	$ 0.024	$ 0.037	$ 0.030
Mahaska	$ 13.043	$ 0.434	$ 0.070	$ 0.232
Marion	$ 12.165	$ 0.037	$ 0.038	$ 0.111
Marshall	$ 26.027	$ 0.497	$ 0.092	$ 0.080
Mills	$ 7.337	$ 0.010	$ -	$ 0.192

County	Flood	Tornado	Winter Storm	Flash Flood
Mitchell	$ 8.329	$ 0.014	$ 0.011	$ 0.218
Monona	$ 8.513	$ 3.980	$ -	$ 0.111
Monroe	$ 9.131	$ 0.416	$ 0.030	$ 0.080
Montgomery	$ 8.350	$ 0.023	$ -	$ 0.087
Muscatine	$ 0.345	$ 0.289	$ -	$ 0.004
O'Brien	$ 7.003	$ 0.058	$ -	$ 0.008
Osceola	$ 6.978	$ 0.145	$ -	$ -
Page	$ 8.476	$ 0.188	$ -	$ -
Palo Alto	$ 10.026	$ 0.104	$ 0.031	$ 0.030
Plymouth	$ 6.719	$ 0.229	$ -	$ -
Pocahontas	$ 10.375	$ 0.378	$ 0.032	$ 0.025
Polk	$ 15.971	$ 0.780	$ 0.057	$ 0.930
Pottawattamie	$ 2.580	$ 1.355	$ -	$ 0.005
Poweshiek	$ 11.062	$ 0.211	$ 0.095	$ 0.015
Ringgold	$ 8.973	$ 0.536	$ 0.013	$ 0.086
Sac	$ 10.307	$ 0.167	$ 0.032	$ 0.063
Scott	$ 0.404	$ 0.574	$ -	$ 0.091
Shelby	$ 6.406	$ 0.089	$ -	$ -
Sioux	$ 0.418	$ 0.152	$ -	$ 0.004
Story	$ 14.804	$ 0.536	$ 0.052	$ 0.155
Tama	$ 11.685	$ 0.528	$ 0.134	$ 0.078
Taylor	$ 8.712	$ 0.386	$ 0.031	$ 0.019
Union	$ 8.756	$ 0.564	$ 0.034	$ 0.125
Van Buren	$ 7.891	$ 0.070	$ -	$ 0.041
Wapello	$ 11.132	$ 0.463	$ 0.032	$ 0.243
Warren	$ 11.053	$ 0.061	$ 0.033	$ 0.051
Washington	$ 7.945	$ 0.642	$ -	$ 0.136
Wayne	$ 11.050	$ 0.622	$ 0.013	$ 0.371
Webster	$ 11.880	$ 0.065	$ 0.033	$ 0.305
Winnebago	$ 10.812	$ 0.146	$ 0.029	$ 0.026
Winneshiek	$ 8.105	$ 0.098	$ 0.001	$ 0.207
Woodbury	$ 7.231	$ 4.047	$ 0.004	$ 0.046
Worth	$ 10.688	$ 0.207	$ 0.025	$ 0.052
Wright	$ 11.437	$ 0.405	$ 0.029	$ 0.127

County	Hail*	Drought	Ex. Heat	Wildfire	Total
Adair	$ 0.068	$ 7.822	$ 0.034	$ -	$ 17.813
Adams	$ 0.042	$ 7.822	$ 0.034	$ -	$ 17.214
Allamakee	$ 0.026	$ 0.361	$ 0.006	$ -	$ 9.310
Appanoose	$ 0.043	$ 7.822	$ 0.034	$ -	$ 17.977
Audubon	$ 0.034	$ 7.822	$ 0.034	$ -	$ 17.523
Benton	$ 0.163	$ 1.736	$ -	$ -	$ 9.834
Black Hawk	$ 0.330	$ 7.028	$ 0.034	$ -	$ 20.884
Boone	$ 0.096	$ 7.568	$ 0.034	$ -	$ 19.024
Bremer	$ 0.022	$ 7.028	$ 0.034	$ -	$ 18.806
Buchanan	$ 0.192	$ 1.187	$ -	$ -	$ 9.661
Buena Vista	$ 0.010	$ -	$ -	$ -	$ 7.118
Butler	$ 0.068	$ 7.028	$ 0.034	$ -	$ 20.990
Calhoun	$ 1.911	$ 7.028	$ 0.034	$ -	$ 19.586
Carroll	$ 0.081	$ 7.568	$ 0.034	$ -	$ 19.542
Cass	$ 0.096	$ 7.822	$ 0.034	$ -	$ 17.562
Cedar	$ 0.031	$ 1.736	$ -	$ -	$ 2.075
Cerro Gordo	$ 0.064	$ 6.667	$ 0.034	$ -	$ 18.452
Cherokee	$ 0.001	$ -	$ -	$ -	$ 6.864
Chickasaw	$ 0.042	$ 0.361	$ 0.008	$ -	$ 7.894
Clarke	$ 0.033	$ 7.822	$ 0.034	$ 0.005	$ 19.026
Clay	$ 1.856	$ -	$ -	$ 0.002	$ 11.212
Clayton	$ 0.581	$ 0.361	$ 0.006	$ -	$ 12.298
Clinton	$ 0.012	$ 1.736	$ -	$ -	$ 2.741
Crawford	$ 0.140	$ 7.568	$ 0.034	$ -	$ 17.392
Dallas	$ 0.140	$ 7.822	$ 0.034	$ -	$ 20.760
Davis	$ 0.165	$ 7.822	$ 0.034	$ -	$ 17.804
Decatur	$ 0.038	$ 7.822	$ 0.034	$ -	$ 18.548
Delaware	$ 0.262	$ 1.736	$ -	$ -	$ 13.598
Des Moines	$ 0.839	$ 1.736	$ -	$ -	$ 10.740
Dickinson	$ 0.053	$ -	$ -	$ -	$ 7.310
Dubuque	$ 0.081	$ 1.736	$ -	$ -	$ 11.970
Emmet	$ 0.049	$ 7.028	$ 0.034	$ -	$ 18.257

***Hail figure also includes lightning damage and is representative of Thunderstorm/Lightning/Hail hazard identified in the Risk Assessment**

County	Hail*	Drought	Ex. Heat	Wildfire	Total
Fayette	$ 0.514	$ 0.361	$ 0.007	$ -	$ 10.341
Floyd	$ 0.103	$ -	$ 0.011	$ -	$ 8.029
Franklin	$ 0.031	$ 7.028	$ 0.034	$ -	$ 19.404
Fremont	$ 0.006	$ -	$ -	$ -	$ 9.181
Greene	$ 0.035	$ 7.568	$ 0.034	$ -	$ 19.603
Grundy	$ 0.981	$ 7.028	$ 0.034	$ -	$ 19.600
Guthrie	$ 0.084	$ 7.822	$ 0.034	$ -	$ 19.423
Hamilton	$ 0.067	$ 7.028	$ 0.034	$ -	$ 19.469
Hancock	$ 0.047	$ 6.667	$ 0.034	$ -	$ 17.702
Hardin	$ 4.593	$ 7.028	$ 0.034	$ -	$ 24.811
Harrison	$ 0.006	$ -	$ -	$ -	$ 4.501
Henry	$ 0.027	$ 1.736	$ -	$ -	$ 9.740
Howard	$ 0.029	$ 0.361	$ 0.004	$ -	$ 8.647
Humboldt	$ 0.037	$ 7.028	$ 0.034	$ -	$ 19.212
Ida	$ 0.004	$ -	$ -	$ -	$ 6.816
Iowa	$ 0.155	$ 1.736	$ -	$ -	$ 11.064
Jackson	$ 1.180	$ 1.736	$ -	$ -	$ 10.587
Jasper	$ 0.169	$ 7.822	$ 0.034	$ -	$ 20.531
Jefferson	$ 0.048	$ 1.736	$ -	$ -	$ 10.090
Johnson	$ 2.442	$ 1.736	$ -	$ -	$ 24.791
Jones	$ 0.024	$ 1.736	$ -	$ -	$ 11.537
Keokuk	$ 0.062	$ 1.736	$ -	$ -	$ 10.227
Kossuth	$ 0.077	$ 12.361	$ 0.034	$ -	$ 26.170
Lee	$ 1.451	$ 1.736	$ -	$ -	$ 11.727
Linn	$ 0.383	$ 1.736	$ -	$ -	$ 48.264
Louisa	$ 0.387	$ 1.736	$ -	$ -	$ 10.759
Lucas	$ 0.030	$ 7.822	$ 0.034	$ -	$ 19.765
Lyon	$ 0.018	$ -	$ -	$ -	$ 0.895
Madison	$ 0.064	$ 7.822	$ 0.034	$ -	$ 18.608
Mahaska	$ 0.087	$ 7.822	$ 0.034	$ -	$ 21.721
Marion	$ 0.051	$ 7.822	$ 0.034	$ -	$ 20.257
Marshall	$ 0.086	$ 7.568	$ 0.034	$ -	$ 34.384
Mills	$ 0.015	$ -	$ -	$ -	$ 7.555

***Hail figure also includes lightning damage and is representative of Thunderstorm/Lightning/Hail hazard identified in the Risk Assessment**

County	Hail*	Drought	Ex. Heat	Wildfire	Total
Mitchell	$ 0.040	$ 0.361	$ 0.017	$ -	$ 8.990
Monona	$ -	$ -	$ -	$ -	$ 12.604
Monroe	$ 0.034	$ 7.822	$ 0.034	$ -	$ 17.547
Montgomery	$ -	$ -	$ -	$ -	$ 8.460
Muscatine	$ 0.033	$ 1.736	$ -	$ -	$ 2.407
O'Brien	$ 0.825	$ -	$ -	$ 0.013	$ 7.906
Osceola	$ 0.088	$ -	$ -	$ -	$ 7.210
Page	$ 0.002	$ -	$ -	$ -	$ 8.666
Palo Alto	$ 0.338	$ 7.028	$ 0.034	$ -	$ 17.591
Plymouth	$ 0.013	$ -	$ -	$ -	$ 6.960
Pocahontas	$ 0.046	$ 7.028	$ 0.034	$ -	$ 17.918
Polk	$ 0.872	$ 7.822	$ 0.034	$ -	$ 26.466
Pottawattamie	$ 0.001	$ -	$ -	$ 0.125	$ 4.066
Poweshiek	$ 0.102	$ 7.822	$ 0.034	$ -	$ 19.341
Ringgold	$ 0.632	$ 7.822	$ 0.034	$ -	$ 18.096
Sac	$ 2.110	$ 7.568	$ 0.034	$ -	$ 20.281
Scott	$ 0.044	$ 1.736	$ -	$ -	$ 2.848
Shelby	$ 0.002	$ -	$ -	$ -	$ 6.497
Sioux	$ 0.197	$ -	$ -	$ -	$ 0.770
Story	$ 0.166	$ 7.568	$ 0.034	$ -	$ 23.315
Tama	$ 0.040	$ 7.568	$ 0.034	$ -	$ 20.066
Taylor	$ 0.226	$ 7.822	$ 0.034	$ -	$ 17.229
Union	$ 0.089	$ 7.822	$ 0.034	$ -	$ 17.424
Van Buren	$ 0.016	$ 1.736	$ -	$ -	$ 9.753
Wapello	$ 0.052	$ 7.822	$ 0.034	$ -	$ 19.779
Warren	$ 0.105	$ 7.822	$ 0.034	$ -	$ 19.158
Washington	$ 0.144	$ 1.736	$ -	$ -	$ 10.603
Wayne	$ 0.040	$ 7.822	$ 0.034	$ -	$ 19.951
Webster	$ 2.031	$ 7.028	$ 0.034	$ -	$ 21.375
Winnebago	$ 0.151	$ 7.028	$ 0.034	$ -	$ 18.226
Winneshiek	$ 0.813	$ 0.361	$ 0.009	$ -	$ 9.594
Woodbury	$ 0.246	$ -	$ -	$ -	$ 11.574
Worth	$ 0.037	$ 7.028	$ 0.034	$ -	$ 18.072
Wright	$ 0.057	$ 7.028	$ 0.034	$ -	$ 19.116

4.2 Estimating Potential Losses of State Facilities

Iowa HSEMD maintains 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 vast majority of the assets is privately owned. Close to 550 assets are publicly owned, either at the local, state or federal levels. The vast majority of these publicly owned assets are either state-owned or locally owned with state offices within the facility, e.g. County Courthouses.

Much of the state facilities data has not changed significantly in the last three years. Some information concerning state owned information technology (IT) equipment and property was gleaned from routine data inquiries for the update of the plan. While the majority of state IT resources are located in facilities already accounted for in this section it bears mentioning. The Department of Administrative Services – Information Technology Enterprise (DAS-ITE) owns IT equipment for backup and support of a variety of state functions. Additionally DAS-ITE owns backup tapes for certain systems that are stored at National Records Management offsite at a private facility. Some IT facilities may be located in a floodplain, but in the event these locations were lost it would not impair critical business functions for the State due to the existence of networking switches, built in redundancy, and other continuity of government measures.

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 primary hazard dataset was FEMA Q3 Floodplain data. 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. Discussion with relevant HSMED staff on vulnerability of state assets to additional tier one hazards included Tornado/Windstorm, Severe Winter Storm, and Flash Flooding having similar vulnerability as any building. While many state owned buildings do not have tornado safe rooms they do have identified shelter areas and procedures. A catastrophic failure of the dam at Saylorville Reservoir would impact several state assets. Iowa HSEMD and DAS-ITE provide training and technical assistance in threat assessment and security measures and procedures to reduce vulnerability to terrorism.

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 roughly 900 buildings, 70+ sites, 11.7 million square feet and a replacement value of $2.5 billion.

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
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**

Hazard Specific potential loss would likely not be the same as replacement cost. Replacement cost continued to be the best available data for this update. For example potential losses for flooding would likely include basement and first floor damages while damage from a severe winter storm would likely be to the roof of the building.